

**PROCEEDINGS  
OF THE  
22nd, ANNUAL MEETING  
FERTILIZER INDUSTRY  
ROUND TABLE  
1972**

**November 1, 2, 3, 1972  
Sheraton-Peabody Hotel  
Memphis, Tenn.**

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**Editor**

**Albert Spillman**



THIS ISSUE OF THE  
PROCEEDINGS  
IS  
DEDICATED TO THE MEMORY  
OF  
HOUSDEN LANE MARSHALL  
OUR  
SECRETARY-TREASURER  
1951-1971





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Suffolk, England

Adolfo Sisto  
Gerente De Operation,  
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De Mexico, S.A.,  
Av Insurgentes Sur 1079 Pisco,  
Mexico 18, D. F.

Rodger C. Smith  
Manager Market Development,  
Amex Chemical Corp.,  
1270 Ave. of Americas,  
New York, N.Y.

Albert Spillman  
4005 Glen Avenue  
Baltimore, Md., 21215

Joseph B. Spillman  
Director of Sales,  
National Accounts,  
Central Chemical Corp.,  
Hagerstown, Md., 21740

Dan O. Walstad  
Production Manager,  
Plant Food Dept.,  
American Cyanamid Co.,  
Princeton, N. J., 08540

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340 Stevenson Lane  
Baltimore, Md., 21204

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# Index of Participants in Program

Frank P. Achorn  
Head, Process Products  
Improvements,  
Tennessee Valley Authority,  
Muscle Shoals, Alabama, 35660

Billy E. Adams,  
Manager Eastern Division,  
Agricultural Chemicals,  
Allied Chemical Corp.,  
Hopewell, Virginia, 23860

Ronald E. Ashcroft,  
V.P. Manufacturing,  
Wycon Chemical Co.,  
Cheyenne, Wyoming, 82001

Tom Athey,  
3403 Rodman Avenue,  
Washington, D.C. 20008

Hubert L. Balay,  
Chemical Engineer,  
Tennessee Valley Authority,  
Muscle Shoals, Alabama, 35660

Phillip D. Bleser,  
Application Engineer,  
W. S. Tyler Co.,  
Menton, Ohio, 44060

Theodore C. Byerly,  
Asst. Director of Science,  
And Education Coordinator,  
Environmental Qual. Activities,  
Office of the Secretary,  
U.S. Dept. of Agriculture,  
Washington, D. C.

Ben F. Day,  
Asst. Vice Pres.,  
Member Services,  
The Fertilizer Institute,  
1015 18th St., N.W.,  
Washington, D. C., 20036

D. L. Dibble,  
Director of Production,  
Rainbow Division,  
International Minerals  
and Chemical Corp.  
Atlanta, Georgia

Geoffrey Drake,  
Chief Chemical Engineer,  
Technical Development Div.,  
Fisons Limited,  
Levington Research Station,  
Levington, Ipswich Suffolk,  
England

Travis P. Hignett,  
Director Chemical Development,  
Tennessee Valley Authority,  
Muscle Shoals, Alabama, 35660

George Hoffmeister, Supervisor,  
Evaluation Section Applied  
Research,  
Tennessee Valley Authority,  
Muscle Shoals, Alabama, 35660

Thomas Hogan,  
Farmers Chemical Association,  
Tunnis Complex Plant,  
Tunis, North Carolina

Allen Jackson, V.P.,  
Fesco, Inc.  
Atlanta, Georgia, 30340.

Stephen J. Janovac,  
Application Engineer,  
W. S. Tyler Co.,  
Menton, Ohio, 44060

Wayne W. King,  
Tyler Screen Co.,  
803 Kingston Road,  
Baltimore, Md., 21212

Elvis Lee,  
Farmers Chemical Asso.,  
Tunas Complex Plant,  
Tunas, North Carolina

Elmer J. Leister,  
Vice President,  
Edw. Renneberg & Sons Co.,  
Baltimore, Md., 21224

John S. Neild, Plant Supt.,  
Kerr-McGee  
Cambridge, Maryland, 21613

Jon L. Nevins,  
Agricultural Economist,  
Tennessee Valley Authority,  
Muscle Shoals, Alabama, 35660

Frank T. Nielsson,  
Technical Serv. Consultant,  
Agricultural Chemicals Div.,  
International Min. & Chem.  
Corp.,  
Libertyville, Illinois

R. H. Perkins,  
Process Quality Supervisor,  
W. R. Grace Co.,  
Memphis, Tenn., 38110

Herman G. Powers,  
Asst. Production Manager,  
Borden Chem-Smith Douglas  
Div.,  
Norfolk, Virginia, 23501

Joseph L. Prosser, President,  
Prosser Co., Inc.,  
Glen Arm, Maryland, 21067

Paul Prosser, Jr., V.P.  
Prosser Co., Inc.,  
Glen Arm, Maryland, 21067

Joseph E. Reynolds, Jr.  
Manager Mixed Fert. Div.,  
W. R. Grace Co.,  
Memphis, Tennessee, 38110

Michael J. Sackett,  
A. J. Sackett Sons Co.,  
Baltimore, Md., 21224

Walter J. Sackett, Jr.,  
Executive Vice President,  
A. J. Sackett Sons Co.,  
Baltimore, Md., 21224

Jack Seahunt,  
Farmers Chemical Assn.,  
Tunas Complex Plant,  
Tunas, North Carolina

William F. Sheldrick,  
Operations Manager,  
Fisons Limited,  
Harvest House-Felix Stowe,  
Suffolk, England

Milton R. Siegal, Chief  
Applied Research Branch,  
Tennessee Valley Auth.,  
Muscle Shoals, Alabama, 35660

Julius Silverberg,  
Chemical Engineer,  
Tennessee Valley Auth.,  
Muscle Shoals, Alabama, 35660

Adolfo Sisto,  
Gerente De Operacion,  
Guanos Y. Fertilizantes,  
De Mexico, S.A.  
Av Insurgentes Sur 1079 Pisco,  
Mexico, 18, D.F.

Rodger C. Smith,  
Manager Market Develop.  
Amax Chemical Corp.,  
1270 Ave. of Americas  
New York, N.Y.

Robert L. Sommerville,  
Robert L. Sommerville  
& Assoc.,  
Route No. 1, Box 256,  
Neshanic, N. J., 08853

Albert Spillman,  
4005 Glen Avenue,  
Baltimore, Md., 21215

R. O. Tayloe, Asst. Mgr.,  
Fertilizer Section,  
Smith-Douglas Div-Borden,  
Norfolk, Va., 23501

Hovey Tinsman,  
Chemical Engineer,  
Twin State Chem. Eng. Co.,  
Davenport, Iowa

E. K. Thompson, Sales Engin.  
Atlanta Utilities Works,  
East Point, Georgia, 30349

Tomoaki Tsuno, Chem. Engin.  
Research and Quality Control,  
Mitsubishi Chem. Industries  
Ltd.  
Kutosaki Plant,  
Jurosaki-Yahata-Ku,  
Kitakusho, Japan

William A. Wilson,  
Compliance Officer,  
Occupational Safety  
and Health Act Admin.  
1600 Hays St.,  
Nashville, Tenn., 37203

Ronald D. Young,  
Chemical Engineer,  
Tennessee Valley Auth.,  
Muscle Shoals, Ala., 35660

Note: There were more participants who did not announce their names when asking or answering questions.

# Wednesday, November 1, 1972

## Morning Session

Moderator: Herman G. Powers, Chairman

CHAIRMAN POWERS: Good morning! On behalf of your Directors, I extend to you a most cordial welcome to the 22nd Fertilizer Industry Round Table.

Every man in this room has one thing in common. In fact, every human being in this city, state, country and the world has this same thing in common — Appetite. Of all the common denominators, man's appetite for food is the oldest and never ending.

The second thing that is common to every person in this room is that in some way he is part of the Industry that plays a most important part in satisfying man's appetite to live on the Universe.

The third thing that is common to everyone in this room is that he has a desire to improve himself — to be a better man in his Industry. He has elected to come here today and devote some of his time to learning more about the Industry in which he makes his living.

These three points are common to every man in this room.

Your Directors have met several times since the last Round Table and our main effort has been to arrange a program designed by your requests — a program that is *your* Round Table, *your* forum. I am sure that some of you can appreciate that it is a most difficult job to provide a program that appeals to everyone. There are certain things on our minds today that are far from our concerns of yesterday. Taking priority in our surveys were requests for discussions on the Occupational Safety and Health Act. And along with that, that continues and will continue, the environmental problems that we are faced with in our industry. Also, in our program we want to keep up, so we have some speakers on new production techniques including speakers from overseas. There will also be discussion on the problem of  $P_2O_5$  world supply. Getting back to home — *analysis guarantees*, that all of us in the production business and selling business are faced with this problem.

So, this is your forum for exchanging ideas. For some it will be the one opportunity you have this year to expose yourself to some facets of your Industry that are not routine. By learning something about these, you will be a better member of your Industry.

Last year we took on the tables in the afternoon and had a very favorable response. I like to look at these tables as part of our program that maybe we could consider a solution oriented approach, where you can get down with some of the speakers on an informal basis and ask questions and have a fruitful discussion.

And last, but not least, the forum gives you the opportunity to make contacts with others in your Industry on a social basis whether it be in the halls or at dinner together, or what have you. I think we have a very challenging, a very interesting program for you and we will now get started.

As is the pattern of life — a gentlemen that was most active in the affairs of the Fertilizer Industry Round Table from its very beginning is no longer with us — Doc. Marshall. Al Spillman will make a few remarks to you about Doc.

## HOUSDEN LANE MARSHALL

1902 — 1972

*Albert Spillman*

With a heavy heart and much sadness I report to you that Housden Lane Marshall, our Secretary-Treasurer for 21 years, and one of the Founders of Our Round Table, died on May 27, 1972, at age 70, at Montgomery County Hospital, La Plata, Maryland, after a short illness.

Housden known to all of us and throughout The Fertilizer Industry was a most faithful, hard working Secretary-Treasurer, always working to improve the image of our Round Table. Housden was a kind man, cheerful, agreeable and always ready to help. He lived and loved our Round Table. All of us are indebted to Housden for a great job well done.

Housden was born in Cleveland, Ohio, and moved to Washington, D.C. at an early age. He graduated from McKinley High School, Washington. He received his B.S. and Masters Degrees from The University of Maryland, with a major in Chemistry.

From 1930-42 Housden was employed doing fertilizer research for U.S.D.A., Beltsville, Maryland and at T.V.A., Knoxville, Tenn., 1942-44. He was with Virginia Smelting Co., Norfolk, Va., working on Fertilizer Chemical

Research, 1944-46, and with Southern Acid and Sulphur Co., Little Rock, Ark., 1946-49. Olin-Mathieson purchased Southern Acid in 1949, at which time "Doc" was transferred to The Olin Fertilizer Plant in Baltimore, Md. with the Title "Chief Chemist". He retired from Olin in March, 1967.

Housden was a member of The American Chemical Society, The American Men Of Science and The Alpha Chi Sigma Chemical Fraternity. He is survived by his wife Agnes, a son Dr. John H. L. Marshall, Memphis, Tennessee, and three daughters, Mrs. Paula Clark Marshall Gray, Port Tobacco, Md., Mrs. Lane M. Debevoise, Potomac, Md. and Mrs. Eugenic M. Tomorria, Silver Spring, Md. and ten grandchildren.

On behalf of the Round Table members, our Secretary-Treasurer, Paul Prosser, sent a letter June 6, 1972, to Mrs. Housden Lane Marshall and I quote.

"Dear Mrs. Marshall: All of us were shocked and saddened on learning, through your letter June 1, 1972, of the passing of Mr. Marshall. On behalf of all the Directors and Members of The Fertilizer Industry Round Table, may I extend to you, our sincere sympathy and offer our condolences to you and the other members of your family. "Doc" Marshall will long be remembered with affection and respect by all of the members of The Round Table. His many years of unselfish work on its behalf, and his stout defenses of its structure and aims will not be soon forgotten. We all acknowledge our indebtedness to him for those effective and productive efforts" End of Quote."

Continued by Spillman. "Now Housden, I am talking to you. We miss you at this meeting and we are grateful to you for the guidance and advice you have given us for the past 21 years. We are going to do our best to keep the Round Table operating on the highest level possible and we shall always be thinking of you." "God Bless You."

It will be appropriate at this time for all of us to stand in silent prayer for one minute to register our great sorrow and devotion for our Departed Friend Housden Lane Marshall. Thank you very much.

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CHAIRMAN POWERS: We are most fortunate to have as our Keynote Speaker, Dr. Theodore C. Byerly of the United States Department of Agriculture. Dr. Byerly whose title is Assistant Director of Science and Education and Coordinator of Environmental Quality Activities, works directly in the office of the Secretary, comes to us with a most distinguished career. Dr. Byerly was born in Iowa, got his doctorate at the University of Iowa, has been a teacher, and served in many research projects and in administrative capacities in the Department of Agriculture. In his present position Dr. Byerly is responsible for the coordination of all the Department of Agriculture programs

related to environmental quality and for coordination of such activities with other agencies. Dr. Byerly holds a Borden Award for 1943, the U.S.D.A. distinguished service award for 1965. Of the many societies of which he is a member, one is the American Association for the Advancement of Science Council and various committees of many others. It is now my pleasure to introduce you to Dr. Byerly.

## FERTILIZER, FOOD, FIBER, FORESTS, AND THE ENVIRONMENT

*Theodore C. Byerly*

The Cultivated area of the world amounts to about 1.42 billion hectares, a little more than 10 percent of the land surface. The population of the world is expected to reach about seven billion in Year 2000 which may be compared to about 3.65 billion in 1969.

The world can feed itself in Year 2000 by increasing yields on the present cultivated area, increase the cultivated area, or tighten belts.

The first course would require greatly increased use of fertilizer with some increase in eutrophication of waters. The second course would sacrifice grasslands and forests with loss of wildlife habitat and increase in wind and water erosion and consequent increase in sediment in our air and water. The third course would increase the proportion of the world's people undernourished or malmourished.

Table 1 shows the number of people in the world and its major geographic regions and certain of its largest countries in 1950 and 1969. As a whole, the population grew by 46 percent during this period. Population is likely to be double the 1969 figure by Year 2000.

Table 2 shows the land resource total and by principal use for the world its principal regions and for certain major countries.

Table 3 shows the plant nutrients consumed in the world, principal regions, and certain major countries in 1950 and 1970.

Table 4 shows wheat and rice yields in 1950 and 1970.

In 1969, food and fiber used by the people of the United States required an estimated 16.8 million metric tons of nitrogen for its production.<sup>(3)</sup> About 15.1 million metric tons were required to produce the animal protein we ate and about 0.9 million tons to produce the vegetable protein.

The people of the United States ate about 1.2 million metric tons of nitrogen of which about 70 percent was animal protein.

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[3] Accumulation of Nitrate. National Academy of Sciences, pp. VII plus 106 illustrations. Committee composed of Martin Alexander, Chairman, Thomas J. Army, Frederick J. deSerres, Charles R. Frink, Victor J. Kilmer, Thurston E. Larson, Norton Nelson, W. H. Pfander, Gerard A. Rohlich, Perry R. Stout, and Sylvan H. Wittwer. Published in 1972.

TABLE 1. World and Major Area and Country Populations  
1950 and 1969 (Billions)

Area	Year		Area	Year	
	1950	1969		1950	1969
World	2.50	3.65	Africa	0.19	0.27
Europe	0.39	0.46	Oceania	0.012	0.02
North America	0.17	0.22	U.S.S.R.	0.18	0.24
Latin America	0.16	0.28	Mainland China	0.55	0.83
Near East	0.10	0.17	United States	0.15	0.20
Far East	0.75	1.13	Brazil	0.053	0.09

Table 2 shows the land resource total and by principal use for the world its principal regions and for certain major countries.

TABLE 2. Land and Land Use -- World's Principal Regions and Certain Major Countries - 1969

Region	Land	Cultivated Land	Grassland	Forest & Woodland	Other Land
World	13.39	1.42	3.00	4.05	4.88
Europe	0.49	0.15	0.09	0.14	0.11
North America	1.97	0.22	0.28	0.74	0.73
Latin America	2.06	0.12	0.50	1.00	0.43
Near East	1.20	0.08	0.19	0.14	0.81
Far East	1.12	0.27	0.11	0.45	0.29
Africa	2.51	0.19	0.82	0.56	0.94
Oceania	0.85	0.05	0.46	0.08	0.26
U.S.S.R.	2.24	0.23	0.39	0.91	0.72
China	0.96	0.11	0.18	0.08	0.59
(U.S.A.)	0.94	0.19	0.26	0.30	0.20
(Brazil)	0.85	0.03	0.11	0.52	(0.19)

Cultivated land per capita varied from about 0.25 hectare in Mainland China to about 2.5 per capita in Oceania in 1969.



Table 3 shows the plant nutrients consumed in the world, principal regions, and certain major countries in 1950 and 1970.

TABLE 3. Plant Nutrients Consumed (Thousands of Metric Tons)<sup>1/</sup>

Region	Nitrogen		P <sub>2</sub> O <sub>5</sub>		K <sub>2</sub> O	
	1950	1970	1950	1970	1950	1970
World	4,277	25,792	6,101	17,945	4,484	15,461
Europe	1,897	9,074	2,555	7,305	2,533	7,044
North America	1,208	6,924	2,076	4,497	1,303	3,815
Latin America	117	1,172	107	786	55	618
Near East	94	693	33	339	5	40
Far East	617	3,546	295	1,464	145	1,202
Africa	33	399	141	467	27	230
Oceania	18	187	466	1,171	15	194
U.S.S.R.	281	3,798	442	1,748	422	2,319
China <sup>2/</sup>	?	?	?	?	?	?
U.S.	1,173	6,679	1,964	4,177	1,243	3,625
Brazil	11	1.44	12	237	13	186

<sup>1/</sup> 1970 Production Yearbook. FAO, Rome.

<sup>2/</sup> Fertilizer production and use in Mainland China is reported to have increased very substantially. (Brown, G. S. 1970. The Agricultural Situation in Communist Areas. ERS-Foreign 314. USDA, Washington, D. C.)

Table 4 shows wheat and rice yields in 1950 and 1970.

TABLE 4. Wheat and Rice Yields in 1950 and 1970  
(100 kg/hectare)

Region	Wheat Yield		Rice Yield	
	1950	1970	1950	1970
World	9.9	14.8	16.3	22.6
Europe	14.7	24.5	43.0	48.4
North America	11.5	20.3	25.6	51.2
Latin America	10.5	13.6	17.0	19.0
Near East	9.2	10.2	23.6	36.1
Far East	7.8	12.0	14.4	19.8
Africa	6.0	7.6	9.9	14.4
Oceania	11.3	11.7	31.1	53.3
U.S.S.R.	8.4	14.4	14.5	36.4
China	6.9	? <sup>2/</sup>	23.7	?
United States	11.2	20.9	25.6	51.2
Brazil	7.4	10.1	15.8	16.4

Brown (1970) reported an excellent cereal crop in Mainland China in 1970.

<sup>2/</sup> Brown, G. S. 1970. The Agricultural Situation in Communist Areas. ERS-Foreign 314-USDA. Washington, D. C.

TABLE 5. Estimated Nitrogen Inputs and Utilization  
for the Land Area of the United States (1970)<sup>1/</sup>

<u>Inputs</u>		<u>Utilization</u>	
Source	Millions of Metric Tons	Product	Millions of Metric Tons
Non-symbiotic Nitrogen Fixation	1	Fiber	< 1
Symbiotic Nitrogen Fixation	4	Vegetable Food -N	2
Rainfall	6	Animal Food - N (excludes fish)	15
Chemical Fixation	7	Other	4
Mineralization of Soil-Organic Nitrogen	3		
TOTAL	21	TOTAL	21

<sup>1/</sup> Values aggregated and rounded.

Nitrogen budgets are still in the stage of estimates based on calculations from limited empirical data. Those given by the Committee on Nitrate Accumulation (op cit.) for the United States are shown in the following table.

The Committee estimated a net annual retention of nitrogen in soil and water of about 1.5 million metric tons in the United States. About one-third of the nitrogen inputs was from chemical fertilizer. As production continues to increase in the U.S. to meet domestic and foreign market demands, nitrogen inputs or efficiency of nitrogen utilization must increase or, hopefully, both. The Committee estimated 50 percent recovery of nitrogen inputs in harvestable vegetation with a wastage of 25 percent of that product to pests, spoilage, and other causes, thus a 37.5 percent net efficiency of fertilizer nitrogen use. Surely there is ample opportunity for improvement in efficiency.

Alternately, we might curtail our appetite for animal protein foods. Our diet is much higher in such proteins than that of most of the world's people. We used an estimated 15.1 million metric tons of nitrogen to produce 0.84 million metric tons of nitrogen in the animal food products we ate in 1969. Thus, about 18 tons of nitrogen were used to produce each ton of nitrogen in animal food eaten. Production of 0.36 million tons of nitrogen in the plant protein we are used only about 0.90 million metric tons of nitrogen or about 2.5 tons of nitrogen for each ton of plant protein food nitrogen.

The people of the world could be nutritionally well fed on 11 grams of nitrogen daily intake compared to our daily intake of about 16 grams. Let us assume that the average person in the world would eat seven grams of vegetable protein nitrogen, three from animal protein sources other than fish and other aquatic food products, and one gram from these latter food sources. Three grams animal protein nitrogen per person per day is equivalent to the protein nitrogen consumed in 80 pounds of utility beef on a carcass basis or 80 pounds of ready-to-cook broilers per year.

This suggested diet would contain about one-third of the animal plus fish protein in the current U.S. diet. It would be more than adequate to meet nutritional protein requirements.

Such a diet would require world input of about 190 million metric tons of nitrogen on cultivated and grazing lands. The rate of application of chemically fixed nitrogen to cultivated lands would be about 90 kg/hectare assuming only the present area to be under cultivation. This average rate is somewhat less than current usage on maize in the U.S.[4] This chemically fixed nitrogen in Year 2000 would be about five times 1969 usage at 1969 efficiencies. Phosphorus and potassium usage will also need to increase very sharply.

[4] Statistical Reporting Service. 1971. Cropping Practices 1964-1970. SRS 17. U.S. Department of Agriculture, Washington, D.C.

The Committee on Nitrate Accumulation stated that: "For example, a predominantly vegetarian diet with small amounts of milk and meat can be had for as little as 23 pounds of plant-available nitrogen per capita per year; in contrast, 179 pounds of farm-site plant-available nitrogen per capita per year were required to support the 1968 American diet."

Projecting these cited adequate diet requirements, world food requirements for a population of 7.3 billion about Year 2000 would be about 80 million metric tons for the vegetarian diet or almost 600 million metric tons at the 1968 American diet level.

The lower level is substantially less than current input levels. The 1968 American diet level seems to me to be unlikely to be achieved on a world basis.

Man uses only a small portion of the animal world biological primary production of dry matter either directly or through secondary productivity of food producing animals. Rodin et al[5] estimate total primary productivity as about 232 billion tons. This includes *all* underground and above-ground parts and all aquatic primary production. Man's direct and indirect use of this material as food probably amounts to no more than five percent now and is not likely to exceed ten percent in Year 2000.

It is possible that single cell proteins grown on cellulose materials, petroleum components, animal wastes, and leaf proteins may contribute substantially to animal and human food production in the future. Urea already has an important place in ruminant feeding.

There are more than a few problems to be solved. Among them is probably future cost of chemically fixed nitrogen. Abundant low-cost energy for use in fixation has kept fertilizer nitrogen prices down. There is widespread concern that future demand for energy will increase more rapidly than supply. Environmental pollution control will increase costs. Oil and gas supplies are clearly limited. Coal and oil shale are still abundant. However, the use of coal will necessitate increasing costs to control pollution. The Third Annual Report of the Council on Environmental Quality[6] estimates that 10.65 percent of average 1970 revenues of the electric energy generating industry in the Tennessee Valley Authority region will be required in 1976 to cover the full cost of air and thermal pollution controls. The CEQ estimate of these costs for all regions was seven percent of the 1970 average revenues.

Phosphorus without the use of phosphate fertilizers yields are limited by the release of phosphorus from its insoluble salts.[7] It is estimated that these natural rates of

[5] Rodin, L. E., N. I. Baxilevich, and N. N. Rozov. Productivity of the Main World's Ecosystem. August 31, 1972.

[6] Council on Environmental Quality. 1972 Environmental Quality. Third Annual Report. GPO, Washington, D.C. 20402. PP. i-xxvi and 1-450. Illus.

[7] Hasler, A. D. 1971. Man in the Living Environment. The Institute of Ecology (10E). Madison, Wisconsin. PP. 1-267. Illus.

mobilization would support a world population of between one and two billion people.

The 10E Report assumes that fertilizer use must increase 2.7 times faster than population in order to keep food production per capita at its present level. 10E assumes exhaustion of known phosphorus reserves at present rate of use in about 400 years. With double the present world population, 10E estimates exhaustion of known reserves in about 64 years.

The 10E Report lists 25,000 million tons of known phosphate rock averaging 31 percent  $P_2O_5$  (thus, 7,900 million tons)  $P_2O_5$  equivalent. The Report estimates undiscovered reserves as no more than an additional 25,000 million tons of phosphate rock or a total estimate reserve of 15,800 million tons of  $P_2O_5$  equivalent.

Emigh (1972)[8] estimated quantifiable reserves as 1,298,000 million tons of phosphate rock or 402,380 million tons  $P_2O_5$  equivalent. Emigh also reported that there are large but presently unquantifiable additional reserves. Emigh's estimate of known reserves is thus 50 times that of the 10E Report.

World usage of phosphorus increased about three fold from 1950 to 1970, nitrogen by about six fold, and potassium by more than three fold.

Forest fertilization to obtain high yields is a new and growing practice. Weyerhaeuser (1972)[9] practices controlled fertilization about every five years.

The Forest Service is evaluating the practice on a pilot basis in several locations. Fertilization by FS is operational on the Florida wetlands.

#### Efficiency of Nitrogen Use

Recovery of fertilizer in harvested crops varies widely. The law of diminishing returns applies for particular locations, soils, seasons, and crops. The more nitrogen added, the less is returned per unit added.

Soils vary widely in both the amount of nitrogen they contain and in the proportions of that nitrogen which can be mineralized. Mineralization is a prerequisite to assimilation of nitrogen by plants.

The amount of mineralizable nitrogen in a soil is one of the factors determining the amount of nitrogen which must be added to obtain maximal yield. Stanford and Smith (1972)[10] found that the rate-constant for mineralization of widely differing soils incubated under standard conditions did not differ significantly among a group of soils varying from 5 to 40 percent in the portion of contained nitrogen which was metabolized. It is likely that tests for mineralization can be applied with high predictive value for the amount of nitrogen which will be supplied by the soil itself. Such estimates could be used as a guide to amount of nitrogen needed for each crop, location, and anticipated yield.

In testimony before the Illinois Pollution Control Board, Stanford stated[11] that a 100 bushel/acre yield of corn required assimilation of 120 pounds of nitrogen by the corn plant. Illinois soils studied provided from 46 to

144 pounds of nitrogen. Recovery of fertilizer nitrogen was about 50 percent. One hundred fifty to 250 pounds of spring applied nitrogen was required for maximum yield of 120 to 172 bushels per acre.

With respect to water pollution, the Council on Environmental Quality Third Annual Report (op cit.) states: "The problem of nutrients (phosphorus and nitrogen) is worsening dramatically in all types of basins probably because of increased use of fertilizers." This statement was based on a contract study performed by "Enviro Control" performed for CEQ.[12]

Enviro-Control used data collected by U.S.G.S. in basins characterized by Enviro-Control as indicated in the following table.

Increase in pollution was attributed principally to non-point sources; i.e., to runoff rather than to such point sources as municipal and industrial sewage. The Enviro-Control association of increase in pollution was stated as follows: "Our findings reflect that water quality trends were sensitive to the dramatic growth in fertilizer use."

#### Eutrophication

A recent report of the "Phosphorus Technical Committee" to the Lake Michigan Enforcement Conference noted an apparent decrease in nitrate nitrogen in the open waters of the Lake. The report concluded that phosphorus is the plant nutrient determining biological productivity in the Lake. Inflow of phosphorus appears to be sufficient to produce eutrophication in offshore areas such as Green Bay and the southern portion of the Lake. Phosphorus sources include direct point sources from municipal and industrial sewage outfalls into the Lake (4 million tons per year) and indirect point sources from such outfalls on Lake Michigan tributaries (Ca 9 million tons per year). In addition, about two million tons per year reach the Lake on sediment and another two million on plant and animal wastes washed into the Lake. The report concludes that point sources can and should be reduced by more than 80 percent by sewage treatment but that non-point sources are probably only about 50 percent controllable.

The major opportunity for further control of non-point sources is through the small watershed program conducted by the Soil Conservation Service in cooperation with local individuals and agencies responsible for land use.

[8] Emigh, G. D. 1972. World Phosphate Reserves - Are There Really Enough. Reprint from Engineering and Mining Journal. McGraw-Hill, Inc., New York, New York. 10036.

[9] Weyerhaeuser. 1972. Weyerhaeuser High Yield Forestry. Weyerhaeuser Co., Tacoma, Washington. Form No. PA-55.

[10] Stanford, G. and S. B. Smith. 1972. Nitrogen Mineralization Potential of Soils. Soil Science Proceedings 36:465-472.

[11] Stanford, G. 1971. Nitrogen Fertilizer Use for Corn. Hearings, Illinois Pollution Control Board, Urbana, Illinois.

[12] Enviro-Control. 1972. Final Report. National Assessment of Trends in Water Quality. Enviro-Control, Inc. Washington, D.C.

TABLE 6. Trend from 1965-1970 in Total Phosphorus  
Organic Nitrogen and Ammonia in River Basins in the  
United States

Type of Basin	Trend (No. of Stations)		
	Better	No Trend	Worse
High agriculture and/or population	0	10	15
High agriculture and low industry and population	1	0	4
Low agriculture			
High population or high industry	4	4	14
Undeveloped	2	5	5
TOTAL	7	19	38

The program consists of upstream watershed conservation measures including vegetative cover of highly erodible areas such as water courses, road sides, and development sites and water management structures such as sedimentation pools, water retention structures, and channel improvements.

From this report, I conclude that not more than 20 percent of the phosphorus reaching Lake Michigan can be attributed either indirectly or directly to fertilizer use. I support the finding of the Committee that acceleration of the P.L. 566 small watershed program, including emphasis on implementation of conservation measures by land owners is desirable.[13]

The contribution of chemically fixed nitrogen is uncertain. Such nitrogen seems no more and no less likely to leach than mineralized nitrogen from other sources.

With respect to trends in our waters, Viets and Hageman[14] stated: "The authors of this paper cannot conclude that there is any trend in nitrate in surface waters, although they would not deny that the total nitrogen and total soluble nitrogen in many lakes and rivers may have increased significantly. It should be noted that the 10 p.p.m. NO<sub>3</sub>N related to public health standards for water is far in excess of the 0.3 p.p.m. total soluble nitrogen sometimes regarded as sufficient for eutrophication."

I began by stating three possible courses of action to produce food, fiber, and forest products. These were (1) to increase yields on the present cultivated area of the world, about 1.42 billion hectares; (2) increase the area under cultivation; or (3) to reduce the quality, and sometimes the quantity, of the human diet.

I conclude that increased development and application of technology, including efficient use of chemical fertilizers, is the generally preferable course. There should

be some new areas brought under cultivation, generally such areas should be those of potential high productivity, not subject to heavy erosion or soil degradation. We, in the U.S., for example, have transformed several million acres in the Delta and Southeast from woods and grasslands to the production of soybeans. More than a million acres have been so transformed in Louisiana alone with demonstrated increase in farm income and community growth in business and jobs.[15]

Increased use of fertilizer as a part of improved technology also including crop plants of high genetic yield capacity and pest resistance, pest control, water management, and appropriate planting and harvest is, in my opinion, essential.

Equally essential is the efficient use of fertilizer to achieve economic returns from its use and to minimize fertilizer contribution to eutrophication.

CHAIRMAN POWERS: Now that we have justified the necessity for some of the ways that we've got to think about — some of the things we are faced with to becoming a better Industry. One of those things is the Occupational Safety and Health Act.

[13] Zap, H., et al. 1972. Report of the Phosphorus Technical Committee to the Lake Michigan Enforcement Conference. Mimeo. EPA.

[14] Viets, Frank, and Richard Hageman. 1971. Factors Affecting the Accumulation of Nitrate in Soil, Water, and Plants. Agriculture Handbook No. 413, ARS, USDA, Washington, D.C.

[15] Corty, F. 1972. The Impact of Land Clearing and Soybean Production. Louisiana Agriculture 16:6, 7, and 9. Louisiana University and A&M College, Baton Rouge, Louisiana.

As most of you possibly know, Ben Day is the Assistant Vice President of a number of services for the Fertilizer Institute and in this position he is responsible for implementation for the Institute's technical safety and transportation programs. Ben was formerly Director of Technical Services for TFI and is a graduate of the Apprentice School of the Newport News Shipbuilding and Drydock Company, Virginia State University. Ben is a native Virginian and presently lives in Alexandria with his wife and three children. It is now my pleasure to present to you, Mr. Ben Day who will talk on Personal Experiences with OSHA.

## MY EXPERIENCE WITH OSHA

*Ben F. Day*

Good morning: I have been asked to speak to you for a few minutes relative to my experience with the Occupational Safety and Health Administration.

For convenience, I divided this presentation into three topics. These topics are:

1. A brief discussion of OSHA itself;
2. NIOSH or the National Institute of Occupational Safety and Health; and,
3. The part The Fertilizer Institute plays.

*The Act itself.* We're all familiar with the fact that President Nixon, late in December 1970, signed into law what has been described as the most far-reaching legislation ever passed by the Congress of the United States. The intent of the Congress is to free the place of employment from any known hazards and to make the employer responsible for removing known hazards. Remember, we are talking not only about safety hazards, but hazards to the health of the employee as well. This brings us to a basic: What is a hazard? Senator Steiger was asked this question during Senate investigation hearings. He described a hazard as a condition which may be detected with one or more of our senses (eyes, ears, nose, etc.). We know United States Department of Labor officers have gone beyond the normal human senses in detection of hazards. Compliance Officers use instruments which, in some cases, may be far more sensitive than the human senses. This places an additional responsibility on the employer. In addition to the tangible conditions, there is the intangible or judgment factor of the Compliance Officer.

Let's briefly look at safety standards, or the guides furnished to Compliance Officers. Under the Act, the Secretary of Labor is empowered to adopt certain safety standards and the Act named, specifically, the American National Standards Institute (ANSI) and the National Fire Protection Association (NFPA) as being consensus standards bodies. Recently, the American Society of Testing Materials (ASTM) has been recognized. The major problem was, and still is, that the standards adopted by ANSA and NFPA were written to be voluntary guides to an industry, yet, under OSHA, the standards were adopted as law. The Department of Labor employees were working during the time of adoption within a very tight timeframe; hence,

many mistakes were made during the translation and many undue restrictions were placed on industries; one of these being that all ammonia appurtenances should be either Factory Mutual or Underwriters' approved. We will come back to this in a moment in more detail. The fact still remains that the Secretary of Labor had to adopt certain guides for Compliance Officers and, in all fairness, guides to an industry. Therefore, on May 29, 1971, the initial standards package was published in the Federal Register. It was assumed by government that, since these were consensus standards, industries had no real problem with compliance. This was not true in every case, as we will see. This initial standards package was divided into 19 general and rather broad areas of coverage — such topics as walking working surfaces; occupational health and environmental control; welding, cutting and brazing; material handling and storage. Since these areas are general, The Fertilizer Institute summarized (in layman's language) these standards in what we call our OSHA Handbook. Since the publication of the original standards package, many revisions have been published; but, as you know, changes within the federal government are quite slow and very difficult to accomplish. This brings us into what I refer to as the intangible area, or the judgment factor of the Compliance Officer. As we have said, the intent of the Act is to free the workplace of known hazards. What about those areas not, at this time, covered by standards? Our advice to our industry has been to organize and work with a safety committee; satisfy the complaints (if there are any) before they get outside of the plant or in a formal complaint procedure; perform safety inspections with the employees and listen to the employees. I think you will find most Compliance Officers do execute certain common sense factors and are reasonable in their assessment of safety conditions within a plant. Our members have reported that where effort is being made, most Compliance Officers take this into consideration. However, there is a third phase to be considered — this is the inspection of a plant at the initiative of a Compliance Officer. Upon showing proper identification, the officer may enter a plant for inspection even though no complaint has been received by OSHA. No doubt, these Compliance Officers will ask to see the records, poster and the other requirements of the Act. Here again, attitude and effort surely will be taken into consideration in analyzing the safety hazards within a plant.

Now, if we may speak briefly to our second topic, NIOSH or the National Institute of Occupational safety and Health. This is the research arm of OSHA. NIOSH plans, directs and coordinates the national program effort to develop and establish recommended occupational safety and health standards and conducts research, training and related activities to assure safe and *healthful* working conditions for every working man and woman. It is important to remember that under NIOSH an employee, if he believes a *health hazard* exists in his place of employment, may file a request of investigation under more



or less the same procedure an employee files under OSHA. A NIOSH employee will investigate and file a report.

NIOSH not only plans and directs, but administers research in the field of occupational safety and health, including the psychological factors involved. NIOSH provides medical criteria which will ensue insofar as practical that no employee will suffer diminished health, functional capacity or life expectancy as a result of his work experience — with emphasis on ways to discover latent diseases; establishing casual relationships between diseases and work conditions; serving as a principal focus for training programs to increase the number and competence of personnel engaged in the practice of occupational safety and health; and, in addition, consulting with the United States Department of Labor, other federal agencies, state and local government agencies, industry and employee organizations and other appropriate individuals, institutions and organizations with regard to promotion of occupational safety and health.

Gentlemen, it is our prediction that the real emphasis in this federal safety program will come, not in occupational safety, but in occupational health under the NIOSH program. One of our member companies has already experienced a voluntary inspection — no citations were issued but some rather pertinent questions were asked:

"Do you have a safety committee, and who's on it?"

"Do you have a Safety Engineer on the staff?"

"Do you have a doctor on the staff, or first aid services?"

"Do you have periodic employee physical exams?"

"Do you examine for particular exposure to substances?"

"When a person is off sick, do you question reasons why and could it be work-connected?"

"Do you monitor dust?"

"Do you require washing hands before eating?"

In order to guide the administration of NIOSH, a series of laboratory tests were performed. The results of the tests established an initial priority list. Interestingly enough, ammonia is number five on the list of priority items. This may, within the near future, present problems for the ammonia industry since the safety standard prescribes an exposure of 50 ppm for eight hours. We understand that OSHA is considering a maximum of 25 ppm. Two other items on the priority list, relatively high, are nitric acid and sulfuric acid. We cannot leave the subject of occupational health without alluding briefly to dust and dust control. Recently, I obtained an OSHA program directive, which detailed OSHA policy on the issuing of citations for violations of standards relating to air contaminants. According to the directive, citations of serious violations and other similar standards will not be issued if there is evidence to show the employer is taking steps to reduce employee exposure to toxic substances, even though he has yet to install engineering controls to eliminate the problem. The directive states that OSHA policy is that engineering controls provide the best protection to employees and

should be required in all instances to the extent such engineering controls are feasible. Administrative controls should be considered the next best alternate as an abatement solution. Control of the atmosphere or control in reduction of the opportunity for employee exposure, rather than the use of protective equipment against exposure should be the primary objective in writing citations; however, even in situations where the toxic level exceeds the limited application for serious violations and feasible engineering controls were not implemented, citation for another violation shall be issued if the employees utilize an administrative control such as rotation of employees or personal protective equipment in accordance with the requirements of standards so that the employee exposed is reduced within the limit for other violations. It is important to note that this does not mean that no citation will be issued, only that no citation for serious violation will be issued if you meet certain "good faith" criteria. A citation would still be issued if the toxic substance exceeds the threshold limit value set by the application standard and the employee has failed to implement either (a) feasible and effective engineering controls, (b) feasible administrative controls to reduce exposure or, (c) provisions of effective personal protective equipment in instances where engineering and administrative controls in instances where engineering and administrative controls were not feasible.

There is one other area here. We talked a little bit about dust, but the other area of real concern is noise. Sound which exceeds the standard or permanent damage to hearing may be caused is the case in point. Earmuffs are, generally, only a temporary measure. Noise is everywhere — noise of electric motors, dryers, roller chain, knockers on dryer cylinder. To try to reduce this noise, you install rubber knockers. You reduce the noise alright, but you don't knock the fertilizer loose in the dryer, so we have an area that requires a good deal of study and thought. I believe this is probably the fertilizer industry's weakest area and we're not doing as much in this area as we should toward protecting ourselves — yet, within a short period of time (a year or so), NIOSH is going to get really moving . . . they're studying our problems now and the real "crunch", so far as keeping these plants running, is going to come in this area.

That brings us down to the third point. What is The Fertilizer Institute doing about this?

As you know, The Fertilizer Institute is the result of the merger of the Agricultural Nitrogen Institute (ANI) and the National Plant Foods Institute (NPFI). In 1953, the ANI published its first anhydrous ammonia standard. Actually, NAI was formed for the purpose of creating a safety standard to protect the industry as well as the public. As the ammonia industry grew, so did the standard and at the time OSHA came into being, the original standard had been utilized in about 20 of the large fertilizer-consuming states as a basis for regulations. The ANI did not, nor does



TFI now, promote regulations in lieu of education or safety practices. Where it was proven there was a definite need for regulations, we recommended the standard which had been concurred in and written through the committee process.

The NPFPI had within its purview for a prolonged period of time a committee which spoke to ammonium nitrate fertilizer. This committee wrote the NFPA's Bulletin No. 490 and this was adopted by the Secretary of Labor in the initial standards package. This procedure executes the action as it was intended to be; hence, no problem for the government and no problem for industry.

OSHA's action in dealing with anhydrous ammonia was quite a different story. The May 29 Federal Register published anhydrous ammonia standards, but since the Secretary was bound to ANSI as an original source, the standard, as published, did not truly represent agricultural interests. Additionally, certain changes were instigated by staff employees of the Secretary; one being a requirement that all ammonia appurtenances must be Underwriters' or Factory Mutual approved. We consider there are three major manufacturers of ammonia appurtenances and only one has a part of its production Underwriters' or Factory Mutual listed. This, of course, threw all ammonia installations throughout the United States into non-compliance with OSHA regulations. TFI petitioned the Secretary of Labor on June 4, hopefully initiating action which would relieve the agricultural ammonia industry of a condition which supposedly was as distasteful to the Secretary as it was to industry. Since that time, 34 separate transactions have transpired between The Fertilizer Institute and the Secretary's office — with no relief to report at this time.

Our committees, however, continue the effort of seeking relief. We have a Task Force writing test criteria for ammonia appurtenances, but we find the Secretary's office has no authority to adopt a testing procedure, as such, except as a standard, nor can his office recognize a testing facility as such. He can, however, adopt the criteria as a standard under the 6 (b) procedure. TFI, through its predecessor organization, in 1968, began the long and tedious process of receiving ANSI recognition of the ammonia standard; this recognition was granted in February of 1972, four years later. Of course, we have petitioned the Secretary's office for adoption of this standard and have learned the Secretary does not intend to adopt the standard en toto — only portions thereof. We continue to seek relief. We have ferret out those portions of the two standards (that published in the May 29 Federal Register and those portions of ANSI K61.1, February, 1972) which conflict or are less stringent than that already published or adopted by OSHA. An additional petition will soon transpire, asking the Secretary to update what has already been published. We understand that revised standards under OSHA are in process and a new standards package will be published in early 1973. Hopefully, this document will carry corrections and updates that will relieve our industry of an undue burden.

There are many other activities transpiring between the Secretary of Labor and The Fertilizer Institute which time does not allow us to discuss. May I suggest, if you have questions, that you write to me at the Institute office. I will be pleased to consider any suggestions or comments along with answering any of your questions.

It has been a real pleasure to appear before you.

**CHAIRMAN POWERS:** Our next speaker is Mr. John S. Neild who will talk to us about some actual Plant experiences with "OSHA". John Neild, many of us know him as "Pat", is a native of Cambridge, Maryland. He grew up in that farm area, attended the University of Maryland. He graduated from the College of Agriculture.

He served some time in the United States Air Force and was discharged with the rank of First Lieutenant. He is married and has three children and still makes his home in Cambridge, Maryland. He started out in the fertilizer business with the old DORCO Dorchester Fertilizer Company in Cambridge, which was burned one time during his career with them; rebuilt (in which he played a major part), and at that time DORCO was purchased by Baugh and then in turn purchased by Kerr-McGee. Today he is in charge of the manufacturing and operation at Cambridge and has been in the position of Plant Superintendent for the past seven years. It is now my pleasure to present Pat Neild.

#### **"OSHA" AND THE GRANULATION PLANT**

*John S. Neild, Jr.*

Before coming to this meeting, most of you no doubt have had some exposure to the Occupational Safety and Health Act of 1970, and the standards adopted under that Act, in 1971. Your speakers this morning have enlightened you further about this law. It's natural for many of us to ask the question — "Can we *afford* to comply with OSHA". As stated by a leading trade magazine "One thing is for sure — safer plants won't be cheaper". We can all expect increases in costs of new installations, and in day to day operating costs. I have read the OSHA laws and standards several times and have come to this conclusion. If a plant has followed good operating procedures and has maintained a safety program endorsed by top management, compliance will not be too difficult or expensive. However, if the profit squeeze of recent years has caused you to neglect maintenance and safety, then it *may not* be economically possible for you to comply with OSHA. Some of you may feel that you will not be faced with an inspection in the near future. Before you get confident, however, there are several things you should remember.

*First —*

The OSHA budget for 1973 is nearly double that for 1972. The number of inspectors will likely be increased from 430 to 700 in 1973. In the first ten months of operation, these 430 inspectors alone have visited 23,000 plants, found 75,000 violations, and levied \$1.7 million in fines.

*Second —*

Consider that the states are hurrying to take charge of this

situation. They must present to the federal government a plan at least as stringent as the federal codes. It's quite likely that the state laws will become stricter than federal, and they will attempt to be more thorough in their coverage. The state of Maryland proposes to have 65 inspectors who will check larger plants at 30 day intervals, with a total State budget by 1975 of \$2,287,000.00. It isn't likely that any plant will be overlooked for long.

### *Third —*

You *will* be visited immediately if you have a fatal accident, or if one of your employees reports an unsafe condition to an inspector.

My background is with a small plant on the eastern side of the Chesapeake Bay, in Cambridge, Maryland. Our plant is relatively new, being rebuilt after a fire in 1963. We receive materials, granulate and ship fertilizer in bags and bulk, and stock chemicals for resale. The operation is seasonal, requiring large numbers of unskilled people for short periods of time. I don't believe the size of operation has much significance when discussing the OSHA law and its standards. The principles apply to everyone from the large industrial complex to the local distribution warehouse, and even to some farm operations. My objective today is to help focus your attention on the major areas covered by OSHA, those that I believe are most important to us in the operation of our fertilizer plants.

The expense required to comply with all OSHA requirements to the letter of the law *could*, conceivably, put any one of us out of business. Therefore, it is necessary that we start by first correcting those conditions that present the greatest hazards to our personnel.

Now, I will show you some pictures — most of them examples of problems OSHA will *force* us to deal with. I might claim that these pictures were taken in someone else's plant, but I couldn't explain away the Kerr McGee name on some of the equipment. So — I'll just say that we are correcting the problems you'll see on the screen.

The OSHA standards are numbered, and I'll give you the section number as we proceed.

Section 1910.23 deals with general housekeeping. It states that working areas must be free of protruding nails and splinters, floors will be "clean and dry", and all holes or pits will be covered or guarded. Anything obstructing traffic in aisles or on stairways will not be permitted.

### **— LIGHTS OFF —**

Yard areas, especially around moving equipment must be kept clear of trip hazards.

This stairway with tools, and an air hose crossing, would agitate the most liberal inspector. Slide No. 1.

Section 1910.23 tells us floor openings, elevator pits, raised platforms, etc. must be protected by guard rails or fences, and the specifications for these guards are

spelled out in this section. Gratings and covers must be level and secured.

The law states that every wall opening from which the fall is more than four feet shall be guarded by some method. A loading door will have to be equipped with a protective rail, or closed, when not in use, if it is higher than 48 inches.

Floor openings above and below stairways require standard rails and toe boards. Slide No. 2 shows a well designed stair, but notice that a toe board must be added.

Section 1910.24 explains how to build stairways, and specifies angle of incline, width and depth of tread, hand and guard rail height and size, doorways, and a few other guidelines. Complying with *this* section could be a major expense item for most plants, and will likely be a prime item for investigation by the inspectors.

Fixed stairs must be installed at angles of 30° to 50°. In a close area, this will be difficult to comply with.

Sections 1910.25, .26, .27, and .28 must have been written by the greatest ladder engineers that ever lived. I've read these sections several times, and frankly, I'm doubtful that any ladder in our plant would pass inspection. There are several obvious things to look for.

Extension and straight ladders must be properly stored. The type of storage shown on slide 3 is not acceptable. Ladders must be hung on a wall or stored so they will not bend or sag.

If you use step ladders, they must be tall enough for the job.

Any damaged ladder should be repaired or destroyed.

OSHA says in section 1910.37 that all exits must be marked with an exit sign having at least six inch letters.

Most plants have large doors, and marking them with exit signs seems needless. However, if this is *the only* exit for an area, and it is sometimes closed you will be required to have it marked.

Any exit must be unobstructed, at least 6' 8" clearance, and 28" wide.

Anhydrous Ammonia is covered in section 1910.111. Equipment and practices associated with this material will get lots of attention from inspectors, and *should*, because anhydrous is only safe as the equipment in which it is used, and the people that handle it. Good

care of equipment is a must.

Rusty tanks like that shown in Slide No. 4 and poorly kept valves and fittings must be repaired or replaced.

All tank openings used for filling or withdrawal will be equipped with properly rated excess flow valves. Tanks must have relief valves, and these must have rain caps to prevent entrance of water.

Nurse tanks must carry a container of at least five gallons of water and a full face gas mask.

Hoses will be of the anhydrous ammonia type and have markings showing rated pressure and date of manufacture.

All anhydrous containers must have a reflective surface maintained in good condition.

Personal protective equipment is referred to in many places throughout the OSHA standards. Close attention will be given to eye and head protection, and you will likely need to start a hard hat program, and possibly a safety shoe program. Goggles or face-shields must be provided wherever there are grinding operations, or danger of chemical splashes or leaks. Section 1910.132 thru .136 and .215 will give you more information on this.

Extra emphasis is called for on respiratory protection. "Most standard dust masks are no longer acceptable". The employer is required to identify dust areas, and post written procedures for the use of respirators and dust-masks. These must be enforced whether or not the *employee* feels the procedure is necessary. The user will be issued a personal mask and it must be checked and cleaned daily. A written record has to be maintained, showing the inspection dates on all *standby* equipment. There are *special* provisions affecting ammonia masks, including proper labeling and dating of canisters. You should look at *these* rules very closely.

Rest rooms and change rooms will need special attention under this law. Section 1910.141 deals with sanitation, and tells us we must have separate facilities for men and women and at least one toilet for up to nine people, increasing to five for 100 people, and one additional for each additional thirty people. Restrooms can be no more than one floor, and 200 feet from the work area. Here again, I'll use an example of a typical plant rest room to tell you what needs to be changed. The toilet must be enclosed with a partition and door, and inside there will be a coat hanger, door latch, and paper. No more open toilets. Floors and walls must be of materials that can be washed. One lavatory is required for each

ten employees and will have individual or disposable towels and suitable cleaning agent provided.

If you permit your employees to eat on the premises, you must provide them with a lunchroom capable of seating the maximum number who eat at any one table. It must be kept clean and trash dumped daily.

A change room with lockers will be provided wherever it is necessary to change clothes. Fines have been assessed merely because clothes were not *kept* in lockers.

Fire Protection is spelled out in sections 1910.156 thru .165. This specifies the type and number of extinguishers needed, and the maintenance required.

In a fertilizer plant, it's hard to keep any equipment in good condition, and fire extinguishers are no exception.

They should be covered to prevent corrosion. But that isn't sufficient — They cannot be set on the floor, but must be hung so that the top is not more than five feet from the floor. So then, we hang it on the wall, post a sign indicating the type of fire it is to be used on — and still we have a problem if someone forgets that you cannot block the access to a fire extinguisher. Fire extinguishers shall be inspected monthly, or at more frequent intervals when circumstances require, for obvious physical damage, corrosion, or other impairments. At regular intervals, not more than one year apart, extinguishers shall be *thoroughly* examined, repaired, recharged or replaced as necessary. Each extinguisher shall have a durable tag securely attached to show the maintenance or recharge date and the initials or signature of the person who performs this service. Hydrostatic tests shall be performed on extinguishers that show evidence of corrosion or mechanical injury. *Regular* hydrostatic tests shall be performed on extinguishers at intervals not exceeding those set forth in section 1910.157 in most cases, every 5 years. *We* find it practical to contact with a local fire equipment company to maintain and tag our fire extinguishers as required.

Sections 1910.166 thru .171 cover pressure vessels of all types. Acetylene and oxygen cylinders must be secured. If they cannot be moved on a welding cart like that shown on Slide No. 5 then you *must not* transport them unsecured. The valves should be removed and a protective cap put on the cylinder when moving unsecured cylinders.

Propane cylinders also must be bolted or chained down.

This section also covers air compressor tanks, and specifies they shall have water drain valves, pressure gauges, and spring loaded safety valves.

Up to this point, we've covered a lot of items, but now we get into the meat of the plant operation — it's mobile and installed machinery.

Section 1910.178 deals with industrial loaders and trucks. Manufacturers are now required to sell loaders and forklifts with overhead guards. All existing units must also have overhead guards installed.

Operators like to put spinner knobs on the steering wheel. Only those of the type originally supplied with the equipment are now legal. If it sticks up too high, it is not acceptable. Every vehicle must also have a horn or warning device.

If you have a crane at your plant, this law has lots to tell *you* in section 1910.180. Just to mention a few items — you will need a regular inspection and log book, a posted sign showing crane capacity, and a fire extinguisher mounted in the cab, or close vicinity.

In any plant it's difficult to keep equipment properly guarded. Sections 1910.211 through .222 place firm specifications on the guarding of equipment. As the law reads "One or more methods of machine guarding shall be provided to protect the operator and other employees in the machine area, from hazards such as those created by point of operation, ingoing nip points, rotating parts, flying chips, and sparks. Gears, shafts, and belts less than seven feet from the floor *must* be guarded on all exposed sides.

A stair with no hand rail — into an elevator pit with an unguarded chain, is a sure winner for a fine.

The old faithful trunnion (see Slide No. 6) used on dryers, coolers, and ammoniators must be guarded.

Motor couplings must also be covered with a guard.

The chain drive on an ammoniator drum, and both the belt drive and chain drive on bag conveyors need guarding. This section of OSHA also specifies that certain standards of maintenance must be maintained including alignment of bearings and pulleys, and care of belts.

Ever since I've been in the fertilizer business, our employees have used air to clean off their clothing and equipment. In recent years, some accidents have been reported *resulting* from this practice.

There are air guns on the market which the manufacturers *claim* will pass OSHA standards, "provided" the pressure to the guns are regulated to no more than 30 pounds per square inch. Some guns have built in air regulators.

Sections 1910.251 thru .254 cover welding, cutting, and brazing. I'll repeat what I told you earlier, that oxygen and acetylene cylinders must be secured on a special hand truck or else have valves removed and protection cap screwed on when not in use. Cylinders must be shut off when not in use and all valves and gauges must be of approved type, and in good condition. Cutting should be done with the hose protected from sparks as much as possible.

Arc welders must have insulated cables and the operator must wear goggles and protective clothing. There's nothing very new in this section. There *is* one item that may be new to you, and that has cost some companies a penalty already. Fire watchers must be present with fire control equipment at any time welding is being done in an area where fire may start.

A flash guard is required to protect the eyes of others working in the area.

If you are in compliance everywhere else, you'll find the standards on Electrical will provide an unlimited opportunity to spend money and time. These are found in sections 1910.308 thru .392. There's nothing new in the requirement that all receptacles and switch boxes be properly covered and guarded.

This is required even if they are out of normal reach of employees.

Permanently installed equipment cannot be connected by means of a flexible cord. Complete grounding is required on all motor frames, conduit, switches, switch boxes, receptacles, and any other noncurrent carrying components to which electrical equipment is attached. This could be a major project in some plants — especially those of wooden construction. Where electrical components are fastened to a steel building and the building is grounded, this "may" not be a problem.

A couple of the other sections of this law deserve a mention.

*First aid* and supplies are covered in section 1910.151. A remotely located plant will be expected to have personnel trained in first aid with records showing training within 2 years. Eye washes and showers will be required where acids, and ammonia, are handled.

*Noise levels* are set forth in Section 1910.95. We just completed a sound level survey of our plant and found

three problem areas. Our diesel loaders registered 97 decibels under load, our classifying screens registered 118. The ammoniator operator was exposed to 92 decibels. Where sound levels exceed the limit of 90 decibels, either the noise must be reduced, protective equipment must be furnished, or the length of duty within the area must be reduced.

Section 1910.93 deals with air contaminants including gasses, vapors, fumes, dusts and mists. It lists the ones that are of most concern, and these include ammonia, carbon black, chlorine, magnesium oxide, nitric acid, sulphuric acid, phosphoric acid, and about 500 others including many pesticides. My only comment here is if you have *heavy* dust or fumes in your plant, you can be sure correct protective equipment must be provided or the contaminant eliminated.

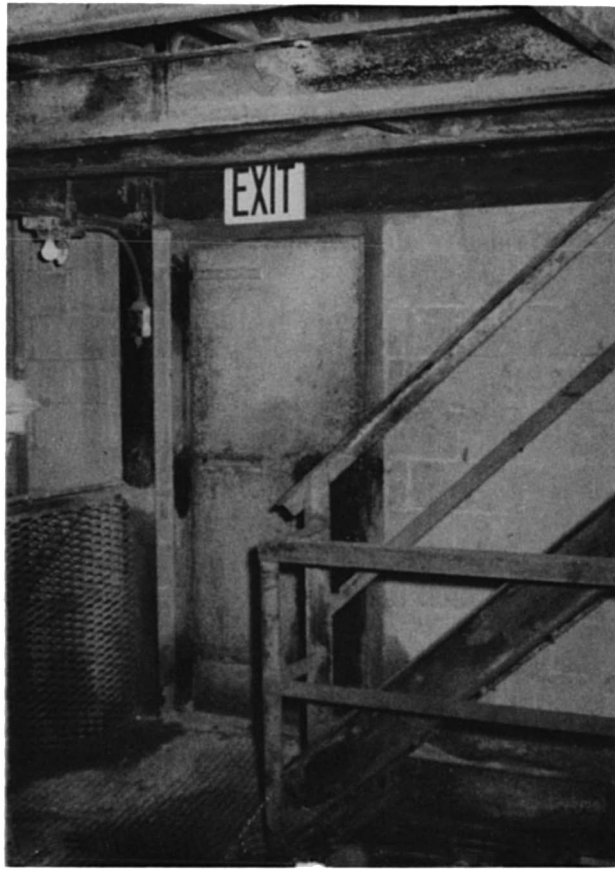
Section 1910.94 covers ventilation. The greatest concern in this section regards sand blasting, grinding, degreasing and welding, where toxic or dust laden air may be generated. Here again, either the problem must be eliminated or equipment used to comply with the law.

Gentlemen, even as I speak to you, many of these standards are being revised. Before undertaking a major project to bring your plant into compliance, take the time to acquire a copy of the Federal Register and it's current revisions, as well as state laws dealing with the subject.

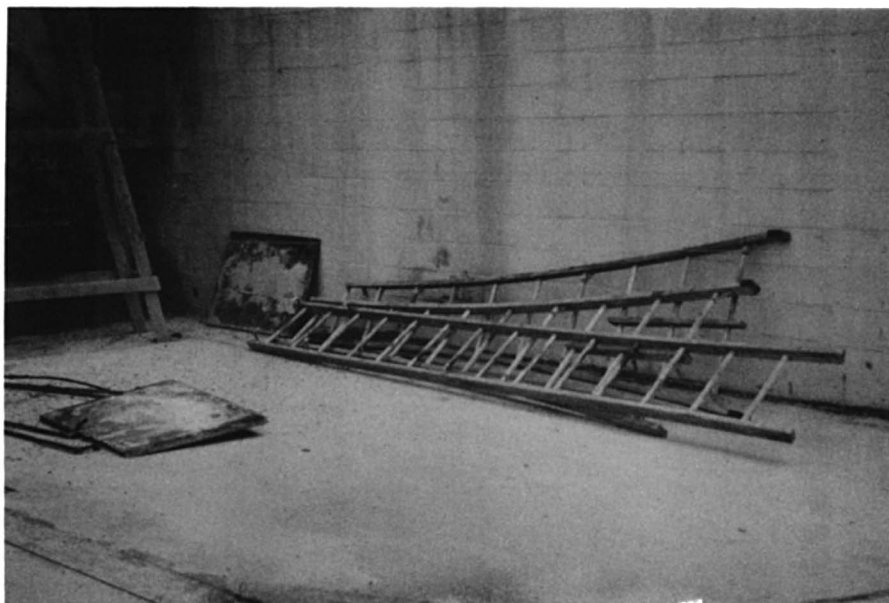
The items I have talked to you about today are the ones I believe deserve your first considerations. Thank you for your kind attention.



*Slide No. 1  
Stairway*

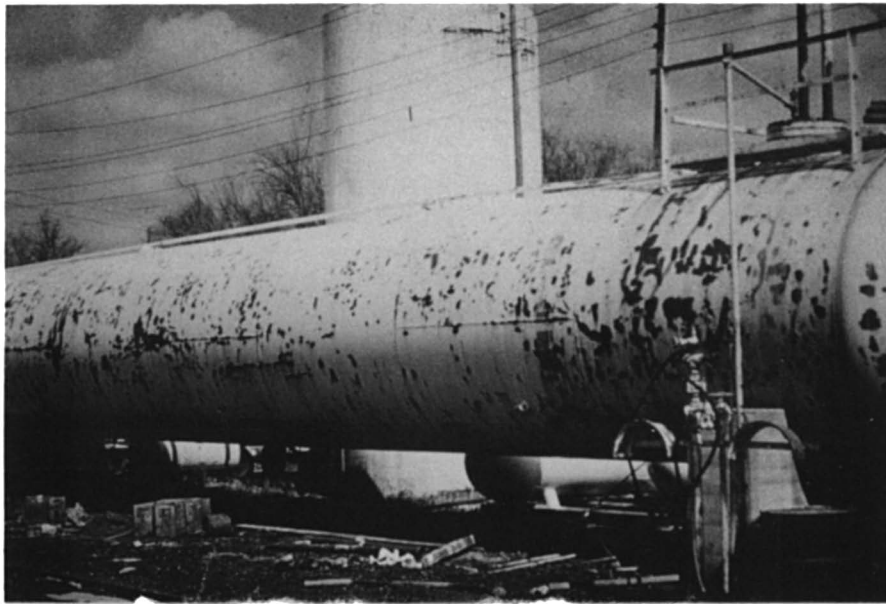


*Slide No. 2  
Floor Openings*



*Slide No. 3  
Extension & Straight Ladders*





*Slide No. 4*  
*Rusty Tank*



*Slide No. 5*  
*Cylinders*



*Slide No. 6*  
*Trunions*



# Wednesday, November 1, 1972

## Afternoon Session

Moderators: Herman G. Powers, Frank T. Nielsson,  
Wayne W. King, Albert Spillman

CHAIRMAN POWERS: Gentlemen, this afternoon we have one Speaker and following his talk Wayne W. King and Albert Spillman will take over and guide you through the informal round table discussions. Frank will introduce our Honored Speaker from Japan.

FRANK T. NIELSSON: It gives me great pleasure to introduce Mr. Tomoaki Tsuno, Chemical Engineer, with Mitsubishi Chemical Industries, Limited, from Kurosaki, on the Island of Kitakyushu, Japan. Mr. Tsuno is a Graduate Chemical Engineer from Ghouma University located near Tokyo. He came to this country in October this year and will stay until next September, spending most of his time at Tennessee Valley Authority in Alabama, observing and studying The American Competitive Controlled Release Fertilizers. Mr. Tsuno is the inventor of "IBDU", a slow release nitrogen fertilizer, comparable, I assume, to Nitroform Uramite. "IBDU" is sold in this country through Swift. Mr. Tsuno is with the Inorganic Technical Section of Mitsubishi Chemical. He is their trouble shooter and Technical Man. I am sure that you will learn a lot from him. It gives me great pleasure to introduce to you Mr. Tsuno.

## PRODUCTION OF "IBDH" AND ITS APPLICATION

*Tomoaki Tsuno*

### 1. INTRODUCTION

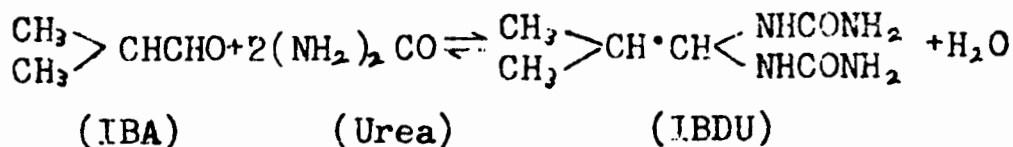
Mitsubishi Chemical Industries Ltd. developed IBDU as a long-lasting nitrogen fertilizer.

In 1957, work began at the Mitsubishi Research Institute in Japan.

Following the success of beaker and Pilot Plant tests, Mitsubishi constructed the first plant for the production of 13,500t/y of IBDU at its Yokkaichi works.

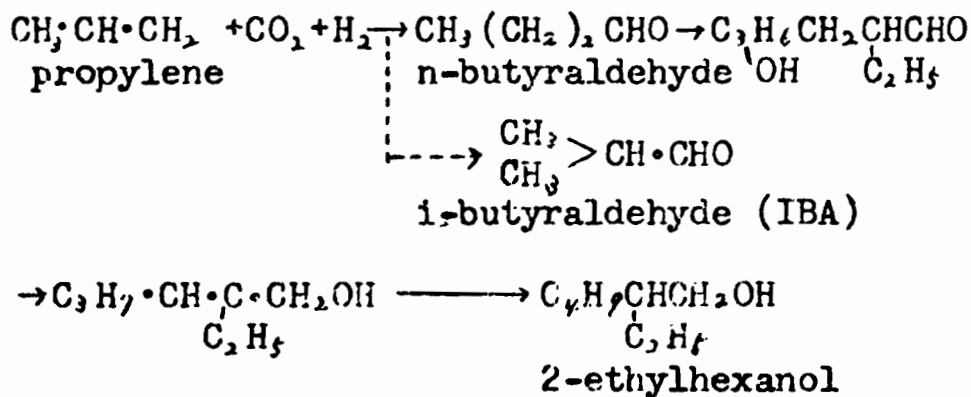
Now, Mitsubishi has a 40,000/y IBDU plant at its Mizushima works and a 60,000t/y IBDU containing compound fertilizers plant at its Kurosaki and Yokkaichi works.

IBDU is readily formed by a condensation reaction between urea and isobutyraldehyde in the presence of acid as catalyzer.



(Fig. 1)

nitrogen fertilizer, several urea-aldehyde condensate products have been studied. We selected Isobutyraldehyde as a raw material to be reacted with urea and found that IBDU has many agronomic advantages over the other urea-aldehyde condensate products. We are now offering various grades of IBDU containing compound fertilizers and straight IBDU to Japanese and the U.S. markets. Isobutyraldehyde (IBA) is produced as a by-product of a 2-ethylhexanol process as illustrated:



(Fig. 2)

## 2. Properties of IBDU

## 2-1 Physical Properties (Table-1)

Molecular weight	174.21
Nitrogen content	32.18 (theoretical value)
Appearance	white crystalline powder
Melting point	205°C with decomposition
Specific gravity	(true) 1.3 (apparent) 0.7-0.9
Solubility	0.3-0.3 gr/100ml H <sub>2</sub> O at room temperature (hardly soluble in alcohol, ether.)
Hygroscopicity	negligible

**2-2 Agronomic Characteristics of IBDU (Table 2)**  
IBDU has the following agronomic characteristics as a long-lasting nitrogen fertilizer.

- i) **Slight Water-Solubility;**  
As IBDU is very slightly soluble in water, it has less concentration hazard and low caking tendency.
- ii) **Mineralization through Urea;**  
The mineralization of dissolved IBDU in the soil water proceeds mainly through urea by hydrolysis and is less dependent

upon direct decomposition by soil microbes. Therefore, the fertilizing effect of slowly released IBDU is as effective as urea without being affected by soil conditions. Briefly, IBDU can be considered as "slightly water-soluble urea".

- iii) Control of slow Action by Granulation; Checking the dissolution velocity of IBDU makes possible the control of its slow action. This is accomplished by adjusting the size and hardness of straight IBDU or fertilizer granules containing IBDU, since the water-solubility of IBDU is very low and the dissolution velocity of IBDU can be lessened by granulation.

- iv) AI-Value;  
AI-Value of IBDU measured by Morgan's  
procedure is as follows:

TN	32.1%
CWIN	24.9%
HWIN	0.9%
AI-Value	96%

- v) Influence of aldehyde on Plant Physiology;

There is no need to worry about liberated aldehyde except in the case of an extraordinarily heavy application, because aldehyde is apt to vaporize into the air. The remaining aldehyde in the soil changes to isobutyric acid which is consumed by soil microbes as are other organic acids.

### 3. Commercial Production Process for IBDU

Wet and dry processes are available, but the latter is recommended for commercial production because it eliminates the tedious filtration and drying steps required of the former. The wet and dry processes are illustrated in the following figures 3 and 4.

However, there are some difficulties connected with the dry process:

(Table 3)

- a. Removal of the reaction heat
- b. Repression of the secondary reaction
- c. Control of the reaction rate

#### 3-1 Removal of the Reaction Heat

Condensation of urea and IBA is an exothermic reaction. As it is inefficient to perform external cooling, it is advisable to employ a sealed reactor using an excess of aldehyde to balance the latent heat of evaporation and heat of reaction. Evaporated excess aldehyde is condensed with a condenser and recovered for re-use. By this system, we can maintain the desired reaction temperature.

The molar ration of the two raw materials to be fed to the plant should be 1 for urea to 0.6-1.1 for aldehyde.

#### 3-2 Effect of the Reaction Temperature

If an excess amount of IBA is employed, generally a considerable amount of by-products are included in IBDU. (Fig. 5) These by-products are isobutylidene monourea (24.6%N), di-isobutylidene triurea (29.2%N) and di-isobutylidene diurea (24.6%N). They are not useful as fertilizers. However, we have discovered that if the reaction temperature is kept higher than IBA's boiling point in reactor, pure IBDU is obtained at high yield without the formation of by-products.

Table 4 gives the reaction rate and the nitrogen content of the product. It will be seen from this table that if the reaction temperature is too low (below about 58°C), the reaction rate increases while the nitrogen content of the product reduces remarkably; on the other hand if the reaction temperature is too high (above 84°C), the nitrogen content of the product approximates the theoretical value of IBDU while the reaction rate considerably drops.

#### 3-3 Effect of pH on the Reaction Rate (Table 5)

Addition of acid as a catalyst is necessary for accomplishing the reaction between urea and IBA.

Organic or inorganic acids, the latter including sulfuric, hydrochloric, and phosphoric acids are used as the catalyst. Sulfuric acid is the most economical. These acids are employed in a 30 to 50% aqueous solution so that the acids come in contact evenly with the starting compounds. The reaction rate shows the highest value at pH 3.

#### 3-4 Particle Size of Solid Urea

The urea employed in this process is not always powdered. As prilled urea in such sizes as 5 to 20 mesh is used in this process, there is no trouble involved.

#### 3-5 IBDU Manufacturing Plant

A typical IBDU plant is illustrated in Fig. 6. If necessary, any sulfuric acid remaining in the continuously obtained product, can be neutralized with an alkali. The analysis of finished IBDU at the outlet of a plant of this type is listed in Table 6, and indicates high purity. By this process, IBDU is obtained as granules of 0.1-0.4mm, and, by changing manufacturing conditions, the distribution can be varied to meet requirements.

### 4. IBDU for Compound NPK Fertilizer (Table 7)

IBDU is used as a straight fertilizer, and new compound fertilizers containing IBDU as a raw material have been widely marketed. The compound fertilizers containing IBDU are divided into two classes according to the difference of the phosphatic raw materials.

#### 4-1 Hardened IB-Compound

When IBDU containing compound fertilizer is used as a fertilizer for paddy fields, it is necessary for the rate of release of available nitrogen to be controlled by adjusting the size and the hardness of granules in order to effect a slow-acting or long-lasting availability

These improvements were achieved by compounding a mixture of IBDU and potassium sulfate or muriate of potash with superphosphate and fused magnesium silico phosphate, and also by producing the fertilizer in large (5-8mm diameter) and very hard (destroyed pressure about 10 kg/granule) granules that keep their form in water for a long time.

When the C-P<sub>2</sub>O<sub>5</sub> (=citric acid soluble phosphate) molar ratio of superphosphate to fused magnesium silico phosphate is 1±0.5, it is most suitable for the production of IB-compound fertilizer.

This hardened IB-compound fertilizer, which was originally developed exclusively for rice

paddies, was later adapted for application to dry fields in recognition of its excellent performance, Fig. 7 shows the process of IB-compound fertilizer, IBDU, fused magnesium phosphate, superphosphate, ammonium phosphate and muriate of potash are continuously fed into the rotary drum granulator (10) through the mixer (9). In the drum, the mixtures of these raw materials are granulated by wetting with urea solution and phosphoric acid or water. The moist granules (2-15mm diameter), which have 5 to 15% of free water, are fed from the granulator to the pre-cooler (11). The moist granules must be detained in the pre-cooler for 10-30 minutes so as to attain sufficient granular strength to resist breakage in the dryer. Finally, at a temperature of 75-95°C, the granules are dried in the rotary dryer.

The dried granules (water content 3-4%) are carried to the double deck screen (13). Undersized granules are sent to a hopper (6). Oversized granules are crushed before mixing the undersized granules. Granules with a required size of 5-8mm diameter pass through a rotary cooler (15) and are then packed into paper or resin bags.

#### 4-2 High Analysis IB-Compound (IB-RINKAAN)

In the autumn of 1964, "High Analysis IB-Compound" — Japan's first synthetic slow-acting fertilizer containing IBDU was placed on the market. This fertilizer later was widely adopted principally for dry fields, as it was found to be well capable of substitution for relatively expensive organic fertilizers such as fish and rapeseed meal, which have been used traditionally in large quantities for mandarin orange and other special crops.

High Analysis IB-Compound can be produced by mixing IBDU with other fertilizers such as ammoniumphosphate, ammonium sulfate, potassium salts and urea or ammonium nitrate.

In some cases, FTE (a Fritted Trace Element containing Manganese and Boron) is added to High Analysis IB-Compound. However superphosphate and fused magnesium silico phosphate are not normally used, because the available phosphate content is less than that of ammoniumphosphate and is therefore not suitable for high analysis fertilizers. The process of manufacturing High Analysis IB-Compound is the same as Hardened IB-compound except for by-passing a pre-cooler (11) in Fig. 7.

High Analysis IB-Compound's granule size is 2-4 mm in diameter. Table 7 lists various grades for IBDU containing fertilizers.

5. IBDU for single N Fertilizer and Bulk Blend Fertilizer  
IBDU is widely used as the raw material for many kinds of compound fertilizers, but it can also be applied to the fields as a single nitrogen fertilizer or a bulk blend fertilizer.

The granule size of IBDU has a significant effect on its mineralization. Experiments were conducted to determine the rates of mineralization of IBDU for different granule sizes. (Fig. 8) We can produce IBDU as a white crystalline powder or as small granules with a wet process or dry process respectively, but powder is dusty and unhandy when transported for use as a straight nitrogen or bulk blend fertilizer. So, we studied granulation of IBDU. But, because of non-water solubility of IBDU, we could not granulate it with usual methods. After many trials, we have succeeded in getting several size of IBDU granules with the special reaction conditions. The technology is very important know-how.

We transport IBDU granules from our Mizushima plant to Yokkaichi and Kurosaki plant by ship in bulk, and, after crushing it to powder, use it as the raw material in many kinds of compound fertilizers. Because of its granular shape, IBDU does not suffer from dusting when transported. Now, we have exported the straight IBDU to the U.S. I think you can get IBDU easily from Swift & Company in the U.S.

6. IBDU for Feed Stuff

Since 1967, Mitsubishi has experimented with IBDU as an Animal Feed. After many trials and much research at Mitsubishi, the laboratories of certain universities, the Japan Ministry of Agriculture and Forestry, and at many agricultural experimental stations, Mitsubishi succeeded in making feed for ruminants, such as sheep and cattle, from IBDU. IBDU is used as the source of a non-Protein Nitrogen for ruminants. The non-Protein Nitrogen provides effective nutrition for a ruminant, and large quantities of urea are used in the U.S.

Urea, however, changes to ammonia too fast in the rumen. It either results in loss of the syntheses of microbial protein, or causes injury from excessive ammonia. IBDU, on the other hand, changes gradually to urea and IBA after solution in water.

- A. Non-toxicity of IBDU

The LD<sub>50</sub> of IBA is 3.7g/kg of the rat drink test, and the upper allowance limit for death in a rat is 16,000ppm in air. Isobutyric Acid is more detectable in the gastric juice of the rumen of an IBDU-fed goat than in that of an ordinary goat. This implies that IBDU changed to IBA and that IBA was further oxidized to isobutyric acid in the rumen of the goat. The isobutyric acid is not only non-toxic but also aids microbes in the decomposition of cellulose. Fig. 9 and

10 show the nontoxicity of IBDU to goats. Three female goats (body weight: 31 to 32 kg) were respectively fed with 20g of urea, 35g of IBDU and 500g of ordinary compound feed, each containing 9 to 10g of nitrogen concentration of urea and ammonia. Blood serum was measured at 10 minute intervals and the condition of each goat was observed. As in Fig. 9, ammonia concentration in the blood serum of the urea fed goat showed a sharp rise. The

goat caused dyspnoea and convulsions after 30 minutes, symptoms of ammonia poisoning. It died 70 minutes after being treated with urea. In contrast, in the two goats that were given IBDU or an ordinary compound feed respectively, no abnormality or increase of serum ammonia was observed. Since IBDU is stable and unhygroscopic, it does not give off an ammonium odor, as does urea mixed feed, when mixed with other feedstuffs in summer.

## FIGURE-1

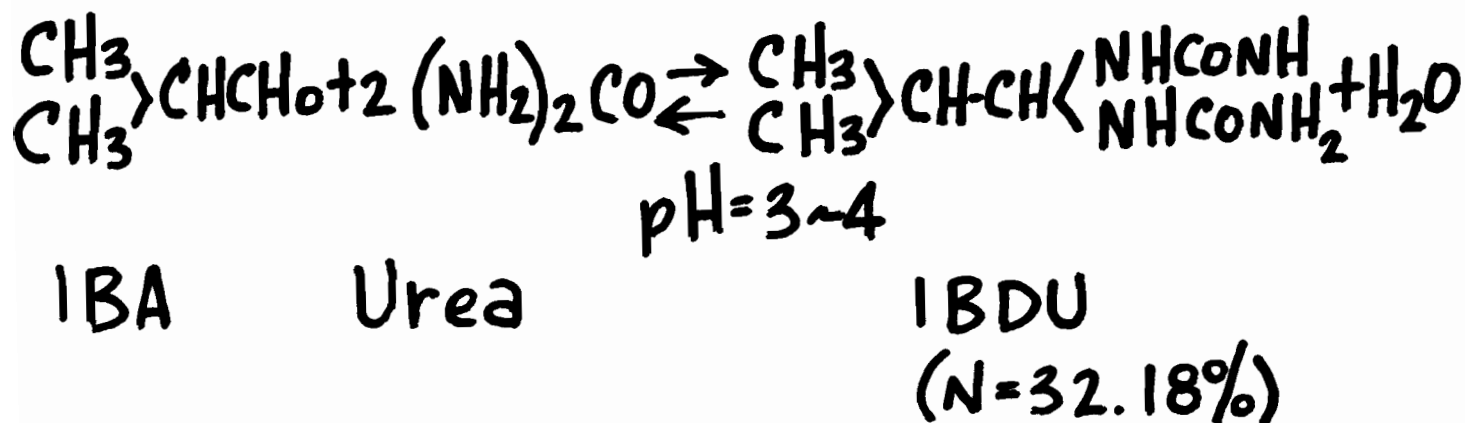
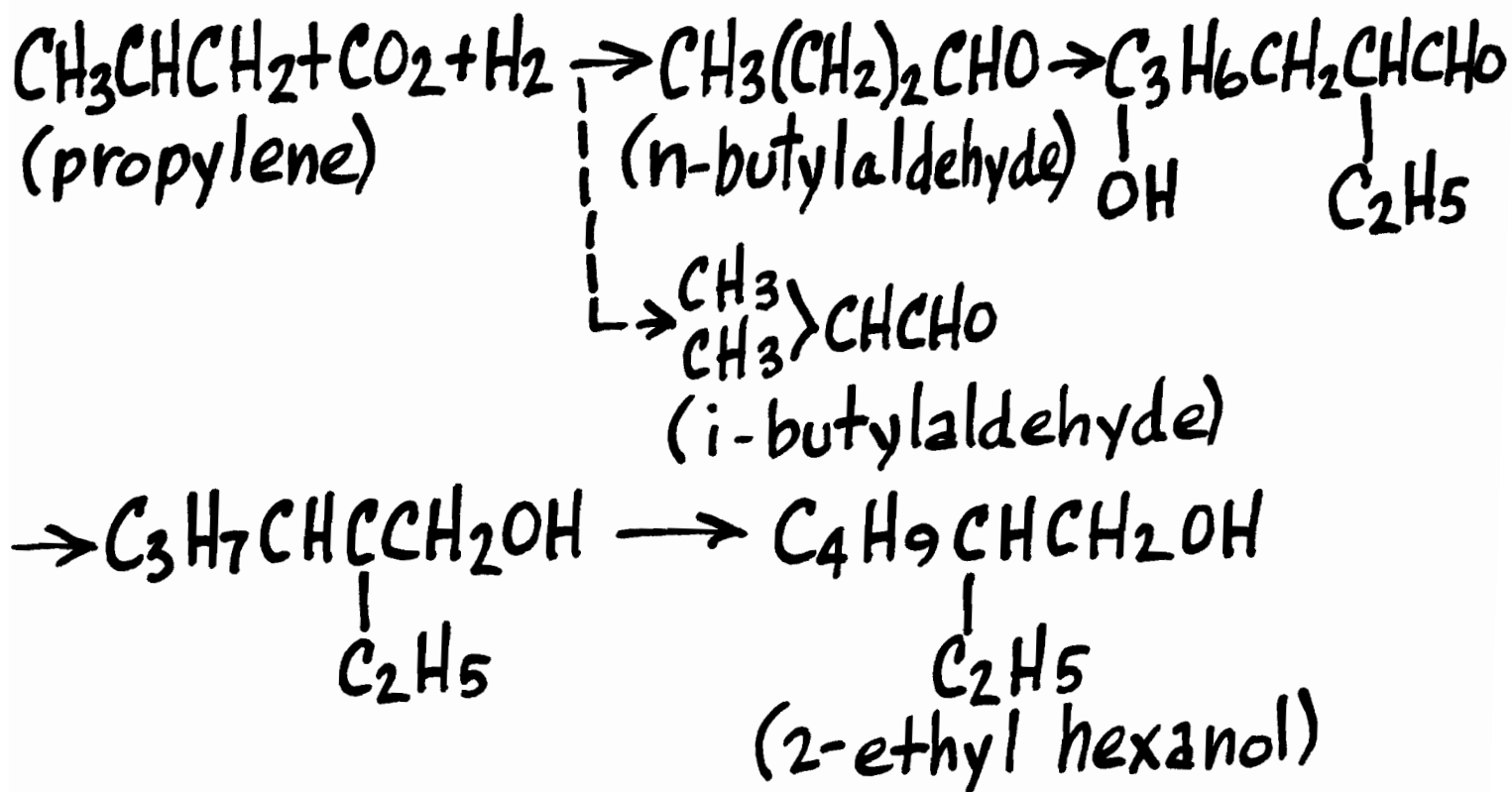


TABLE-1  
PHYSICAL PROPERTIES OF IBDU

Molecular Weight	174.21
Nitrogen Content	32.18
Appearance	White Crystalline Powder
Melting Point	205° with decomposition
Specific Gravity	(true) 1.3 (apparent) 0.7 ~ 0.9
Solubility	0.03 ~ 0.3 g/100ml H <sub>2</sub> O (hardly soluble in alcohol, ether) at room temp.
Hygroscopicity	negligible

## FIGURE-2



## TABLE-2

## AGRONOMIC CHARACTERISTIC OF IBDU

1. Slight water solubility
2. Mineralization through Urea
3. Control of slow-action by granulation
4. AI-Value

TN	32.1%
CWIN	24.9%
HWIN	0.9%
AI-Value	96%
5. Influence of Aldehyde on Plant Physiology

FIGURE-3 WET PROCESS

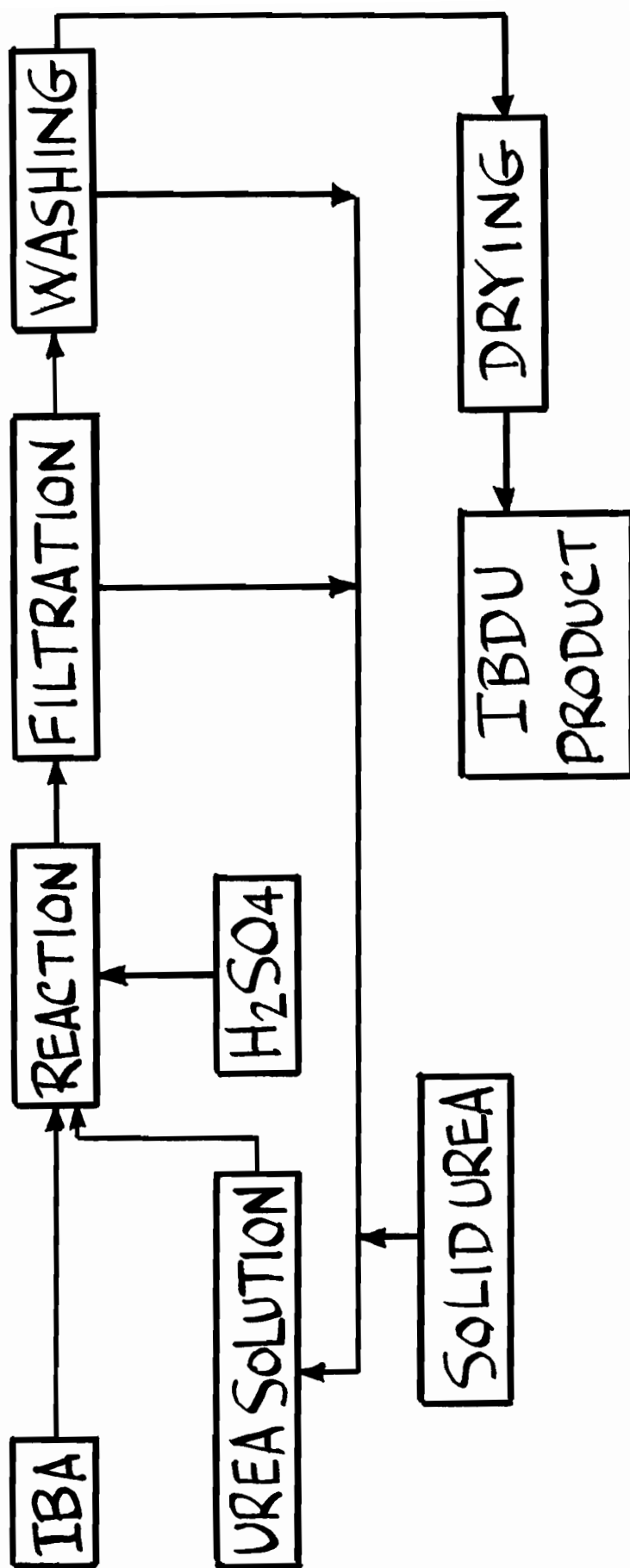


FIGURE-4 DRY PROCESS

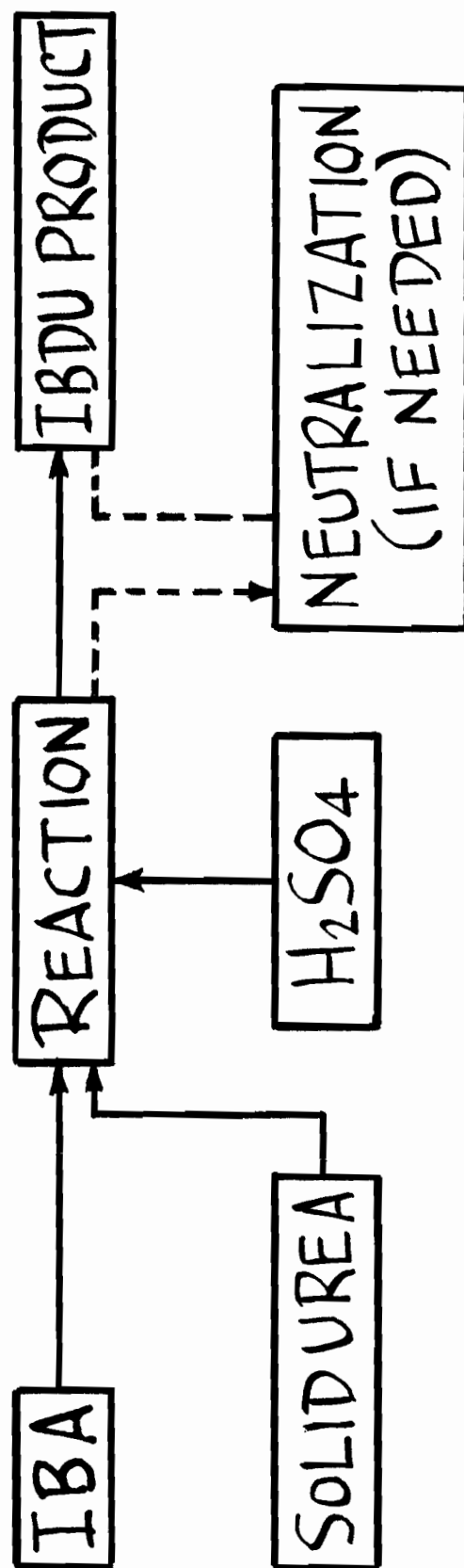




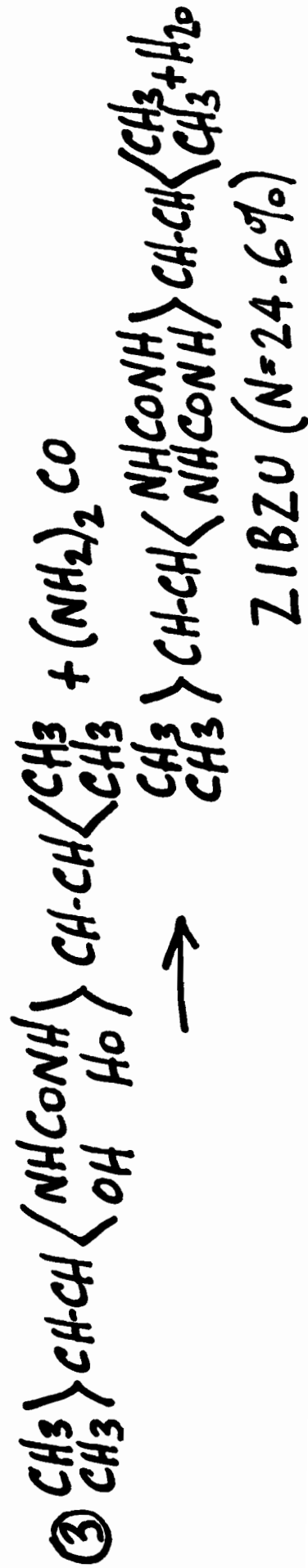
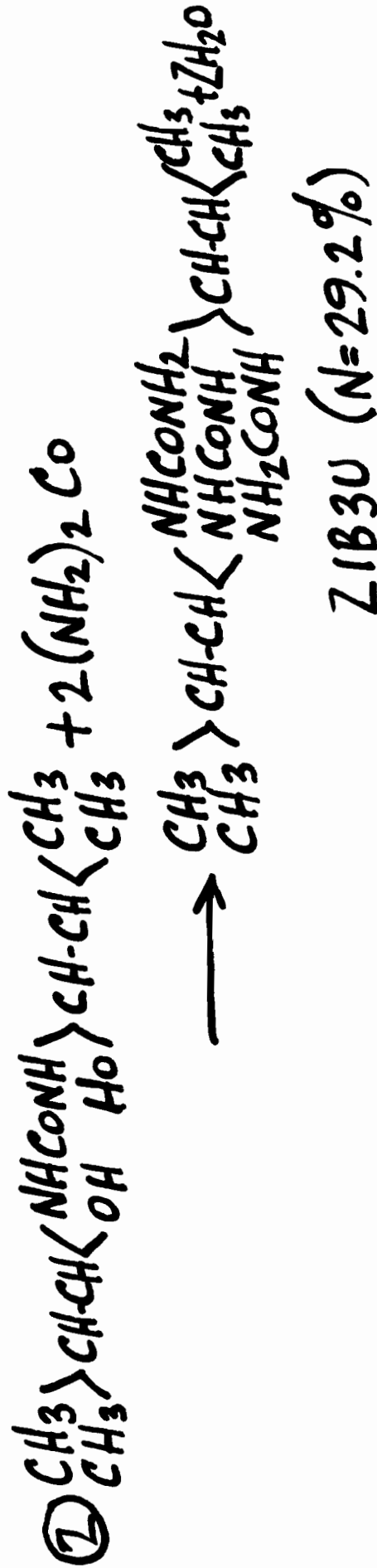
TABLE-3

DIFFICULTIES OF THE DRY PROCESS

a. Removal of the reaction heat
b. Repression of the secondary reaction
c. Control on the reaction rate

FIGURE-5

SIDE REACTION OF IBA AND UREA



# TABLE-4 EFFECT OF REACTION TEMPERATURE

Reaction Temperature (°C)	Reaction Rate of Urea (wt%)	Nitrogen Content of Reaction Product (wt%)
52 ~ 56	98.7	27.00
56 ~ 58	98.6	28.63
58 ~ 64	98.4	30.92
64 ~ 68	98.4	31.46
68 ~ 72	98.0	31.84
72 ~ 76	97.6	32.05
76 ~ 80	95.4	32.17
80 ~ 84	90.3	32.17
84 ~ 88	79.0	32.18
88 ~ 92	64.0	32.18
92 ~ 96	35.0	32.18

Note: Reaction Rate =  $\frac{TN-UN}{TN} \times 100$

Nitrogen Content =  $\frac{(TN-UN) \times 100}{100 - \frac{UN}{46.65} \times 100 - W}$

where TN = Analysis value of total nitrogen

UN = Analysis value of urea nitrogen by urease method

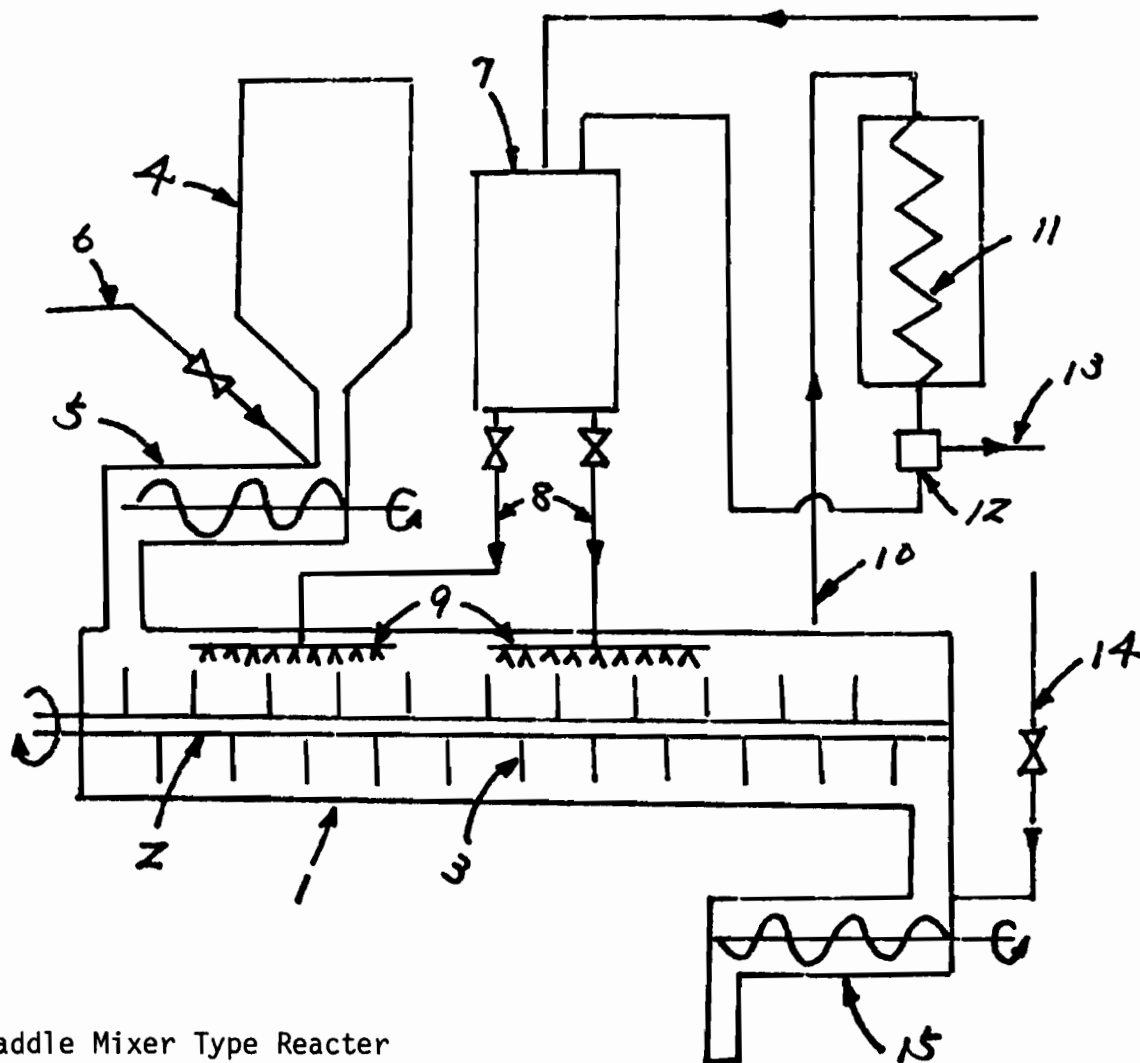
W = Analysis value of nitrogen in urea

# TABLE-5

## EFFECT OF PH ON REACTION RATE

PH	Reaction Rate(%)
0.5	86.5
1	90.0
2	96.0
3	98.0
4	94.0
5	87.7
6	80.0
7	71.6
8	62.0
9	52.5

# FIGURE-6 IBDU PLANT



- |                                   |   |
|-----------------------------------|---|
| 1. Paddle Mixer Type Reactor      | 12. Separater for Separating Water from Aldehyde        |
| 2. Rotary Shaft Turned by a Motor | 13. Outlet Line for Water                               |
| 3. Blade on Shaft                 | 14. Alkali Feed Line to Neutralige Acid Added through 6 |
| 4. Urea Storage Tank              | 15. Product Outlet                                      |
| 5. Constant Feeder for Urea       |   |
| 6. Inorganic Acid Feedline        |   |
| 7. Aldehyde Storage Tank          |   |
| 8. Aldehyde Feed Line             |   |
| 9. Spray for Aldehyde             |   |
| 10. Line for Evaporated Aldehyde  |   |
| 11. Condenser for Aldehyde Vapour |   |

**TABLE-6**  
**ANALYSIS OF PRODUCT IBDU**

ITEM	UNIT	CONTENT
Total nitrogen	Dry weight %	32.3
Urea nitrogen	"	0.2
IBDU nitrogen	"	32.2
Water	Wet weight %	7.5
PH of neutralized product	5gr/100ml water	9.0

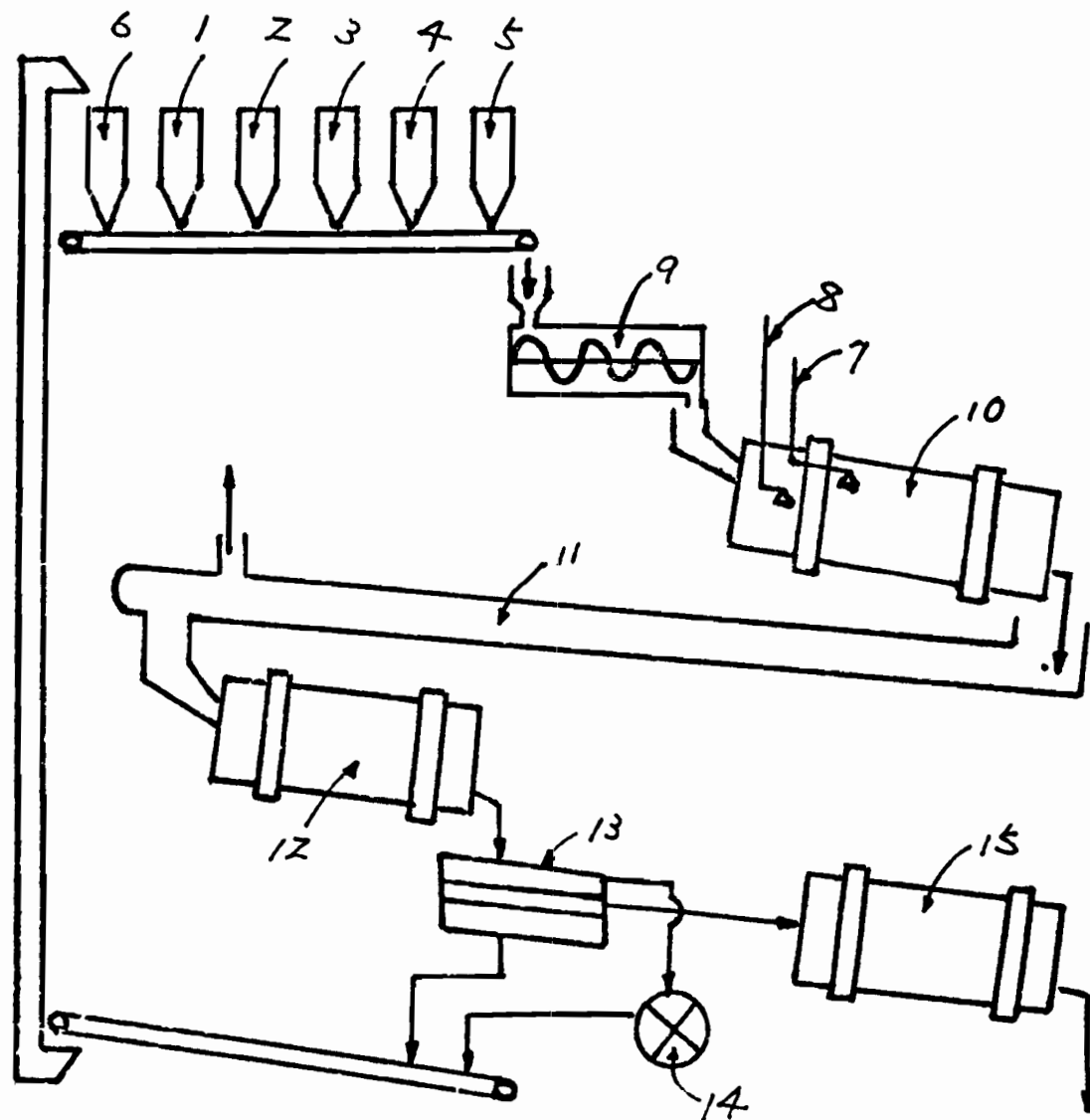
# TABLE-7 GRADES OF IBDU CONTAINING FERTILIZERS

Grade	Composition of nitrogen	Fertilizer material
IBDU (straight)	31 as IBDU	IBDU only
IB-Compound Fertilizer		
ex. IB 10-10-10	8 as IBDU, 2 as Urea	IBDU, Urea, S.P., F.P., Kcl, $H_3PO_4$
IB 10-14-18	3 as IBDU, 2 as Urea, 5 as Ammonium	IBDU, Urea, S.P., F.P., Kcl, DAP
IB 10-15-10	6 as IBDU, 3 as Urea, 1 as Ammonium	IBDU, Urea, S.P., F.P., Kcl, DAP
IB-RINKAAN (High Analysis IB-Compound)		
ex. IB 15-15-15	7.5 as IBDU, 7.5 as Ammonium	IBDU, A.S., DAP, Kcl or $K_2SO_4$
IB 16-10-14	8 as IBDU, 8 as Ammonium	IBDU, A.S., DAP, Kcl
IB 18-11-11	6 as IBDU, 4 as Urea, 8 as Ammonium	IBDU, Urea, DAP, $K_2SO_4$

S.P. : Superphosphate  
 F.P. : Fused magnesium  
 silico phosphate

A.S. : Ammonium sulfate  
 DAP : Diammonium phosphate

# FIGURE-7 IB-COMPOUND FERTILIZER PLANT

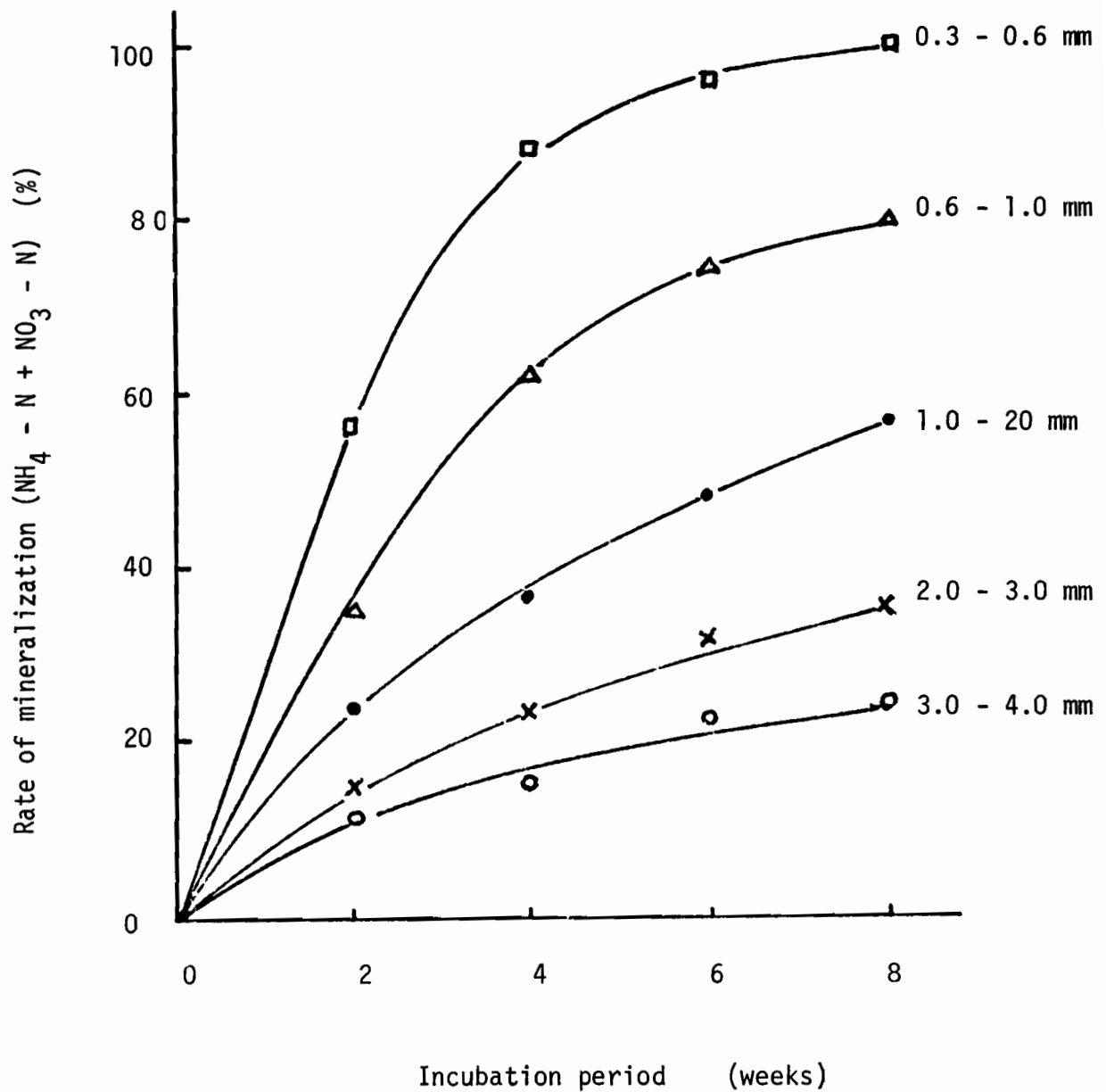


1. Hopper for IBDU
2. Hopper for Fused Phosphate
3. Hopper for Superphosphate
4. Hopper for Ammoniumphosphate
5. Hopper for Potassium Chloride
6. Hopper for Recycle Materials
7. Pipeline for Urea Solution
8. Pipeline for Water or Phosphoric Acid
9. Mixer
10. Rotary Drum Granulation
11. Pre-cooler
12. Rotary Dryer
13. Double Deck Screen
14. Crusher
15. Rotary Cooler

PRODUCT



**FIGURE-8 INFLUENCE OF PARTICLE ON THE MINERALIZATION OF IBDU**

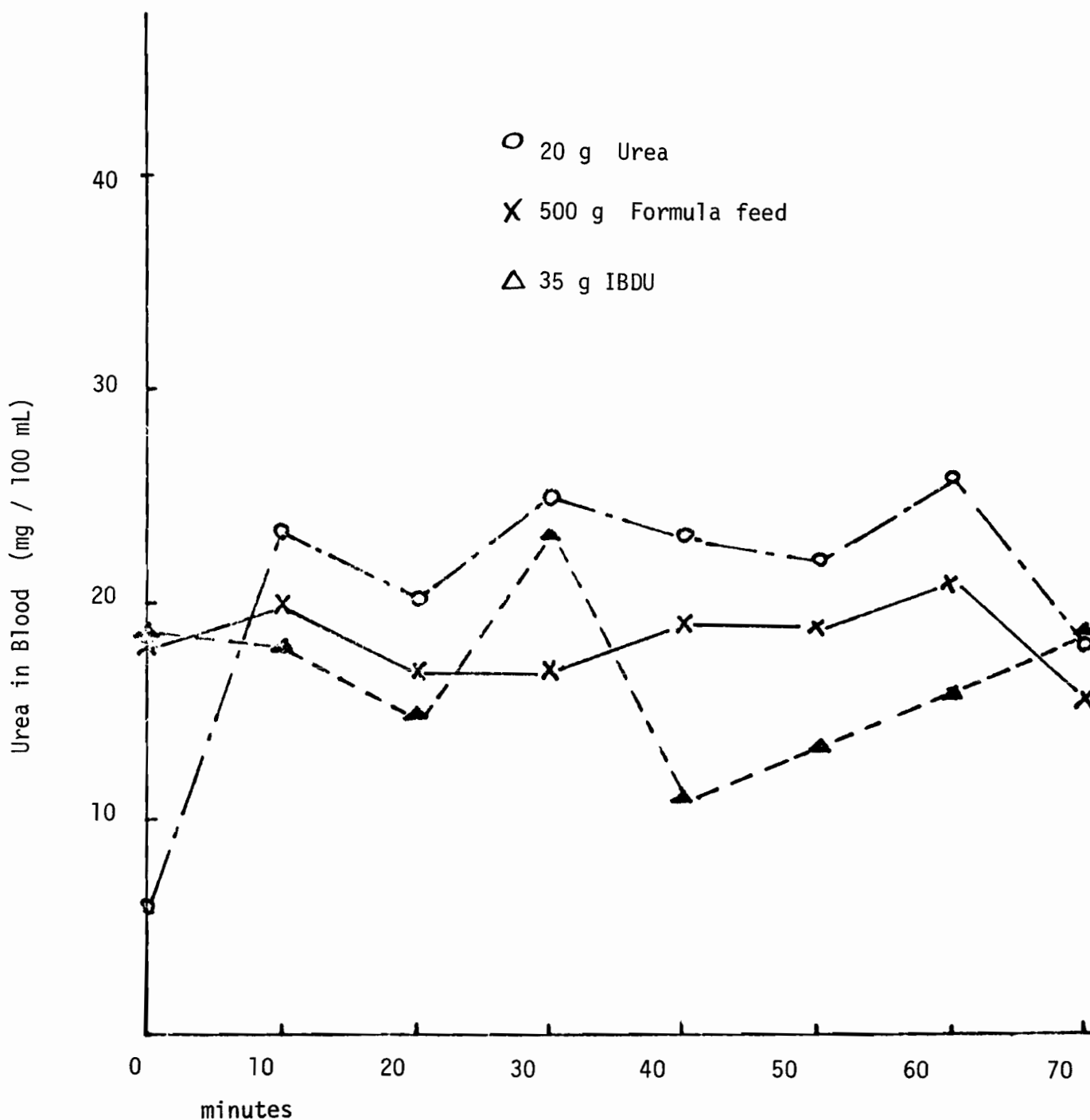


Temp.: 68° F.

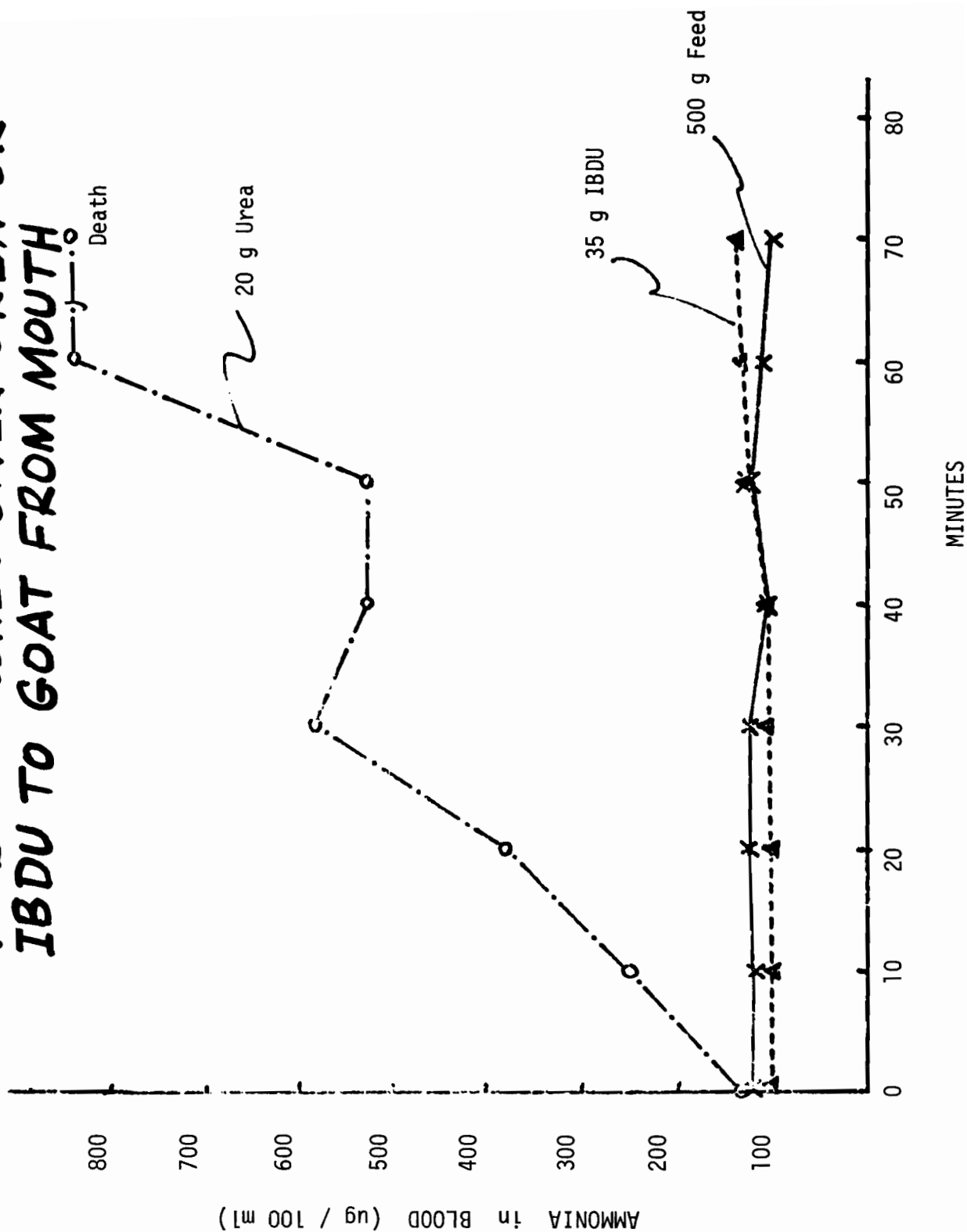
Moisture: 60% of max. water holding capacity

Amounts of N added: 50 mg N/100g dry soil

**FIGURE-9 INCREASE OF UREA CONTENT IN BLOOD WHEN GIVEN UREA OR IBDU TO GOAT FROM MOUTH**



**FIGURE-10 INCREASE OF AMMONIA CONTENT  
IN BLOOD WHEN GIVEN UREA OR  
IBDU TO GOAT FROM MOUTH**



## INFORMAL ROUND TABLE DISCUSSIONS

### Moderators' Remarks:

*Wayne W. King — Albert Spillman*

Our last year Informal Round Table discussions were very good and excellently handled. Averaging 20 per table; the participants were comfortable when asking questions and discussing the answers.

Your program Committee received many requests for this year's program to contain one or two similar afternoon Informal Round Table Discussions. Our Board of Directors unanimously gave their O.K.

You will again have the opportunity this afternoon and tomorrow afternoon to: And we quote Joe Whittington, Moderator of Last Year's Informal Round Tables:

"You are on the program and that means all of us will participate in 'Around Table Discussions' similar to those around the one table at which a small group 21 years ago originated the Fertilizer Industry Round Table." End of Quote.

We have 6 tables this afternoon and it looks encouraging for a good session. The tables are filling up. You will have an opportunity to change tables, if you wish, at least 3 times to permit you to attend, listen and contribute in most of the table discussions.

I note the Leaders for their respective Tables are ready and anxious to start the discussions. Topics are:

- Table No. 1 — Controlled Release Fertilizer.
- Table No. 2 — "OSHA" and The Fertilizer Plant.
- Table No. 3 — Dryers—Coolers—Scrubbers—Cyclones—Ammoniators.
- Table No. 4 — Designing Towers and Pits to Keep Building Costs to a minimum.
- Table No. 5 — Screen Discussions.
- Table No. 6 — Ammoniators—Granulators—Reactors—Pug Mills—Dryers—Coolers—Furnaces.

### TABLE NO. 1

#### DISCUSSION OF CONTROLLED-RELEASE FERTILIZER

*Leaders: Tomoaki Tsuno, Travis P. Hignett, Frank Nielsson*

1. The cost of IBDU was discussed. The cost in Japan was said to be in the order of twice that of urea per unit of nitrogen. Since IBDU is not produced in the United States, the cost is higher here. When water-insoluble nitrogen was required, IBDU was said to be an economical source.
2. The question was raised as to any hazard from IBDU under conditions of heavy rainfall. No such hazard has been identified.
3. Methods of granulating IBDU into large particles were discussed. Briquetting and compaction were said to be suitable.
4. The question was raised as to whether the critical relative humidity of ammonium nitrate would be lowered by admixture with IBDU. No data were available, but the opinion was expressed that there would be little effect.

5. As to the safety of mixtures of IBDU and ammonium nitrate, no data were available, but it was thought that a mixture of the two materials might be hazardous, since any organic material tends to sensitize ammonium nitrate.
6. The length of time IBDU is effective in the soil depends on temperature, moisture level, and soil pH. A range of 12 to 28 weeks is typical.

Comments by Frank Nielsson:

Controlled release fertilizers are of interest primarily to manufacturers of Lawn and Garden fertilizers. Discussion with Mr. Tsuno and Swift indicated that IBDU, the slow-release nitrogen described by Mr. Tsuno, is manufactured only in Japan by Mitsubishi Chemical Company. It is sold in the United States only through Swift to a few manufacturers. Otherwise, Swift uses it in their line of L & G products. It was not possible to obtain any data concerning the price of IBDU so it could be compared with Uramite or Nitroform, or other urea-formaldehyde products. Mr. Hignett described TVA work with sulfur-coated urea which is a new entry in the field of controlled-release fertilizers.

7. It was asked whether the A1 value of IBDU decreased when it was used in compound fertilizer. The answer was no.
8. The maximum quantity of IBDU for safe application was discussed; it depends on the kind of crops. For instance, as much as 1000 pounds of N per acre has been applied to turf grass without injury.
9. Since IBDU is made from byproduct isobutyl aldehyde, the question was raised as to whether the supply of this byproduct was adequate. Some figures were presented showing that the annual production of isobutyl aldehyde would be sufficient for a several-fold increase in IBDU production. Most of the excess isobutyl aldehyde is burned for fuel.
10. The mechanism of release of IBDU in the soil is through hydrolysis. CDU, another slow-release nitrogen material, differs in that it is decomposed by microbiological processes.

### TABLE NO. 2

#### "OSHA" AND THE FERTILIZER PLANT

*John S. Neild, Jr., Leader*

1. *Administration*
  - A. Maintain OSHA forms 100 and 101
  - B. Post OSHA Form 102 yearly
  - C. Notify OSHA of any fatality
2. *Work Area*
  - A. Guard rails needed around all docks and open pits
  - B. Work areas must be clean, dry, and clear
3. Floor and wall openings must be guarded.
4. Stairways need approved rails and proper angle
5. Ladders must be stored properly and maintained in good shape
6. Exits must be marked and unobstructed

7. • Air contaminants, if toxic, must be eliminated
8. Noise levels must be below 90 decibels, or one of the following actions taken:
  - A. Reduce noise
  - B. Provide personal protection
  - C. Reduce exposure of the employee
9. Anhydrous Ammonia equipment must be maintained according to standards and in good condition.
10. Dust masks will be required in dusty areas and employees made to wear them. Regular inspections must be made of masks.
11. Rest rooms need to be constructed according to specifications.
12. Fire extinguishers will have regular inspections and be properly inspected.
13. Mobile equipment will have overhead guards, horns and fire extinguishers.
14. Cranes shall have inspection log books maintained and fire extinguishers in near area.
15. All exposed plant equipment must be safely guarded.
16. All electrical equipment will be properly covered and guarded and grounded.

**TABLE NO. 3**  
**DRYERS-COOLERS-SCRUBBERS**  
**CYCLONES-AMMONIATORS**

*Leaders: Joseph L. Prosser, Paul J. Prosser, Jr.*

Questions:

1. Scrubber vs Baghouse – Why are Scrubbers applied more in South than North.  
Has to do with evaporation rate of Settling Pond and better water control.
2. Basic talk on Bag House –
  - A. Air to cloth ratio
  - B. Bag Material – Basic types and why select one over the other.
  - C. Talked Heat Recirculation on air or strip heaters in duct filter to prevent down time condensation.
3. Gas Routing on Dryer Cooler Applications –
  - A. Eliminate the cyclone precleaner.
  - B. Route Cooler Gas through Dryer to rescue total volume to Bag House.
  - C. Run Ammoniator Gas through Dryer to elevate temperature to prevent the corrosive nature.

**TABLE NO. 4**  
**ILLUSTRATION HOW PLANT EQUIPMENT**  
**CAN BE DESIGNED TO KEEP BUILDING**  
**TOWERS AND PITS TO A MINIMUM**

*Leaders: Walter J. Sakett, Jr & Michael J. Sakett*

First . . .

In railroad car unloading operations, an undertrack concrete pit was eliminated by clamping the undertrack conveyor directly to rails.

Second . . .

In granulation plants, a roof line was lowered by using a low profile raw material blending and feeding system.

Third . . .

In Bulk Shipping Operations, a tower that houses a screen and tailings mill was eliminated by mounting a milling and screening unit over the elevator boot at floor level.

**TABLE NO. 5**  
**DISCUSSIONS ON SCREENS**

*Leaders: Steve Janovac, Wayne W. King,  
and Philip D. Bleser*

1. Almost all of the questions concerned the possibility of lowering the noise level of the Hummer Electric Screens. Messrs Janovac, King and Bleser assured the participants that the W. S. Tyler Co. does have on the drawing boards and in first priority development a Hummer Noise Reduction Kit. Tyler plans are to make this kit available for field conversion of all existing Hummers now in operation with the end result of reducing the noise level to a point where it will be acceptable under "OSHA" standards for 8 hour exposure.
2. Interest was also shown in the use of Fabrica Composition Wear Plates in place of The Tyler Old Standard Steel striking full range on Hummer Screens. Tyler has reports from customers indicating improvements in the noise level ratings of the Hummers using this type of striking plates.
3. There was much interest to all who attended our Informal Round Table. Good discussions and answers were given on all the phases of screen operating problems.
4. Those interested in various catalogs, on wire cloth specifications, were advised to write to W. S. Tyler, Inc., Screening Division, 8200 Mentor, Ohio, 44060

**TABLE NO. 6**  
**DISCUSSION ON AMMONIATORS-GRANULATORS**  
**REACTORS-PUG MILLS-DRYERS**  
**COOLERS-FURNACES**

*Leaders: Elmer J. Leister, E. K. Thompson*

We had an excellent attendance and real good discussions. Photographs featuring this type of processing equipment were shown and thoroughly analyzed by our Group.

Some of the Equipment illustrated and discussed represented the types manufactured for large N.P.K. plants in the world. Example: One plant in particular, having a capacity of approximately 490 metric tons per hour, were using two 13.6" diameter by 101'8" long Rotary Dryers, two 11' diameter by 60' long Rotary Coolers and two 11'

diameter by 24' long Granulators. It was pointed out that this is an indication of the trend toward higher capacity plants creating the need for vastly increased capacity processing equipment.

Many interesting questions and excellent answers were given on proper maintenance. Engineering, manufacturing and operational problems can increase as equipment

size increases. Such problems as (a) developing cracks in "Shells", (b) maintaining gear alignment, (c) maintaining "Trunion" alignment, (d) compensation for thermal expansion, (e) proper distribution of concentrated stresses in the unit, etc., all of which must be given very serious consideration in advance.

We appreciate the cooperation, both on questions and answers, by our attentive group.

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# Thursday, November 2, 1972

## Morning Session

Moderator: Joseph E. Reynolds, Jr.

**MODERATOR REYNOLDS:** Good morning. We have a full program for this A.M. session and I am sure most interesting subjects for discussion. Many of you recently had the opportunity to attend the T.V.A. Demonstrations at Muscle Shoals, Alabama. Our first Speaker, Travis P. Hignett, has always been a real motivating force behind these demonstrations. Travis is extremely well known to the Fertilizer Industry in the U.S.A. and internationally around the world.

Travis is Director of the Tennessee Valley Authority's Division of Chemical Development. He is a graduate of Drake University and came to T.V.A. in 1938, after working with the Fixed Nitrogen Laboratory (USDA) and with Research Associates, Inc. In his present position, which he has held since 1962, he directs T.V.A.'s Research and Development Work in the field of Fertilizer Technology.

### **HIGHLIGHTS OF T.V.A. FERTILIZER TECHNOLOGY DEMONSTRATION**

*Travis P. Hignett*

I have been asked by your program committee to discuss briefly what I consider to be the highlights of TVA's ninth Fertilizer Technology Demonstration. I know that a good number of you were at Muscle Shoals for the demonstration last month, and I hope you thought it was worthwhile. Also, I presume that you who were at Muscle Shoals got one of our booklets that described our work. For you who were not there, we have extra copies here, if you care to have one.

This year at the technology demonstration we had 9 small and large pilot-plant demonstrations and 25 other exhibits. As usual, some of the projects were the same as have been shown in earlier demonstrations; however, the information was extended to reflect our latest stage of development and thinking. The exhibits included research on partial purification of wet-process phosphoric acid by various methods, improvement in the quality of urea and its use in bulk blends, and recovery of oxides of sulfur from stack gas. Also, there was information on physical and agronomic properties of various fertilizer materials, on applications of the scanning electron microscope to

fertilizer research, and on rapid methods for analyzing fertilizers.

Demonstrations reflected our increased emphasis on use of wet-process phosphoric acid and urea and on liquid fertilizer technology, as we believe that these subjects will be increasingly important in the near future.

*Highlights* of the demonstration, of course, depend on your particular interests — whether liquid fertilizers, granulation, or pollution control. Whether highlights or not, we have given considerable emphasis during the past 2 years to the pipe reactor for production of high-analysis polyphosphate liquid fertilizers, to methods for improving the quality and lowering the cost of suspensions, to learning more about and how to better make controlled-release nitrogen by sulfur coating of urea, and to minimizing pollution problems as in granulation plants.

I have chosen these latter subjects for more detailed discussion today because I feel that they are in final stages of development — in fact, some already are being used by industry.

#### *Controlled-Release Nitrogen — Sulfur-Coated Urea*

For several years TVA has studied the encapsulation of soluble granules and prills to impart controlled-release properties to them. Potential advantages of controlled-release nitrogen fertilizers are increased efficiency of uptake by plants; minimization of losses by leaching, runoff, or decomposition; reduction of application costs through reduction in frequency of application; elimination of luxury consumption; and prevention of burning of vegetation or damage to seedlings. As most of you know, we are currently operating a 1-ton-per-hour pilot plant to continue the development of a process for making controlled-release sulfur-coated urea (SCU). Our continued and growing interest in SCU comes from the continuing favorable results being obtained in the laboratory and in the field.

Numerous greenhouses and field experiments have shown that SCU is a superior source of nitrogen for forage crops, rice, sugarcane, and pineapple and, in general, for use on porous soils or where heavy rainfall or irrigation would

result in excessive nitrogen losses. For example, a greenhouse study was made to compare uncoated urea, ammonium nitrate, and SCU in a severe leaching environment. The results (see Fig. 1) showed that SCU produced about 40% more forage than did a single application of urea or ammonium nitrate. Nitrogen uptake was 30% from a single application of urea or ammonium nitrate as compared with 50% from SCU. Another important fact shown in these tests was that only 5% of the applied nitrogen from SCU was lost through drainage water as compared with 15 to 30% from urea or ammonium nitrate.

In 19 field experiments with rice conducted in Asia and Latin America, the yields with SCU averaged 17% higher than with uncoated urea. In these tests, intermittent or delayed flooding was practiced, and the fertilizers were applied at time of transplanting. There was no significant difference under continuous flooding conditions.

When 13 experiments in the United States were summarized, SCU showed an average yield increase of 9% over that from uncoated urea. These latter tests were conducted for the most part under delayed flooding, where both fertilizers were applied at time of seeding.

Yield differences were often sufficient to return \$10 to \$30 per dollar invested in coating urea, assuming that the delivered cost of SCU would be 35% more per unit of N than uncoated urea. This is the order of magnitude of the projected cost if the process were completely developed and carried out on a large commercial scale. We hope that further work will decrease the cost.

Most of our work on the coating process has been with granular urea of fairly large size, from 5 to 7 mesh or 6 to 10 mesh. We have used a commercial urea in these sizes and also have produced a granulated urea in our pan granulation pilot plant. The advantages of using the large size rather than the usual air-prilled size are that there is much less surface area and therefore much less coating is required. A few tests with unusually large granules (3 to 5 mesh) show that the desired release rate can be obtained with even less coating weight.

In the laboratory we evaluate the controlled-release properties of SCU by determining the amount that dissolved in 100°F water in 7 days. Agronomists feel that, for best results on most crops, the 7-day dissolution should be about 25%. Typical dissolution rates after the seventh day are 0.5 to 1.0% per day. Actual rates in the soil depend on temperature and many other factors which are under further study.

A view of our pilot plant is shown in Figure 2. We now can make a product containing 40% nitrogen with an initial dissolution rate of 25%. The coating consists of 8 to 10% sulfur, 2% of a wax sealant, 0.25% of coal tar to combat bacterial action on the wax, and 2% of inert coating to prevent stickiness — a total coating weight of 12 to 14%. This is quite an improvement over the products we made several years ago, which required somewhere in the order of 20 to 25% coating for the same results. Typical coating

thickness ranges from 50 to 70 microns, about half to three-quarters of the thickness of a sheet of bond paper.

The plant utilizes a urea preheater for bringing the urea to a temperature of about 160°F and a drum equipped with multiple spray nozzles for spraying sulfur on the hot urea. From this drum the sulfur-coated material is taken to a second drum where wax coating is applied; then it passes through a fluidized bed cooler into the last drum in which the conditioner is added.

The product has excellent physical properties and has high resistance to humid air so that storage in humid climates without special protection is possible. The coating also will prevent reaction of urea with superphosphate when these materials are used in blends. It is pointed out that, where controlled release of nitrogen is not a factor, the properties of humidity resistance and compatibility with triple superphosphate can be obtained with much lighter coatings. We have done well with 4% sulfur and 0.5 of a wax-oil mixture.

Present estimates indicate that the cost of the controlled-release SCU made in the 500-ton-per-day plant may be about 30% higher than that of urea, per unit of nitrogen. However, the advantages shown for it may make the additional cost well worthwhile in many cases. Our pilot-plant work is continuing with hopes that continued refinement of the process will result in lower cost.

*Pipe Reactor Process for Production  
of High-Polyphosphate Liquid  
Fertilizer from Superphosphoric Acid*

The pipe reactor process for production of high-polyphosphate liquid products has been one of TVA's most significant recent developments. With this process, products containing 75 to 80% of their P<sub>2</sub>O<sub>5</sub> as polyphosphates can be produced from superphosphoric acid of as low as 10% polyphosphate level. The key to this process is the utilization of the energy resulting from the heat of reaction to convert the ortho to the polyphosphate form. Compared with products made by conventional ammoniation of commercially available superphosphoric acid (40 to 50% polyphosphate), the high polyphosphate content of pipe reactor products permits higher analysis (11-37-0 vs. 10-34-0) and prevents or retards precipitation of impurities, particularly magnesium compounds. The storage life of the product depends on the temperature; at 60°F or below, hydrolysis of polyphosphates is very slow, and the storage life should be a year or more; at 80°F, the storage life is 20 to 25 weeks. Although the process has only been under study for about 16 months, several commercial plants are already using it, and others are under construction.

We think this development may go far toward realization of the goal of making good-quality phosphatic liquid materials without special purification of wet-process acid. We have used superphosphoric acid from four major areas of the United States — central and north Florida, North Carolina, and Idaho. We are aware that some of these acids were made from selected, low-impurity rock, and that



some were treated to remove part of certain impurities. We do not have sufficient information to state how much of each impurity can be tolerated in high-polyphosphate liquid. We intend to get more information on this point, but I suspect that there is no simple answer to the question.

The process, as demonstrated last month, is shown in Figure 3. Superphosphoric acid of about 25% polyphosphate level was reacted with gaseous anhydrous ammonia in this pipe reactor. The temperature of the discharge was of the order of 600° to 700°F, which resulted in formation of additional polyphosphates. This melt was mixed with cooled product and water and additional ammonia as required for grade in a circulating loop flow system. Liquid ammonia feed was vaporized by supplying part of the cooling for the system.

Acids from several commercial sources have been successfully utilized, with only minor adjustments in operating procedure.

Some problems encountered in the pilot-scale development of the process were (1) corrosion in the pipe reactor, (2) building of scale of crystalline (Fe, Al)  $\text{NH}_4\text{P}_2\text{O}_7$ , and (3) hydrolysis of polyphosphate during the processing of the melt into liquid fertilizer. Cooling of the pipe reactor shell with a water jacket effectively controlled buildup of scale and corrosion. Even without cooling, there is little corrosion since the scale protects the pipe, so some operators prefer to use an uncoiled pipe and remove scale occasionally. Corrosion of stainless steel is severe when the acid is so pure that scale does not form, but a carbon-lined pipe has proved satisfactory in this case. With cooling of the pipe, there is some decrease in melt temperature and a few percentage points decrease in polyphosphate content of the melt. However, there should be very little loss in a large plant because of the proportionately lower surface area to be cooled.

Figure 4 shows the relationship between the polyphosphate content of the feed acid and that of the melt in the discharge end of the pipe reactor. These data are with an uncooled pipe and were obtained with one sample of acid diluted to different concentrations; similar tests have not been made with other acids. In the present pilot plant the melt is quickly quenched, dispersed, and dissolved in the circulating liquid fertilizer. With this system, little hydrolysis of the polyphosphate in the melt occurs when the recirculation rate is as high as 40 gallons per gallon of product and the temperature of the recirculated liquid is 140°F.

These data show that low-conversion superphosphoric acid (10 to 25% polyphosphate level) can be used to make melts containing 85 to 90% polyphosphate. There seems to be little merit in using acids of higher conversion in a well-designed system.

The low-conversion acid may be produced at substantially higher rates and with less corrosion in some types of concentrators, making it less expensive to produce. Also of importance is the fact that it handles easier because of its lower viscosity.

#### *Nongranular Monoammonium Phosphate*

One of the small pilot plants that we operated last month was for the production of nongranular monoammonium phosphate (MAP). Also, we operated one of the large pilot plants to demonstrate how NPK granulation with MAP instead of with formulation based on sulfuric acid reduces fume formation — and pollution problems.

Other potential benefits of using MAP include (1) capability for shipment and handling a high  $\text{P}_2\text{O}_5$  source in conventional solids-handling equipment without any need for special tank cars or ships as needed with phosphoric acid, (2) avoidance of the sludge problem associated with shipping and storing merchant-grade acid, (3) increased production rates when used to replace phosphoric acid in high-acid formulations, and (4) higher product grades with higher  $\text{P}_2\text{O}_5$  water solubility when used to replace superphosphate. The latter type of operation was demonstrated by us in 1970.

Several commercial processes are available for producing MAP. It is produced and used as an intermediate in the production of granular fertilizers in several other countries. We do not know of any plants producing or using it in the United States at present. However, we think that the potential benefits are significant, and that this material will have a place in the fertilizer industry in this country.

A flow sheet of the production of MAP by a TVA process is shown in Figure 5. The process involves ammoniation of merchant-grade wet-process phosphoric acid in two stages. In the first stage, which is an atmospheric pressure preneutralizer, the acid is ammoniated to  $\text{NH}_3:\text{H}_3\text{PO}_4$  mole ratio of 0.3 to 0.4. The finishing ammoniation to  $\text{NH}_3:\text{H}_3\text{PO}_4$  mole ratio of 1.0 is carried out in a pipe reactor where the temperature reaches 425°F. The melt from the pipe reactor is discharged onto recycle material in a pug mill. Most of the moisture in the system flashes off. The pug mill discharge is cooled and screened on a 10-mesh screen. The plus 10-mesh material is crushed and rescreened. A portion of the minus 10-mesh material is withdrawn as product. About 3 pounds of recycle was needed per pound of product. The product contains less than 1% moisture and has about 10 to 15% of its  $\text{P}_2\text{O}_5$  as polyphosphate. It has excellent storage and handling properties.

Products made in our pilot plant and by two of the commercial processes have been tested in pilot-scale granulation tests at TVA. No substantial differences in ammoniation and granulation characteristics were noted.

During the recent technology demonstration a granular NPK product was produced in the pilot plant using MAP for comparison with the same ratio product produced with conventional materials, including sulfuric acid and ammoniating solution. Substantially less fume was evolved from the granulator when formulations using MAP were used. Equipment and techniques for sampling stack gas from the ammoniator for particulate and fume content were demonstrated at the pilot plant.

Our results from tests of production and use of MAP

have been generally successful and encouraging. However, I believe that more pilot-plant work is needed. In future studies we plan to study granulation of formulations with MAP and urea.

Another possible use of MAP is for fluid fertilizers, especially high-analysis suspensions. With ammonia, urea – ammonium nitrate solution, potash, water, and 1% gelling clay, we made a satisfactory 14-14-14 product.

#### *High-Analysis Suspensions from Wet-Process Orthophosphoric Acid*

Another process demonstrated in a small pilot plant was the production of 12-40-0 suspension fertilizer from merchant-grade wet-process acid. The storage quality appears to be excellent. Since merchant-grade acid is the phosphatic raw material and processing is rather simple, we think that the successful development of this process will be a big step toward making suspensions economically competitive with bulk blends.

In the 1970 demonstrations we had an exhibit showing that 10-30-0 or 11-33-0 could be made from merchant-grade acid by conventional batch ammoniation which we carried out at pH 6.4 and 180°F. The key to overcoming this grade limitation was found to be two-stage ammoniation with the first stage held at least for 30 minutes at pH 4 and at boiling (225°F). Under these conditions (as demonstrated this year), the impurities are precipitated in crystalline form as compared with viscous gell-like material formed in the single-stage tests. The conditions of time and temperature of the second stage, in which the product was ammoniated to pH 5.0, were not critical.

Figure 6 is a flow diagram of the process as we envision it. Acid and ammonia are fed continuously to the first stage at a ratio to give a pH of about 4; this requires about 70% of the total ammonia for the final product, which has a pH of 5.9. No cooling is used for the first stage; a retention time of 30 minutes or more at boiling, 225°F, not only causes the desired precipitation, but is an inexpensive way to dispose of the heat of reaction. Since a lot of water is evaporated from this reactor, water is added to the reactor or the feed acid is diluted. In the small pilot plant we used acid of 38% P<sub>2</sub>O<sub>5</sub> content. The second stage receives the remainder of the ammonia and is maintained at 160° to 180°F by recycling cooled product to prevent ammonia loss at the higher pH. Product from the cooler flows to the clay mixing tank where 1.5% of attapulgite

gelling clay is added to provide suspending properties for solids. The 12-40-0 suspensions had good storage properties at temperatures as low as 32°F.

Figure 7 shows the effect of retention time and pH in the first stage reactor on viscosity of the final 12-40-0 product, using merchant-grade Florida black acid. Best results were obtained with 45 minutes or more retention at pH of about 4.

High-potash suspension (5-15-30) made by mixing potassium chloride, urea – ammonium nitrate, and water with the 12-40-0 also had good storage properties. With these high-grade bases, high-grade mixed suspension of various ratios may be made by blending. These base grades and NPK mixtures are of about as high analysis as made with the more expensive polyphosphates.

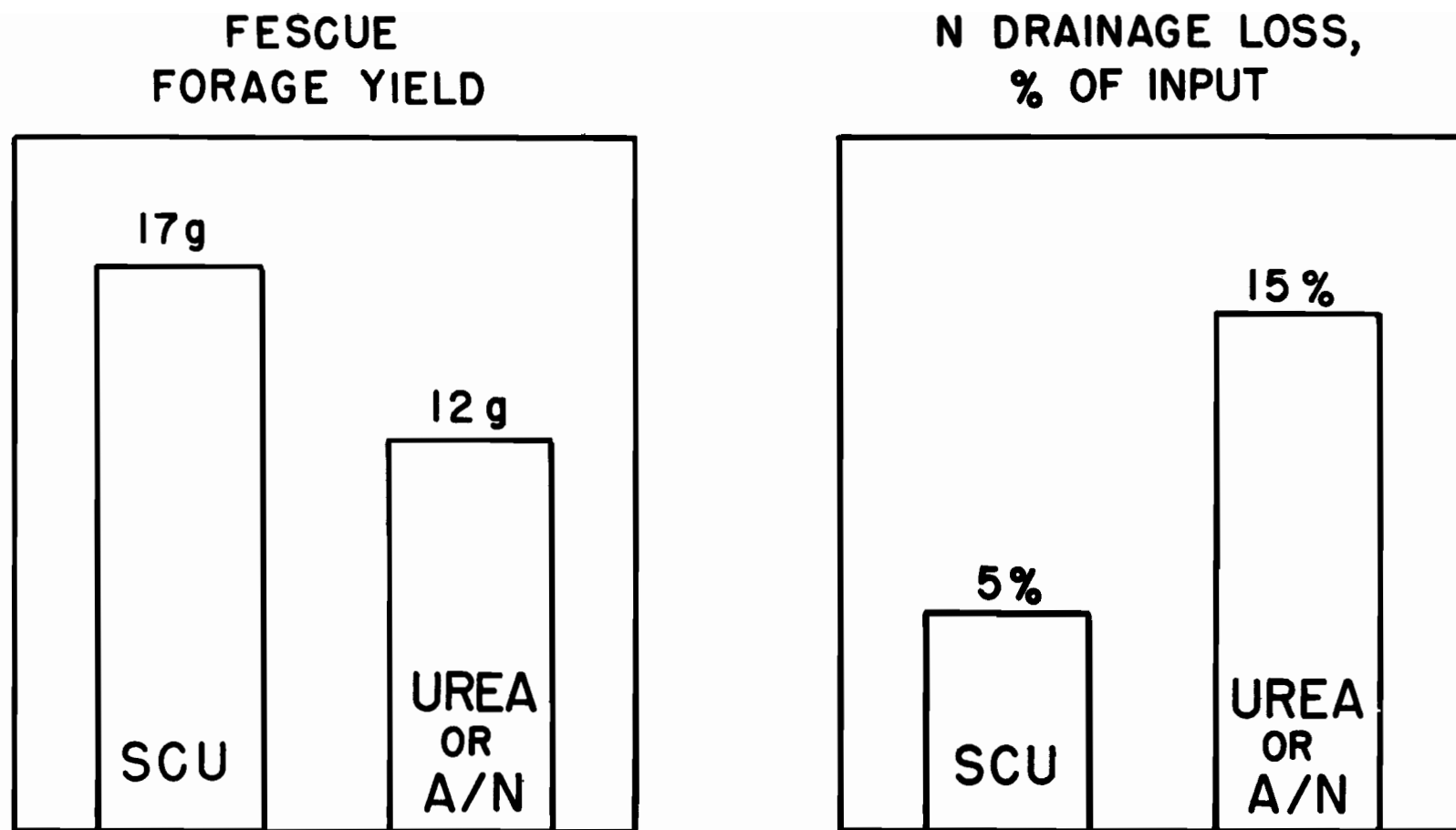
It is visualized that this process would be most useful to the producer with a volume large enough to warrant satellite plants. The bases could be made in a central plant and stored there or shipped and stored at the satellite.

The small pilot plant has a capacity of 75 pounds per hour. We are now studying this process in a larger pilot plant of 0.5 ton per hour capacity; one question to be answered is whether or not an evaporative cooler of the slat type can be used for suspension.

#### *Recovery of Sulfur Oxides from Stock Gas and Potential Use in Fertilizer Production*

During the last few years an increasing amount of our research and development effort has been devoted to work on removal of sulfur dioxide from power plant stack gases. This work has two long-range implications for the fertilizer industry. Much of the SO<sub>2</sub> now discharged into the atmosphere is brought down by rainfall on farmland. When this source is no longer available, sulfur will need to be supplied in fertilizers in many more areas and to a greater extent than at present. If recovery processes are developed that are less costly than removal processes, much of the recovered sulfur or sulfuric acid will have to be used by the fertilizer industry. Perhaps new plants will be located near the source of byproduct sulfuric acid rather than near the phosphate rock mines.

During the demonstration, two pilot plants were shown at the Colbert plant, a coal-fired station near Muscle Shoals. One was built to study a process that would recover sulfuric acid (or sulfur) by an ammonia scrubbing process. The other process (which is further advanced) involves scrubbing with limestone slurry and discarding the calcium sulfate sulfite product.



**FIGURE 1**  
**RESULTS OF GREENHOUSE TESTS UNDER SEVERE LEACHING CONDITIONS**

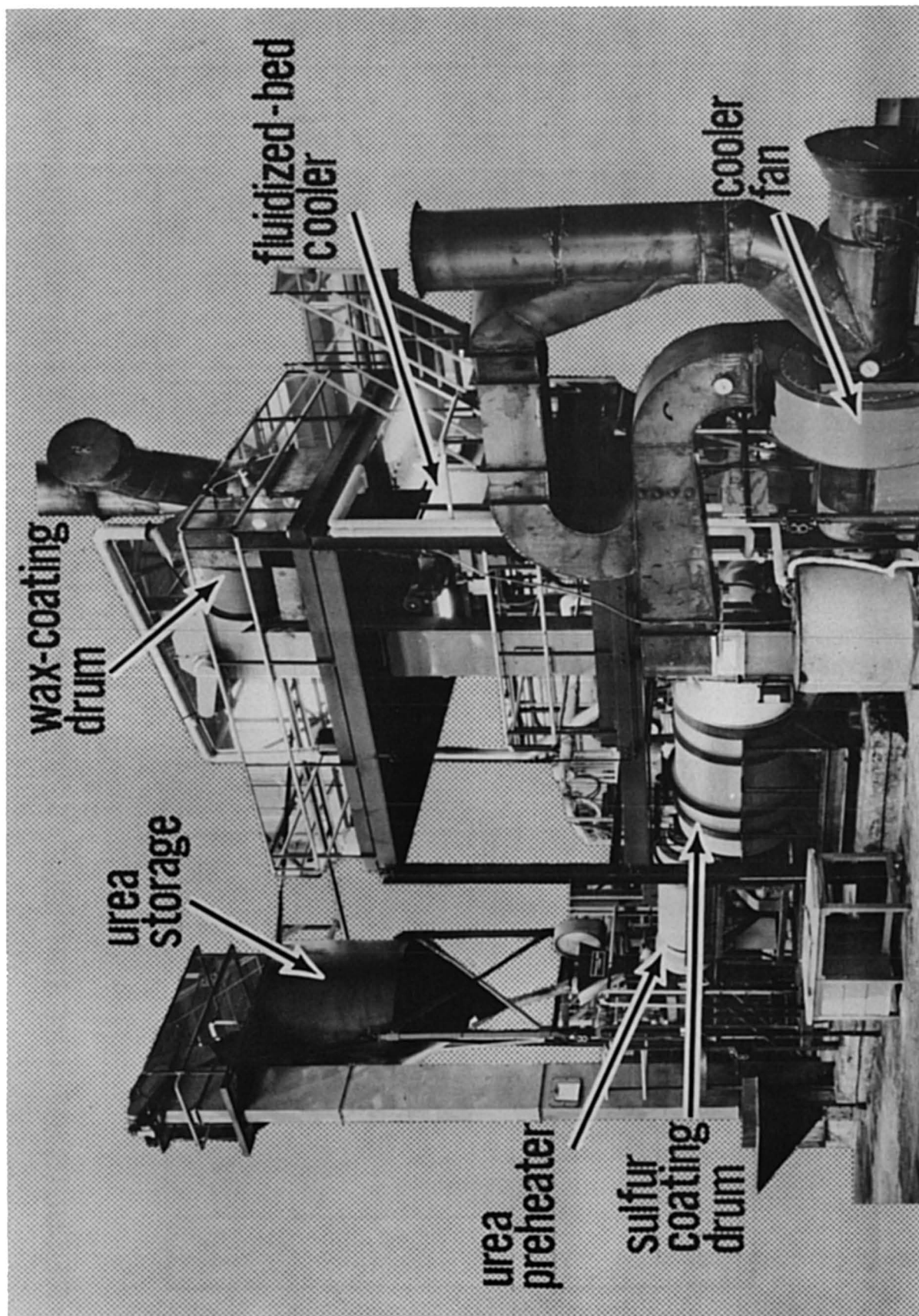


FIGURE 2  
PILOT PLANT FOR COATING UREA

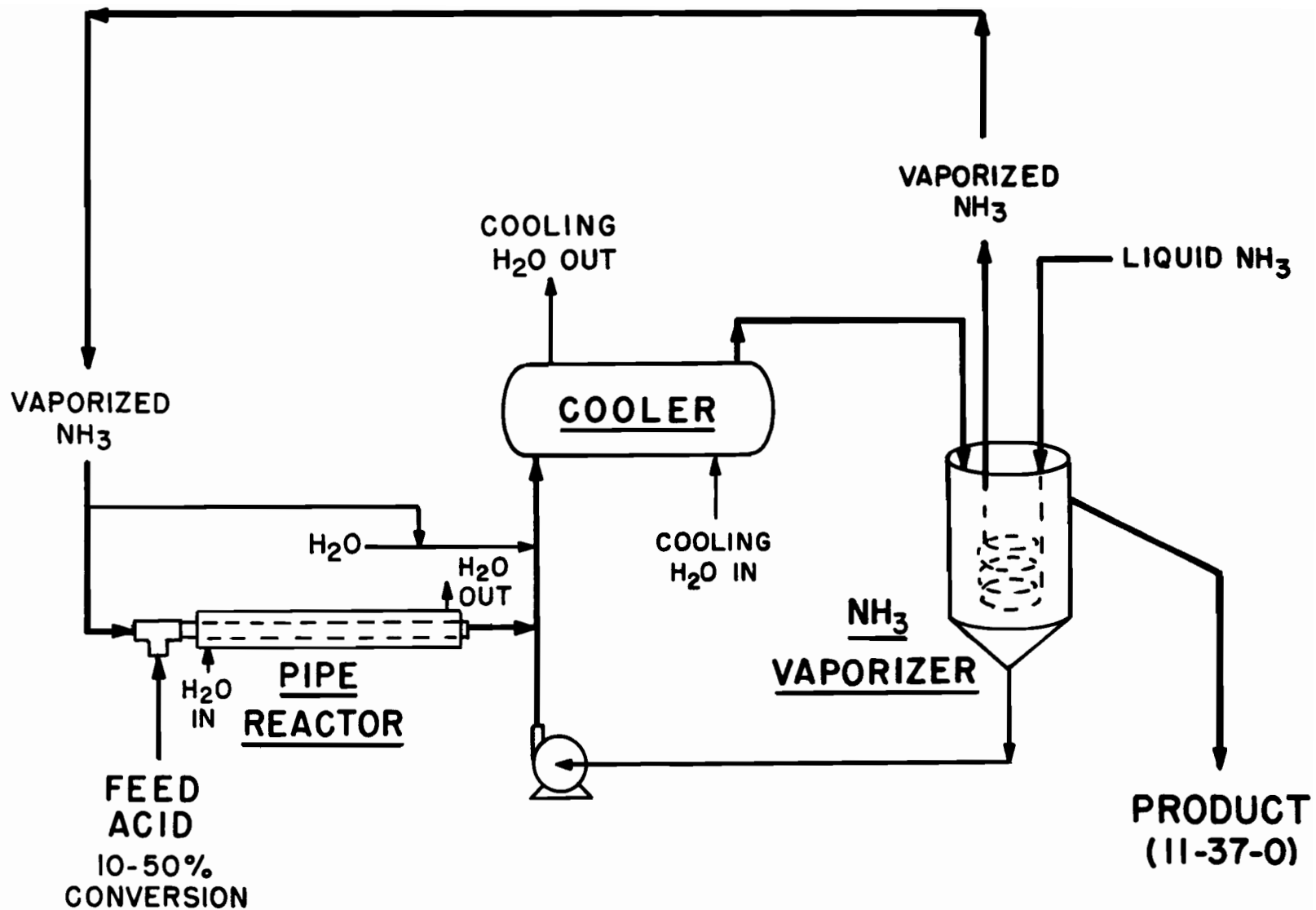
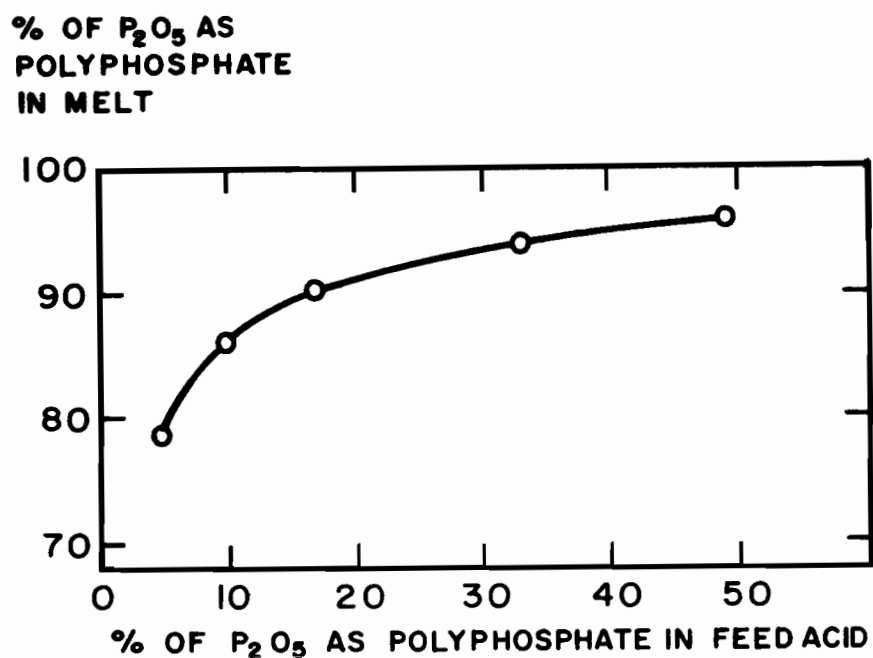


FIGURE 3  
PIPE REACTOR PILOT PLANT



**FIGURE 4**  
**EFFECT OF POLYPHOSPHATE CONTENT OF**  
**SUPERPHOSPHORIC ACID ON POLYPHOSPHATE**  
**CONTENT OF MELT IN PIPE REACTOR PROCESS**

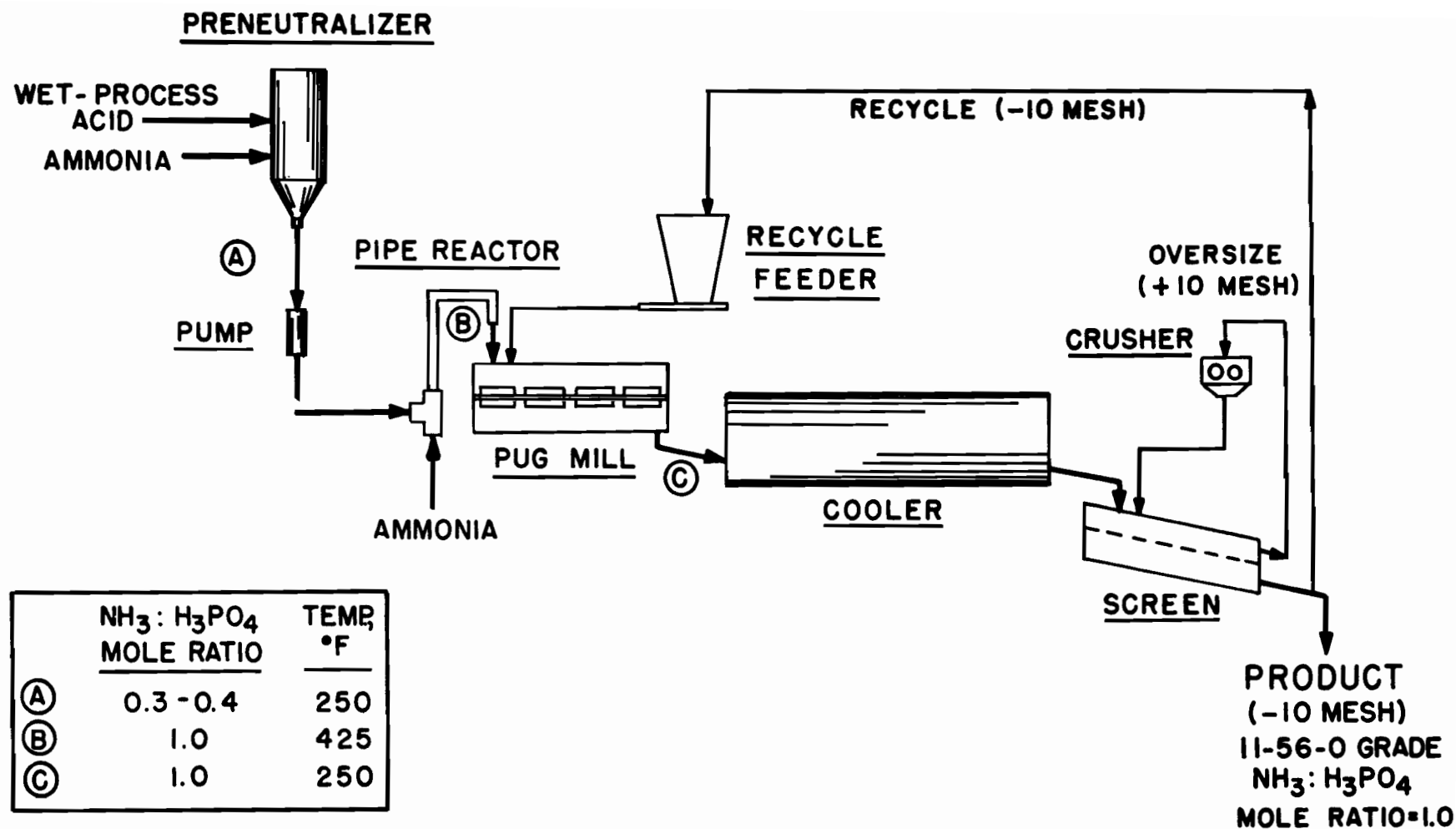
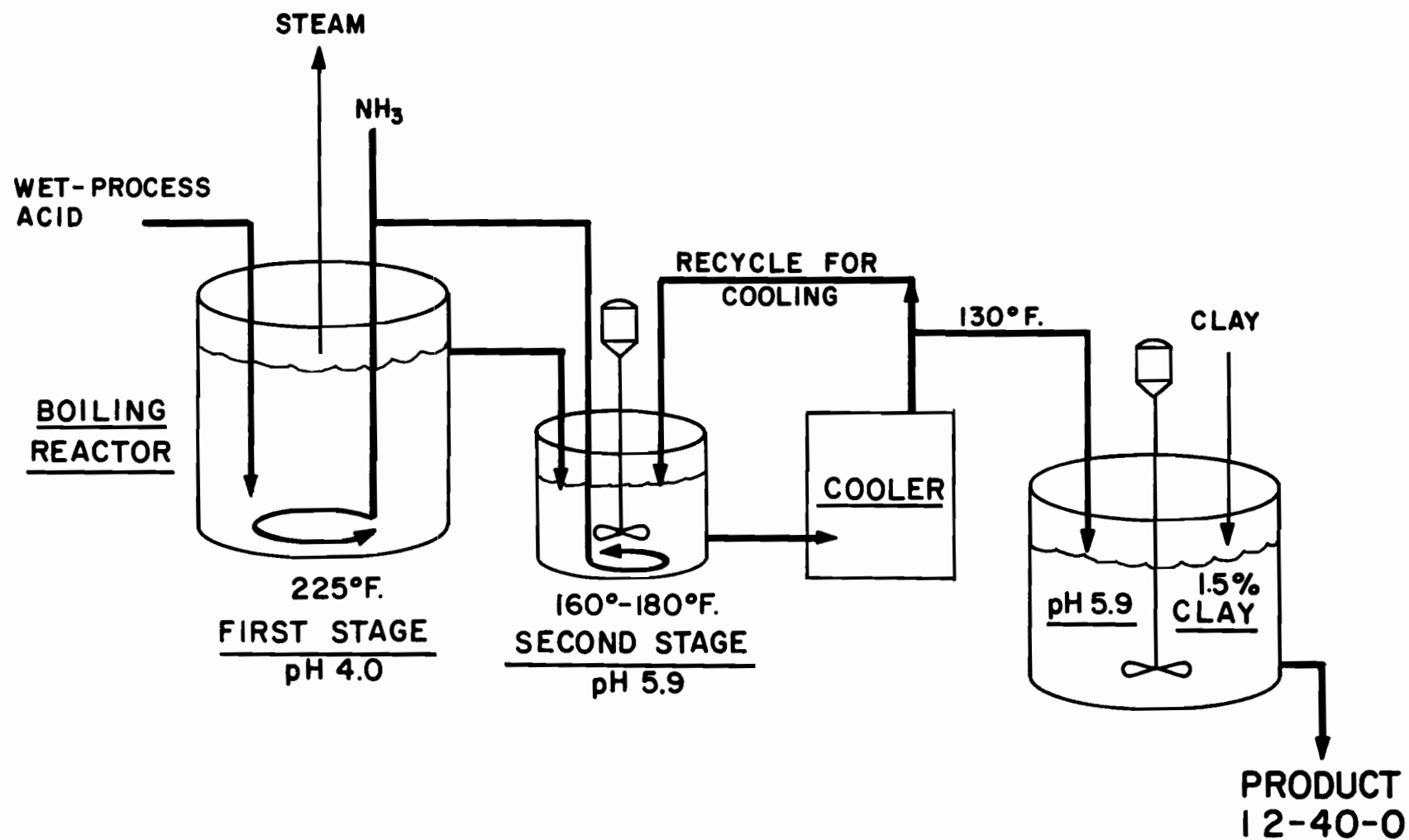


FIGURE 5  
NONGRANULAR MONOAMMONIUM PHOSPHATE PROCESS



**FIGURE 6**  
**12-40-0 SUSPENSION FROM MERCHANT-GRADE ACID**



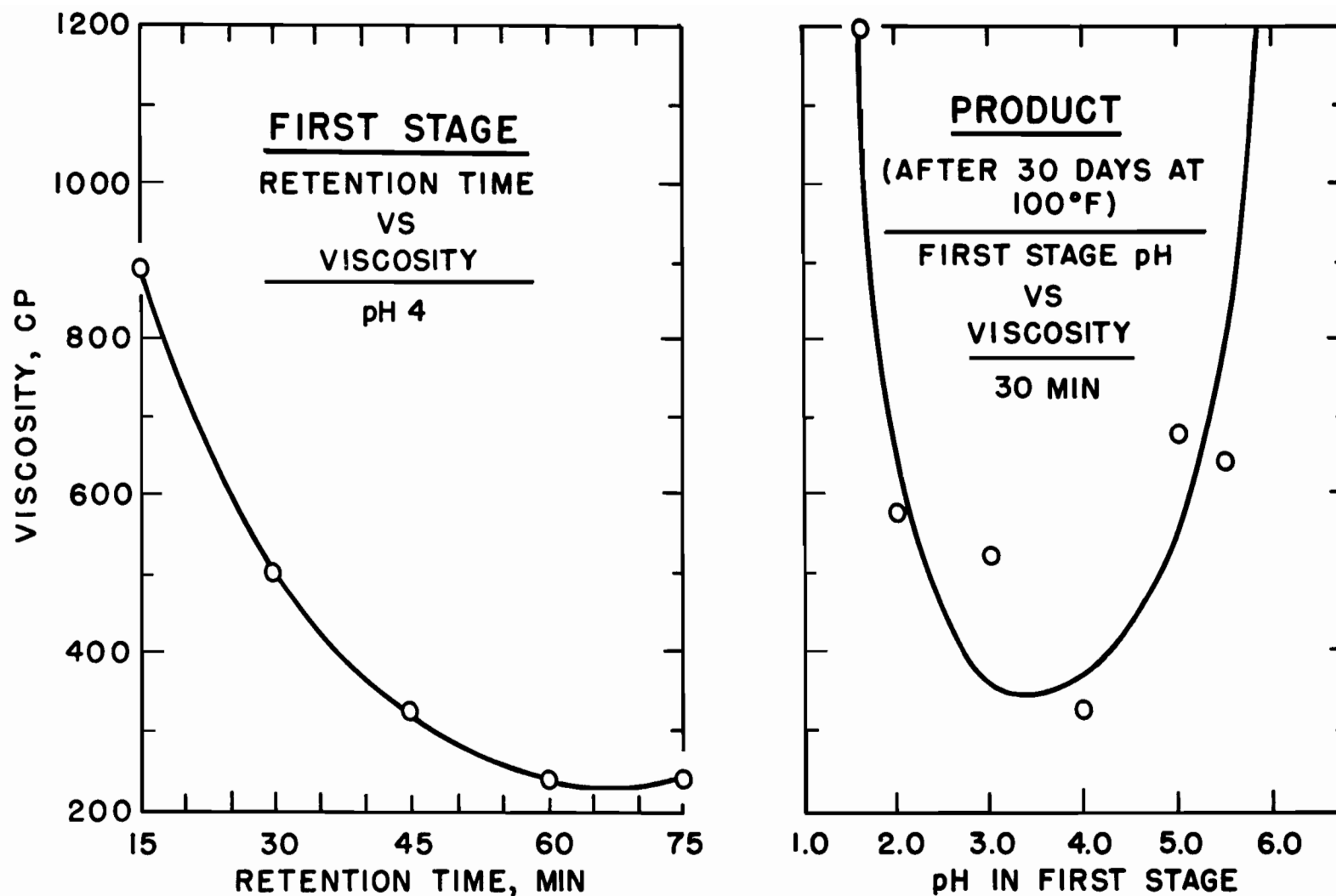


FIGURE 7  
EFFECTS OF RETENTION TIME AND pH IN FIRST STAGE REACTOR  
ON VISCOSITY OF 12-40-0 SUSPENSION

**MODERATOR REYNOLDS:** Our next speaker, Mr. Geoffrey Drake, comes to us from England. His paper for discussion is The Nitro-Top Process For Coated Ammonium Nitrate.

Mr. Drake has the following degrees: M.A. S.M. Chem. Eng. and F.I. Chemical Engineering. Studied Mechanical Sciences and Chemical Engineering at Cambridge, United Kingdom, 1949-53. Appointed Teaching Assistant at M.I.T. 1953 and took S.M. Degree in Chemical Engineering Practice, 1955. Mr. Drake joined United Kingdom Atomic Energy Authority, Head Office, 1955. Joined Fisons, Ltd. Fertilizer Division Production Department, 1960 and transferred to Research and Development Department, 1964 where his main interest has been in Process Development. Mr. Drake it is my pleasure to have you come to the rostrum.

## **THE NITRO-TOP PROCESS FOR COATED GRANULAR AMMONIUM NITRATE**

*Geoffrey Drake*

### **SUMMARY**

Fisons Limited new process for manufacturing a coated ammonium nitrate top dressing fertilizer known as Nitro-Top has many novel and interesting features. The principal technical innovation is that it employs a fluidised bed of fine dust particles to solidify and coat droplets in a unique way. The process produces an ammonium nitrate particle of approximately the same size as a normal fertilizer granule which gives an advantage in use on the farm where it is spread like a conventional granular product. It also gives a manufacturing advantage since it is compatible with and can therefore be readily blended and stored with other fertilizer granules to give a wide variety of product formulations. It is sold in the highly competitive U.K. market at a premium price.

The process has two basic steps. The first is the production of uniformly sized droplets of anhydrous ammonium nitrate. The second is the solidification of these droplets in a cloud of coating dust in controlled conditions to give the direct production of the coated product.

The manufacturing process is simple, cheap and highly efficient. Furthermore the solidification operation does not suffer from the severe effluent problem which afflicts the air prilling process.

### **INTRODUCTION**

The history of the process goes back as far as 1965, when the basic discovery about the solidification process was made. It grew from two major interests which for some time had been pursued independently in Fisons research laboratories. The first of these was anhydrous molten salt systems, on which we have worked for a number of years. A paper on the Fisons ammonium nitrate/ammonium phosphate melt process was given to the Round Table in 1966. This process incorporates rotary granulation of the salts, and while this is efficient (it is a low recycle process requiring no drier) we felt that it should be possible to

develop a simpler and more elegant method of forming melt granules.

The second interest related to the use of fine dusts in fertilizer processes. The dustiness of the fertilizer industry really needs no emphasis; while dust in the industry is tolerated and perhaps sometimes controlled, it is generally a nuisance. We were asking ourselves the question: need dusts be just a nuisance, or are there any fundamental properties which could be employed as a benefit. In particular the improved heat transfer characteristics of dusty air compared to clean air offered interesting possibilities. A limited amount of quite basic research was being undertaken on this topic.

Fluidised beds seemed to be a natural way of bringing together these two lines of thought and so there developed our interest in the solidification of molten salts in fluidised beds of fine dusts, the long term objective being the development of a better granulation system. For simplicity ammonium nitrate was used in the experimental work.

In the early stages of the investigation the dusts were gently fluidised and ammonium nitrate droplets fell into the fluidised bed from a height of only a few inches. A wide variety of dusts was used and the results were always the same: the droplets were severely distorted in the fluidised bed, they were diluted by picking up large quantities of the dust and the injection nozzle became coated with dust which occasionally splashed on to it and which adversely affected the way in which drops were formed. Moving the nozzle further from the bed whilst reducing dust contamination of the nozzle, increased the distortion of the droplet which occurred on impact with the bed. Increasing the air flow both increased the droplet distortion and the nozzle contamination.

We considered that the worst feature was the dust contamination of the ammonium nitrate injection nozzle. In any practicable design this would have to be taken well away from the splashing of the fluidised dust. Once this had been done we found there was a wide range of air fluidisation rates which could be used without causing difficulties in forming ammonium nitrate drops. There was still the problem of avoiding distortion as with low fluidising air velocities it was found, not unexpectedly, that very severe distortion of the droplets occurred. In some conditions this was so severe that the product resembled cornflakes. However, it was found that at air velocities which were several times the minimum fluidising velocity for the dust in use, a very attractive undistorted spherical product could be made. In these operating conditions the bed erupts violently and very substantial quantities of dust are blown out of it to form a thick dust cloud above the bed. Forming and maintaining this cloud is the central feature of the process: in it the first stage of the solidification of the droplet takes place.

Since the essence of the process is prilling into a dust cloud we have called the process "dust prilling." A pilot plant with a fluidised bed two feet in diameter has been the

most important tool used in the development of the process in Fisons Research and Development Department. There have of course been extensive laboratory investigations into the process and the product. A variety of smaller rigs have been used to clarify particular problems and give realistic design information.

Three production plants are in operation at Fisons factories. Two of these which are at Immingham came on stream in 1968; the third at Avonmouth, came on stream in 1969. Figure 1 is a general view of the two plants at Immingham : the plants are housed in a single building.

## OUTLINE OF THE PROCESS

The main stages in the process are illustrated as a block diagram in Figure 2 and a simplified flow-sheet of the process is shown in Figure 3. There are several variations which can be made to the process and the flowsheet illustrates one of them by way of example.

### *Ammonium nitrate feed*

The ammonium nitrate feed system is straightforward and largely conventional. Ammonium solution (at typically 90-92%) is supplied to the plant via a ring main from ammonium nitrate storage, and enters the evaporator feed drum which is under level control. It is pumped to an evaporator where it is concentrated to about 99.7%, the flow being controlled by a control valve. Evaporation is conventional – either an air swept falling film or a vacuum evaporator can be used. In this example an air-swept type is shown. Ammonium nitrate flows down the inside walls of vertical tubes in a thin film and is contacted by a counter-current flow of hot air. The tubes are heated by high pressure (150 psig) steam on the shell-side of the evaporator. Moisture-laden air is discharged from the evaporator to the atmosphere via a stack.

The concentrated ammonium nitrate melt flows by gravity from the evaporator to a distribution tank on top of the dust prilling tower. Most of the melt is distributed to multiple prill heads situated on the tower top, but a small excess overflows back to the evaporator feed drum. In the distribution tank there is a weir, adjustable in height, which controls the level of ammonium nitrate above all the prilling heads simultaneously. Each prilling head consists of a reservoir and a plate which has a multiplicity of nozzles. The ammonium nitrate, under this carefully controlled pressure, is fed through prilling plates by gravity and passes into the dust-bearing air-stream inside the prilling tower.

### *The Dust Prilling Tower*

The tower contains a fluidised bed of dust. Dust is initially fed into the tower using a pneumatic conveying system and the same system is used periodically to top up the tower as dust is removed in the product coating.

The dust is fluidised using two main air-streams. The greater part of the air is supplied through a perforated fluidising plate in the base of the prilling tower. This is sufficient to fluidise the dust and create the essential dust

cloud. A second stream of approximately 10-20% of the total air flow to the prilling tower is supplied through an elutriation tube in the centre of the tower. This is a tube through which the product is discharged and the main function of this air-stream is to hold back the fluidised bed of dust, whilst allowing the product to pass.

Under the influence of these air-streams the fluidised dust bed forms two distinct phases with the tower. At the base of the tower there is a dense phase (the main fluidised bed) which extends to a height of about six feet above the main fluidising plate. The remainder of the tower is filled with a lean dust phase – this is dust carried from the fluidised bed by the air flow and is approximately 10-15 feet in height. While large amounts of dust are continually removed from the fluidised bed by the air flow, only a small fraction is picked up by the droplets. The remainder passes through cyclones and a bag filter where the dust is separated from the air and returned to the dense phase through dip-legs. Clean air from the dust filters passes through to atmosphere. Air is thus blown straight through the equipment, but dust recycles at a high rate from the fluidised bed, through the cyclones and bag filters back to the fluidised bed.

### *Solidification process*

Droplets falling from the prilling nozzles pass through the lean dust phase where the fine coating of dust is picked up and a hard shell is formed around each droplet. This is the vital stage in the process. The important thing is to adjust conditions so that the shell is strong enough to withstand turbulence and impacts which the droplets will suffer lower down in the dense part of the fluidised bed.

The partly solid prills then pass into the dense dust phase where the majority of cooling and solidification takes place. This takes place rapidly and fluidised beds are well-known for their good heat transfer characteristics. The temperature of the dust bed is maintained constant by water cooled coils or plates which are positioned in the bed. The cooled prills eventually flow down to the elutriation air tube at the bottom of the tower where they enter a high velocity air-stream. This is adjusted to allow the prills to be discharged but to retain the dust in the tower. A primary separation of coating dust and prills occurs at this stage but another stage of dust removal is necessary to give a dust-free product.

### *Dust separation*

Prills from the elutriator are collected in the bottom of the tower from where they are discharge via a rotary valve and passed to a secondary deduster. Here the final separation of prills and dust takes place in a small fluidised bed. Dusty air from the fluidised bed is returned to the tower as part of the main air-stream. The product then passes via conveyors and an elevator to the bagging and storage hopper, where, prior to bagging a screening operation takes place to remove small quantities of material which are outside the size specification.

## PRODUCT DESCRIPTION

The production meets the following specification:—

Size				
Tyler Mesh	—	5	8	10
Aperture (mm)	4.00	3.36	2.36	1.65
% through	100	93-100	2-18	0-1.5
Typically	100	98	10	0.8
Mean particle size:	2.6mm			
Coating level:	3.5-5.0%			
Caking properties:	very good, can be transported in bulk			
Therman cycling:	good resistance.			

One feature which distinguished the product from other top dressings is the larger particle size and the narrow size distribution about the mean. This is shown clearly from the distribution graphs of Figure 4 which contrasts a dust prilled product with an air prilled product.

## PROCESS DETAILS

In order to specify the particular mean size and size distribution very extensive trials with fertilizer application machinery were undertaken by Fisons. The objective of the work was to find the product with the same flow and distribution properties through spreaders as our normal granular compounds. The result of this work was the specification given above.

The process is, however, not limited to this particular size distribution and it can be used to make a wide size distribution product if required or a narrower size product with a mean which is larger or smaller than that shown in the table. Conditions in the process are such that there is no coalescence of droplets after leaving the nozzles and it therefore is the drop formation mechanism which determines the final product size distribution.

### Drop Formation Mechanism

The formation of drops, on the face of it is a simple matter, but it is in fact a vast subject which has attracted a large number of researchers, and there is a considerable literature. There are two principal methods of forming drops which are suitable for the dust prilling process.

In the first of these, drops are made to form at the tip of the nozzle. Each drop forms independently, that is, one drop falls off before another one is formed. This is shown in Figure 5. At very low flow rates where the situation is virtually a static equilibrium the drop size is controlled by the geometry of the nozzle tip, and the density and surface tension of the material in the droplet. In this condition these will be the only variables and therefore for a given material the diameter of the nozzle would determine the drop size, and all drops would be an identical size.

In a dynamic situation the flow of the material through the nozzle has some effect. As the flow increases the drop diameter decreases slightly. This is because of the downward momentum, the drop breaking off before it can reach the size it would under more static equilibrium conditions. Eventually, as the flow increases further, a limit is reached at which the drop ceases to form at the tip of the

nozzle. At rates above this limiting flow, which we call the streaming point, the material issues from the nozzle in a long stream or jet. This extends for some distance below the tip of the nozzle and breaks up under the influence of gravity and random vibrations which are transmitted to it. This is the second mechanism of drop formation and is shown in Figure 6. The mean size of the drops produced in these conditions is very less than (approximately half) those produced by the first dropping regime. There is also a considerable variation in the size of these droplets since they are formed by an essentially random process. Furthermore, for each large droplet a tiny secondary droplet is also formed. These have a nuisance value in a fertilizer product made by this method. Drop formation by this method therefore has the advantage of higher production rate per nozzle but the disadvantage of wide size distribution of particles.

In the plants operated by Fisons the drops are formed at the tips of the nozzle in order to get the uniformly sized droplets. Specially manufactured prilling plates are used in which small stainless steel nozzles are fitted to distribute the droplets uniformly into the lean dust cloud and over the surface of the fluidised bed.

In practice, because of the multiplicity of nozzles used, there is some distribution of drop sizes because of the manufacturing tolerance of the nozzle and also because in a large plant not all nozzles operate under exactly the same flow conditions. The flow is controlled by liquid head over a weir in the central distribution vessel, and the plant is normally operated with just a few nozzles in the streaming condition which leads to a small percentage of the material being less than 8 Tyler mesh (2.36 mm).

### Drop Solidification

The general description had made clear that the process makes a larger prill in a very much smaller height than an air prilling tower. For an air tower of a given height there is an upper limit to the size of particle which can be solidified. Similarly in the dust prilling process there is an upper practicable limit for a stable drop size, but since this is well above the mean granule size used in the fertilizer industry it is not particularly important to us.

The coating operation which takes place in the lean phase is the crux of the dust prilling operation. The ammonium droplet is initially at a temperature of about 170°C and the dust and air is at about 50°C. The relatively cold dust is picked up on the ammonium nitrate surface and cools the liquid surface very rapidly forming a skin of dust and solid ammonium nitrate. This skin is thicker than that which would be formed by simply cooling the droplet in air for the same period of time because of the quench cooling by the absorbed dust. There is some cooling by the air as in conventional air prilling, but this is very small compared to the chilling by the dust. Because of the rapidity of dust absorption, the solidification of the ammonium nitrate in very short towers is possible — it is

only necessary for the skin which has formed to have sufficient mechanical strength. The process can be operated in the laboratory with dust height as low as three feet, but in practice, heights somewhat greater than this are preferable to allow operating tolerances: — the 10-15 ft referred to previously is adequate.

The air flow through the dense phase is the most important factor controlling the lean phase dust density. However, a considerable latitude in air flow is tolerable and the whole process can be designed to be relatively insensitive to operating conditions.

After the initial solidification of the surface the drop still has a liquid centre and further cooling is required. This is done in the dense phase of the fluidised bed of dust and a wide variety of geometrical arrangements of cooling surfaces can be designed. The dense bed in fact performs three main functions; it provides a dust cooling of the partially solidified particles to be completed, and it provides a soft area for collecting the falling droplets so that they can be decelerated without breaking.

The process, as described, is the simplest arrangement. It is also possible to design the process in various other ways as described in the principle patent.

The process is able to operate with a wide variety of dusts but certain technical properties are desirable. The dust must be safe to handle and must be compatible with ammonium nitrate. It must fluidise well and agglomerate in the lean phase and its heat transfer properties should be good. The pick-up of the dust on the ammonium nitrate droplet should be within reasonable limits. The dust should also be cheap. Obviously not all dusts have all these features. Provided a dust has some of them it can be treated or mixed with other dusts to give successful operation. In this way use can be made of dusts which would be unsuccessful if used singly.

One of the most important factors of course is to control carefully the pick-up of the dust. This is done by mixing dusts which are readily picked up with those which resist pick-up in such proportions that the mixture is picked up in the correct amount. Fisons have developed a generalised laboratory technique which enables the pick-up properties of any dust to be classified.

Particular dusts can also have particular effects on the properties of the product and this is very important for ammonium nitrate. By appropriate selection of dusts improvements can be made to the hardness of the product, its anti-caking qualities and its resistance to breakdown during repeated heating and cooling cycles (i.e. thermal cycling resistance). Montmorillonite clays (bentonites) give these properties when mixed with ammonium nitrate. Such dusts are also readily picked up by ammonium nitrate in

the dust prilling process. The use of monmorillonite therefor as the high pick-up dust enables it to confer these beneficial properties on the product since a very small proportion of it is completely absorbed into the droplet. It is then a simple matter to control the pick-up by the addition of a proportion of dust which resists pick-up by ammonium nitrate. Talc is a suitable material.

## **EFFLUENTS**

In the air prilling process for ammonium nitrate characteristic dense white fumes of ammonium nitrate are released from the tower often creating effluent problems. The work of several investigators has helped to elucidate the mechanism of formation of this fume. It appears to proceed in two stages, the decomposition of ammonium nitrate into nitric acid and ammonia followed by their recombination into a fog of fine ammonium nitrate particles in the cold air-stream. Avoiding this ammonium nitrate fume is virtually impossible since it is a function of the physical chemistry of the system and no process variables can be changed sufficiently to make a significant difference.

Fortunately, the dust prilling process does not suffer from this drawback: the air is discharged from the bag filters completely free from any ammonium nitrate contamination. The ammonium nitrate from the prilling nozzles fumes in just the same way as that from a normal air prilling process but the fumes are trapped by the bag filters. This means that the prilling dust becomes contaminated with ammonium nitrate which builds up to a low equilibrium level, not a serious matter since the process is tolerant of quite high levels.

## **MAIN FEATURES OF THE PROCESS**

1. The process is compact and highly intensive; it does not require a tall tower.
2. The process is basically simple and cheap; the product is formed in an easily controlled single operation.
3. Good product properties are obtained by coating and internally conditioning the ammonium nitrate from the dust bed.
4. The product is similar size to a normal granular fertilizer, and is designed to behave in the same way in farm fertilizer appliances.
5. The product is very suitable for blends as it is readily compatible with other granular materials.
6. The process has no effluent problems.

## **PATENTS**

Patents covering this new process have been taken out in the major manufacturing countries of the world.



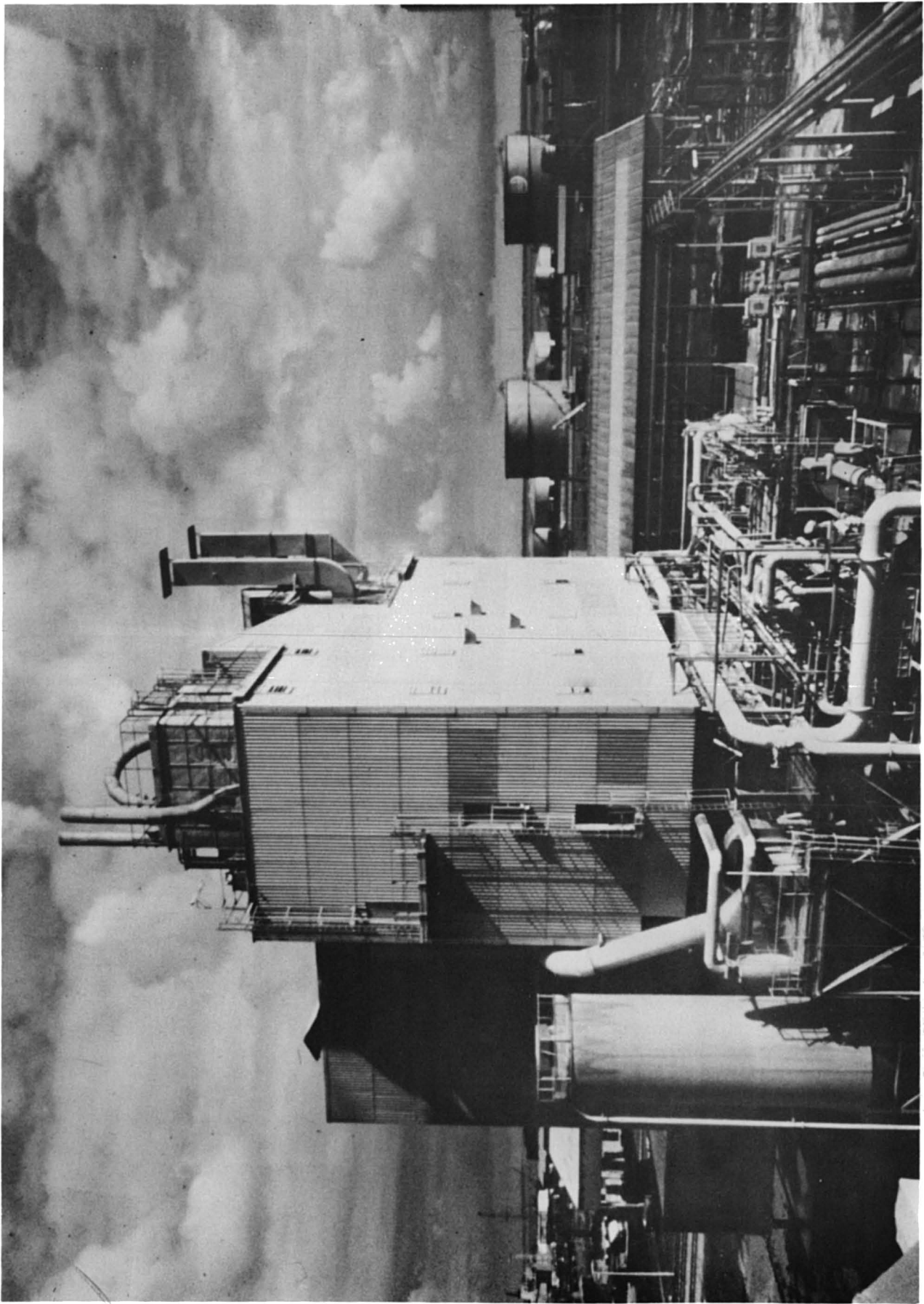


Figure No. 1  
General View of Two Plants at Immingham  
Housed in a Single Building

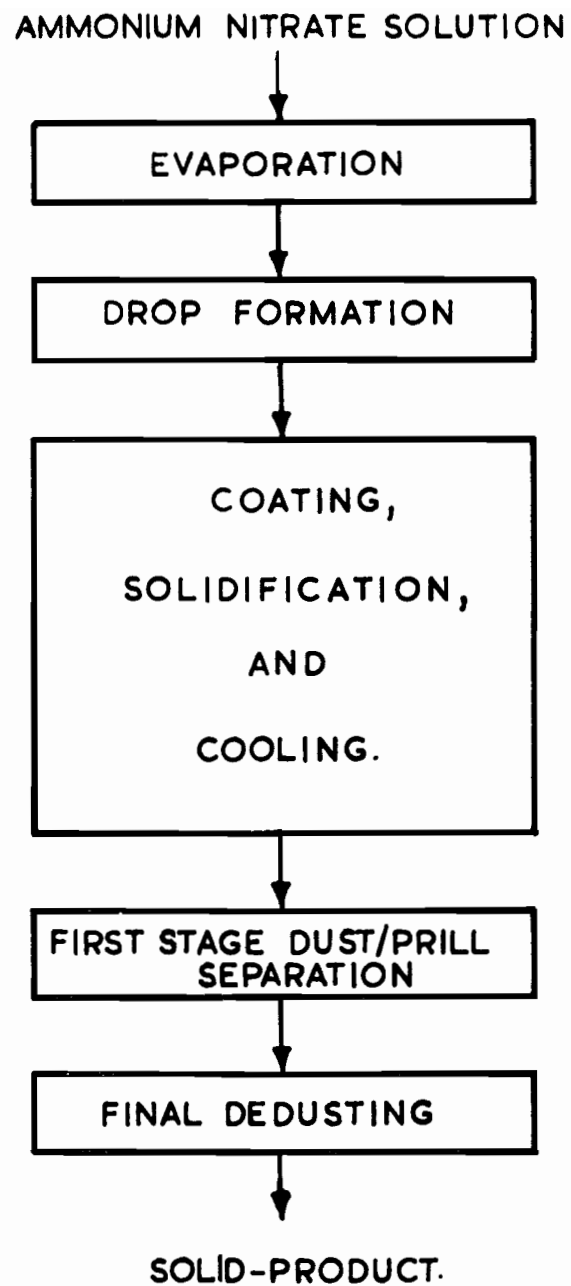
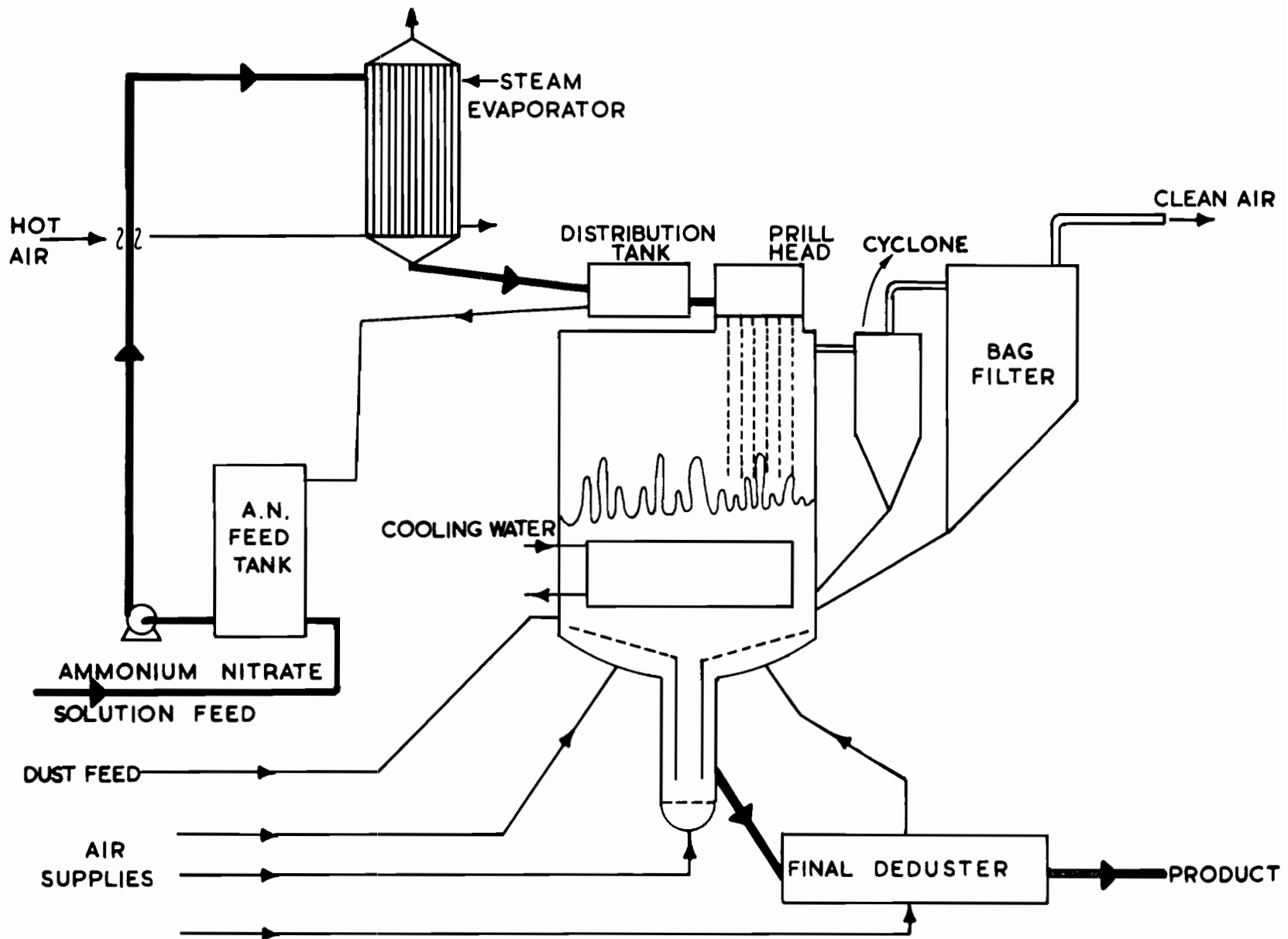


FIG.2.MAIN STAGES OF THE PROCESS.



**FIG.3. FLOW SHEET OF THE NITROTOP PROCESS.**



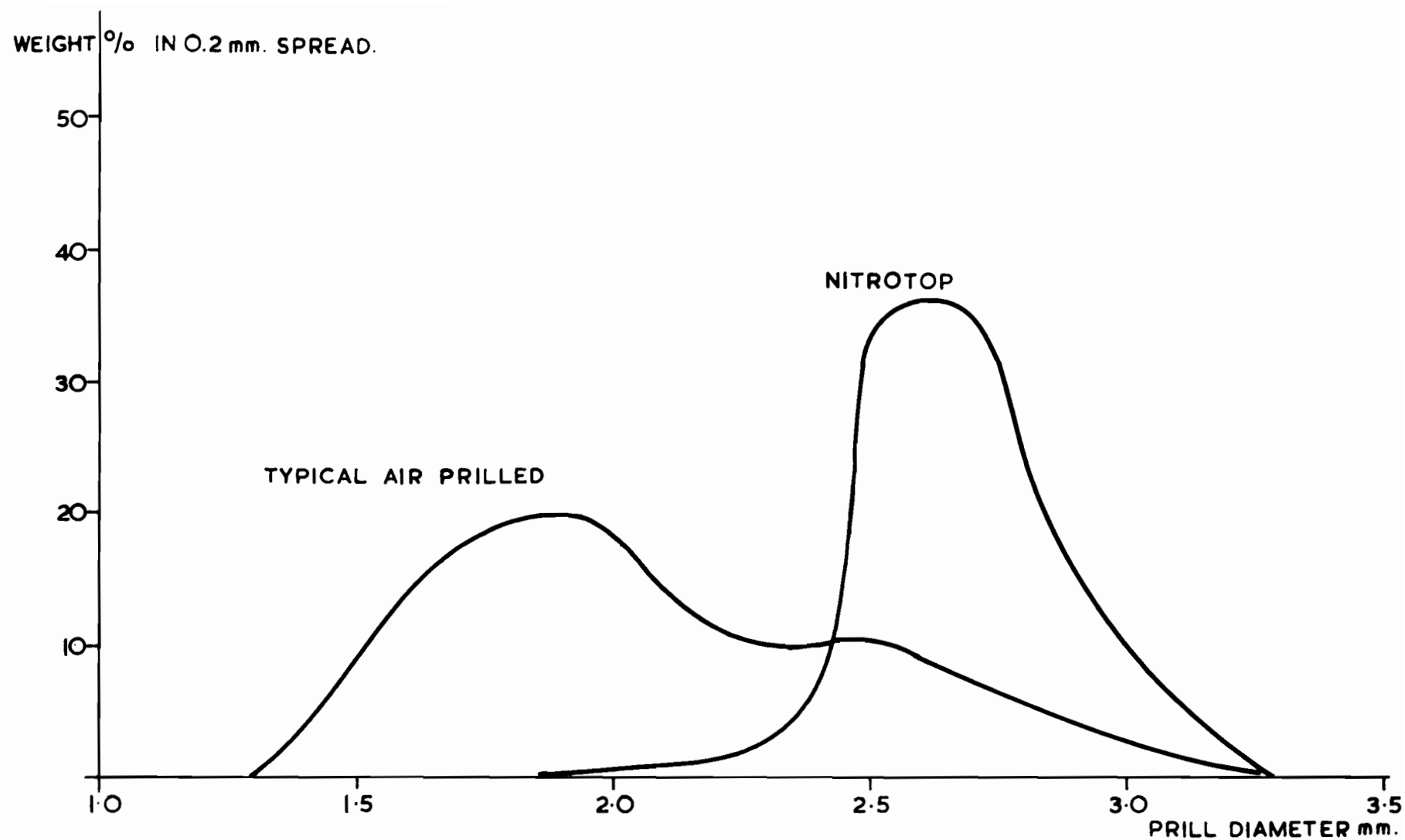


FIG.4. SIZE DISTRIBUTION: COMPARISON OF AIR PRILLED PRODUCT  
AND NITROTOP.

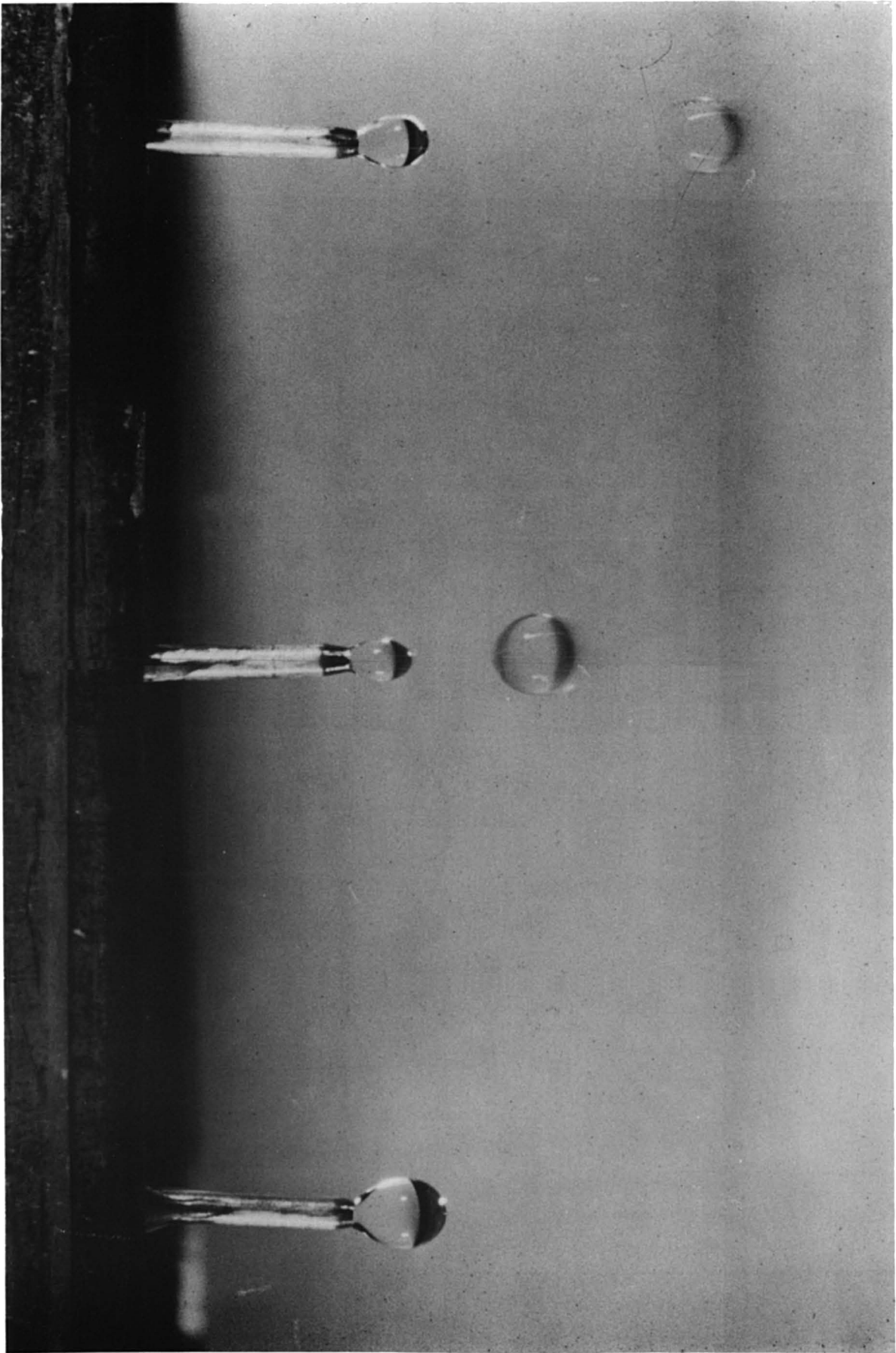


Figure No. 5 — Drop Formation From Tip of Nozzle First Drops

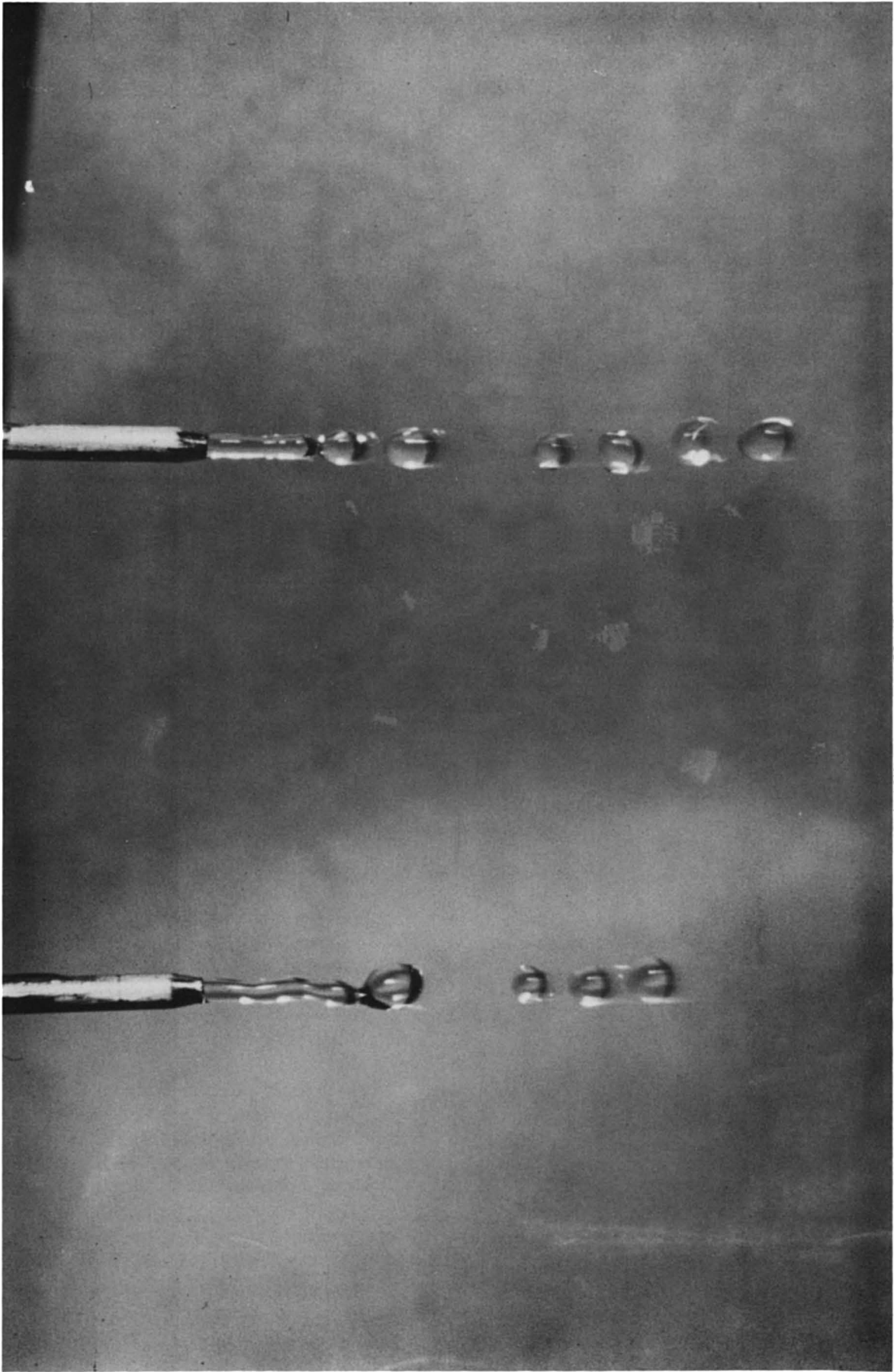


Figure No. 6 -- Drop Formation As Flow Increases

**MODERATOR REYNOLDS:** Thank you Geoffrey for that most interesting discussion outlining Fison's Process "Nitro-Top". For several years we have had considerable interest in the World Supply of  $P_2O_5$ . Frank Nielsson, International Minerals and Chemical Corp., well known to this group will discuss this subject.

### **PHOSPHATE FERTILIZER SITUATION**

*Frank T. Nielsson*

Members of the Fertilizer Round Table: My being here brings to mind the TV sketch wherein a man receives a phone call and is asked if he will be in town on Saturday. When he says yes, the voice tells him he has been chosen for the Man of the Year Award due to his many civic accomplishments and that the committee will present the trophy to him at a dinner Saturday night. The man says he is sorry, but he cannot go out because of a dinner party at his home. The voice then asks, "Do you know someone else who might be available Saturday night?"

Well, I was available and I am here.

Although the program states "World  $P_2O_5$  Situation", my talk deals mainly with the U.S. Phosphatic Fertilizer Situation because of availability of data. [Slide No. 1]

We know that there is a very tight supply and demand situation in today's markets as evidenced by the recent price increases in export prices of phosphatic fertilizers. The same price situation has not occurred in this country because of the price freeze enacted by the President in August, 1971 to stop inflation. This freeze affects only domestic prices, not export prices.

The price freeze happened at a time when fertilizer demand was increasing because of good weather, good farm prices and the resumption of "AID" shipments to India for the first time in three (3) years.

First let's take a look at the trends in U.S. [Slide No. 2] Fertilizer Consumption by product class. In 1962/63, mixed dry fertilizers comprised 66% of the total fertilizer consumption, DA materials 27%, bulk blends 4% and fluid fertilizers 3%.

In 1972/73 the picture has changed to where DA materials comprise 38% of the total fertilizer consumption, bulk blends have increased to 30% while mixed fertilizers now are classified as dry at 23% and fluid at 9%. The increase in bulk blends has resulted in an increased demand for high analysis phosphates derived from phosphoric acid.

Next let's look at the changes in the usage of the principal phosphatic materials. Normal superphosphate shipments [Slide No. 3] have declined by 50% in the last five years and have dropped 19% in 1970/71. Exports have never been a major factor in normal superphosphates shipments. Normal superphosphate plants normally do not manufacture triple superphosphate or Diammonium Ammonium Phosphate so the decline in NSP shipments has not provided replacement capacity in the other phosphatic materials.

Triple superphosphate [Slide No. 4] after some

decline has picked up again and in 1970/71 TSP shipments were back to the same levels found in 1966.

The big change [Slide No. 5] has been in Ammonium Phosphates, largely DAP. Shipments have grown at an increasing rate, jumping by 17% domestically in 1970/71 and also by 17% in the export market for the same year.

On Slide No. 6 we can see the dramatic change in export markets for DAP.

The previous data are summarized on Slide No. 7 to indicate shipments of processed phosphates in tons of  $P_2O_5$  on the same scale. The change to ammonium phosphates becomes more evident on this basis.

Slide No. 8 shows how production has finally caught up with capacity in the domestic  $P_2O_5$  field.

This has not been because of a marked increase in production but because of a marked reduction in capacity [Slide No. 9]

Back in 1965 Phillips closed a 50,000 TPY plant in Texas. In 1967, two more plants totalling 155,000 tons  $P_2O_5$  were closed. But the big shutdown occurred in 1968 when 10 plants capable of 685,000 tons  $P_2O_5$  per year were closed. Last Year, American Cyanamid and New Jersey Zinc closed two more plants producing 340,000 tons of  $P_2O_5$ . This is 6% of U.S. capacity.

With increased demands and lower operating capacities, industry operating rates began to increase. In 1969/70, after the big shutdown, operating rates averaged 72-79%. By 1970/71, rates were up to 81-91%. This year, they probably will run 90-96 of capacity. In spite of increased demands, it does not appear likely that the industry can operate effectively above 95% capacity. [Slide No. 10]

Inventories are one means of measuring price fluctuations. Slide No. 11 we see DAP inventories for 1969/70, a typical recent fertilizer year, some shipments in the fall, the major shipments in the spring, and more than adequate stocks on hand at all times.

However, in 1972/72 record shipments have decreased inventories so that by year-end warehouses were empty and you are in a sellers market, not domestically because of the price freeze, but overseas.

The same story is shown [Slide No. 12] when triple superphosphate inventories are examined in 1970/71 and 1971/72.

The story of excess capacity in the 60's followed by plant shutdowns and a balance between capacity and demand is shown in the price trends of phosphatic fertilizer exports which seem to follow operating rate more than any other factor. [Slide No. 13]

A more up-to-date chart indicates the turnaround in DAP export prices during the past fiscal year, an increase of 33% in prices within six months. [Slide No. 14]

Slide No. 15 indicates that domestic sales of DAP are expected to increase by 3% in 1971/72 at about the same percentage increase as shown for TSP.

On the other hand, export sales for DAP were

expected to increase by 32% while export sales of TSP were expected to increase by 14% in 1971/72. [Slide No. 16]

A composite chart showing exports of concentrated phosphates by regions indicates that DAP exports are expanding into all regions except Canada. On the other hand, exports of TSP, although showing an overall improvement in 71/72 as compared to 70/71, are back to about 69/70 levels. [Slide No. 17]

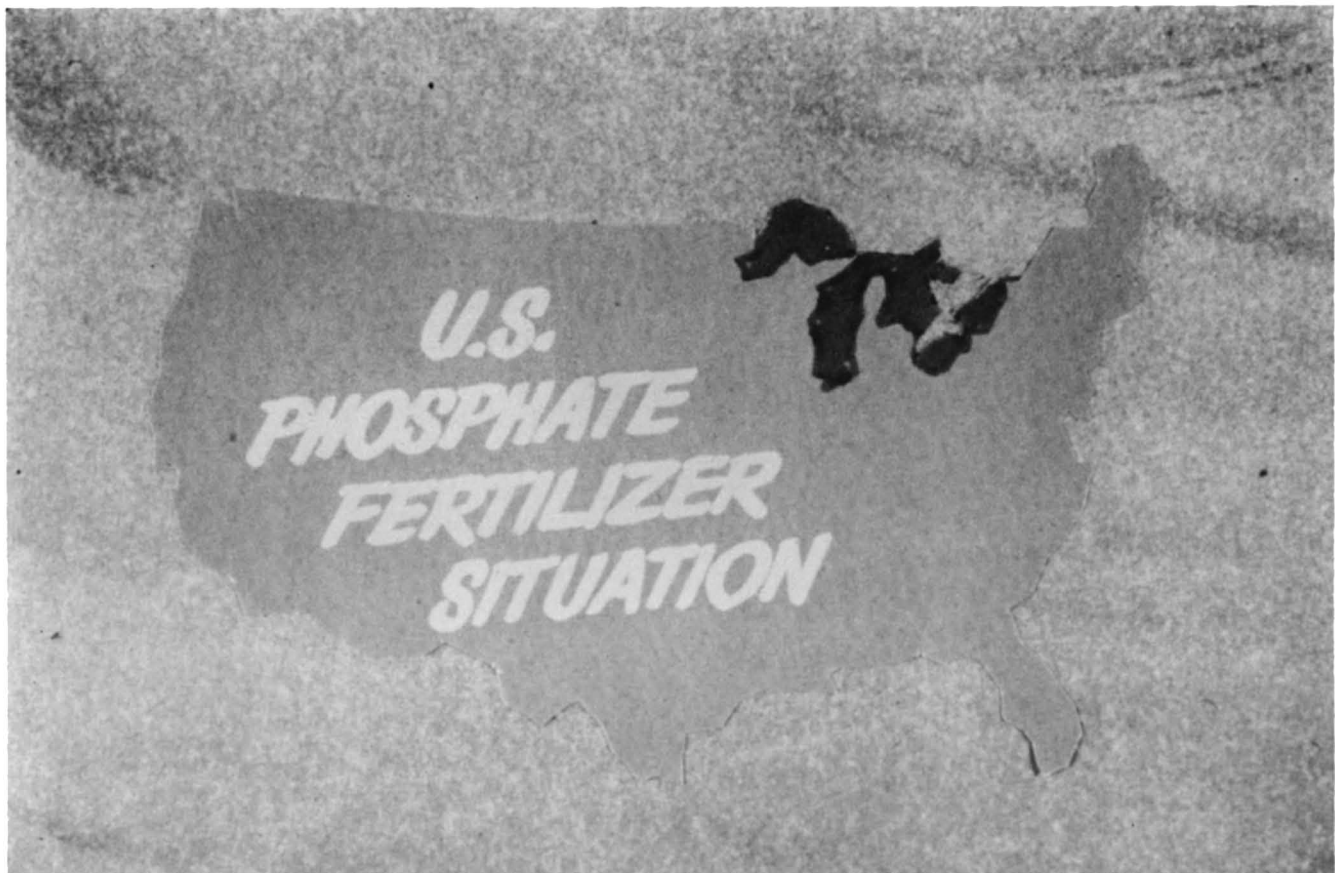
Looking into the immediate future, we estimate that the major growth factors in U.S. wet process acid production will be due to growths in the U.S. fertilizer and non-fertilizer market as well as the replacement of normal superphosphate by more concentrated phosphates. We do not envision much growth in wet acid capacity because of

export demands. [Slide No. 18]

We do expect that World  $P_2O_5$  fertilizer consumption will continue to increase at about the 6% per year rate as it has in the past. [Slide No. 19]

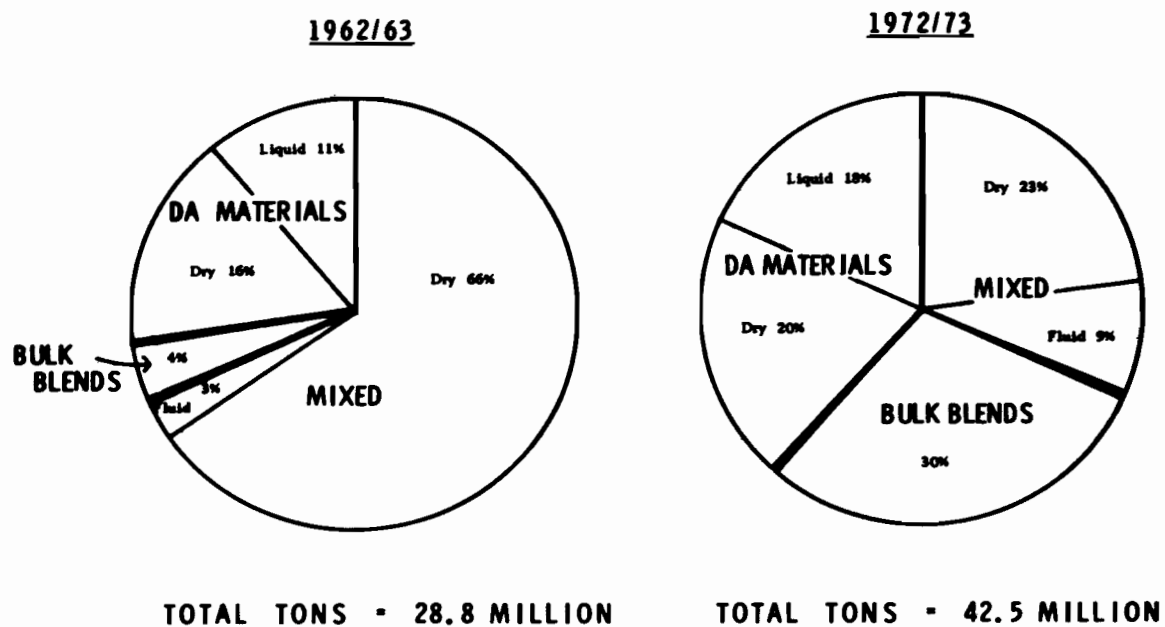
In closing, it might be of interest to show how the ownership of Florida Rock capacity has changed since 1963. At that time, fertilizer companies owned 65% of Florida rock capacity. In 1968, the share of fertilizer companies dropped to 21% being replaced by Petroleum companies and Metals & Mining companies. [Slide No. 20]

We expect some additional changes in 1973 because of the advent of transportation companies into the field at the expense of the petroleum companies. [Slide No. 21]

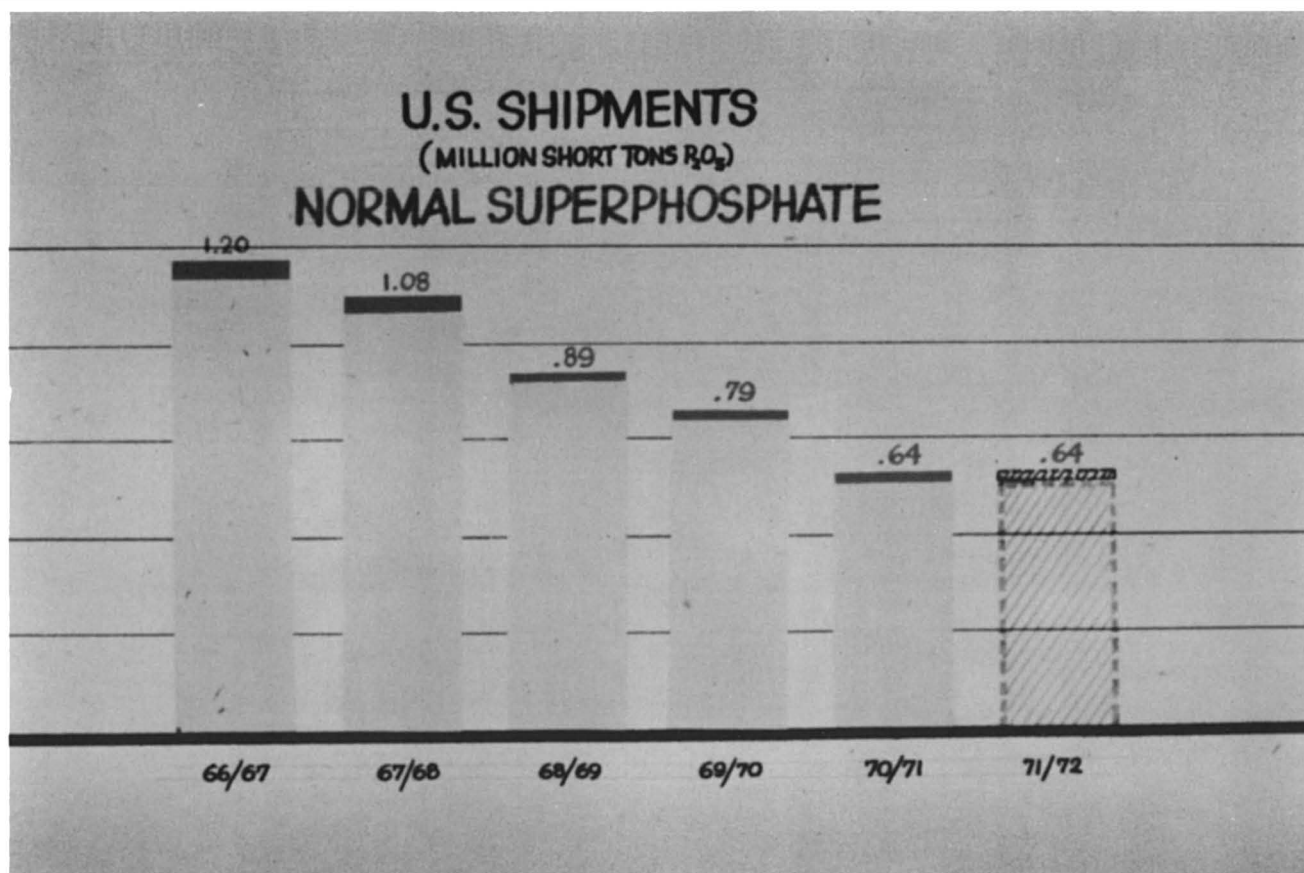


SLIDE 1

# TRENDS IN U.S. FERTILIZER CONSUMPTION BY PRODUCT CLASS

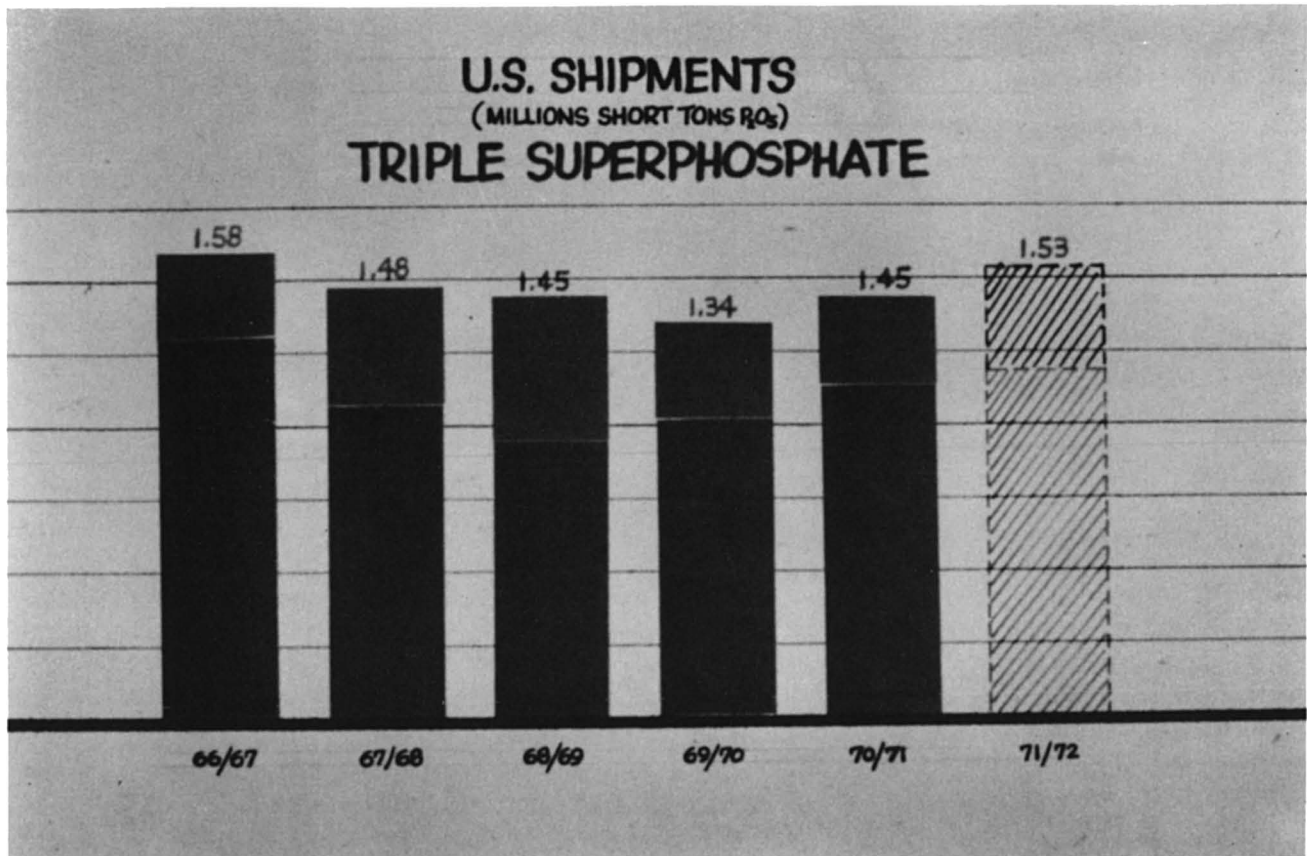


SLIDE 2

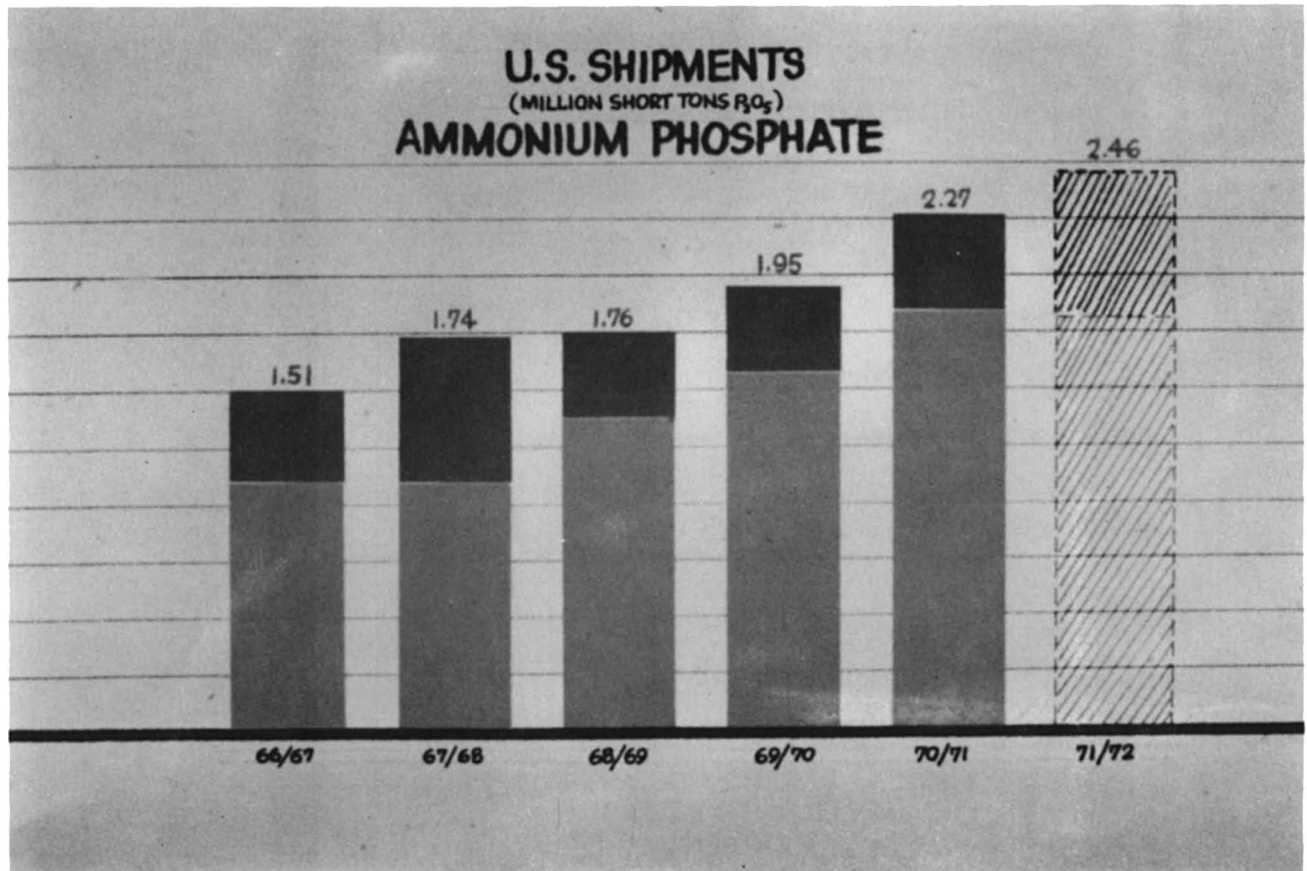


SLIDE 3

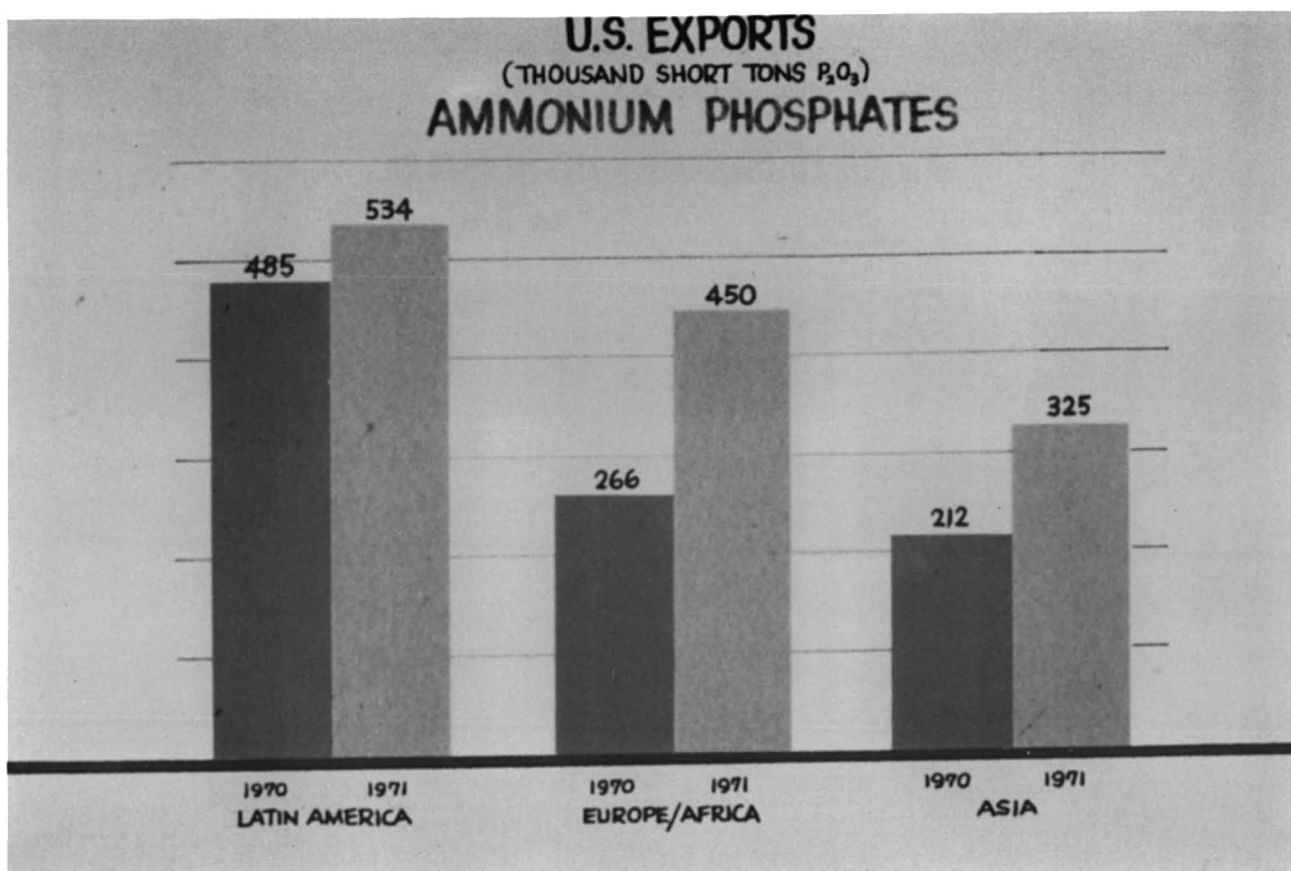




SLIDE 4



SLIDE 5



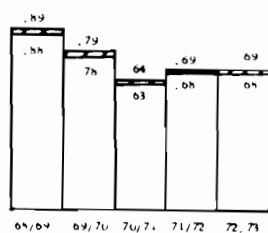
SLIDE 6

#### SHIPMENTS OF PROCESSED U.S. PHOSPHATES

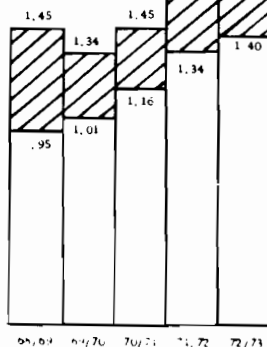
Million Short Tons  
 $P_2O_5$



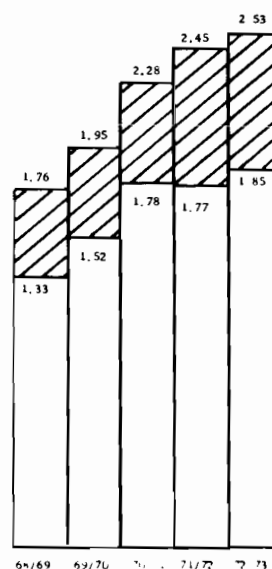
TSP



TSP

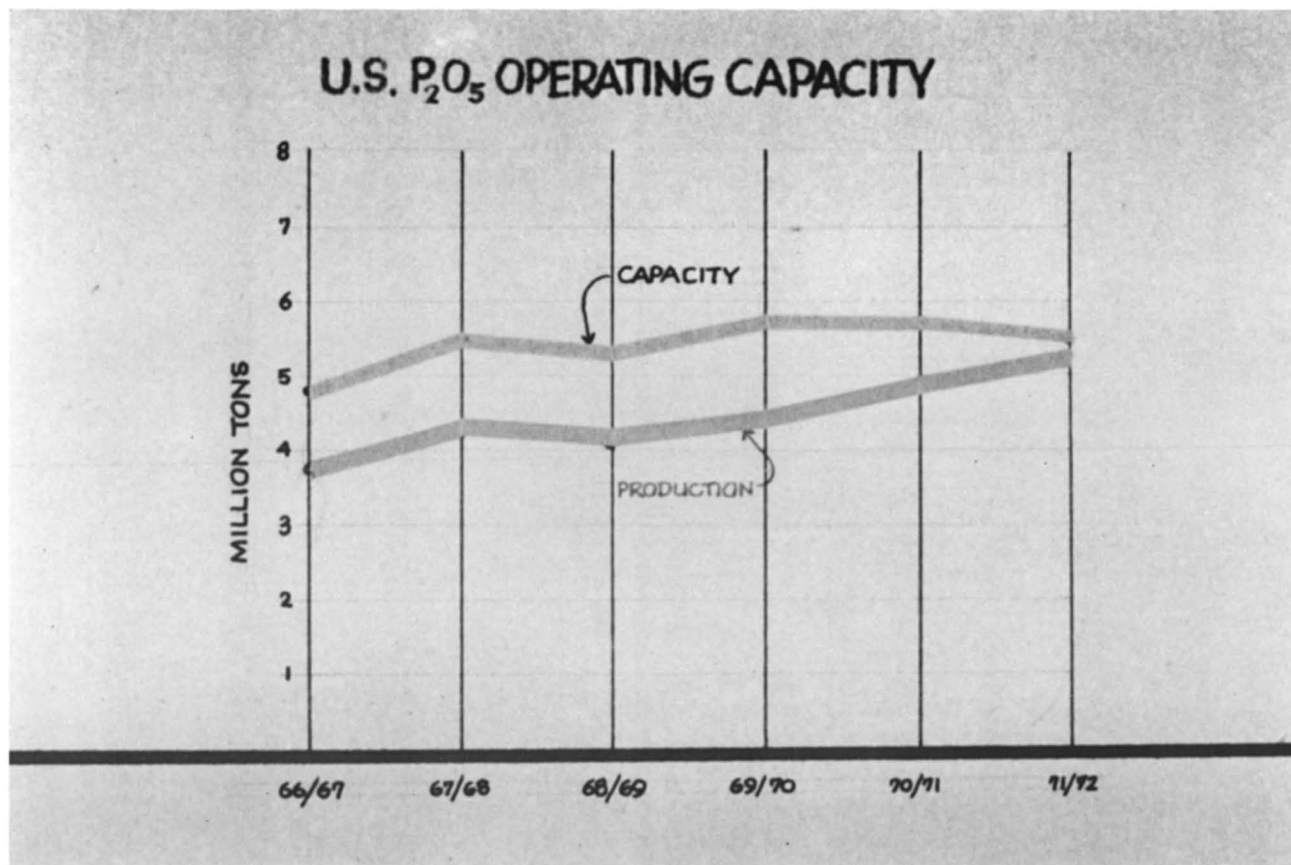


AMMONIUM PHOSPHATES



SLIDE 7



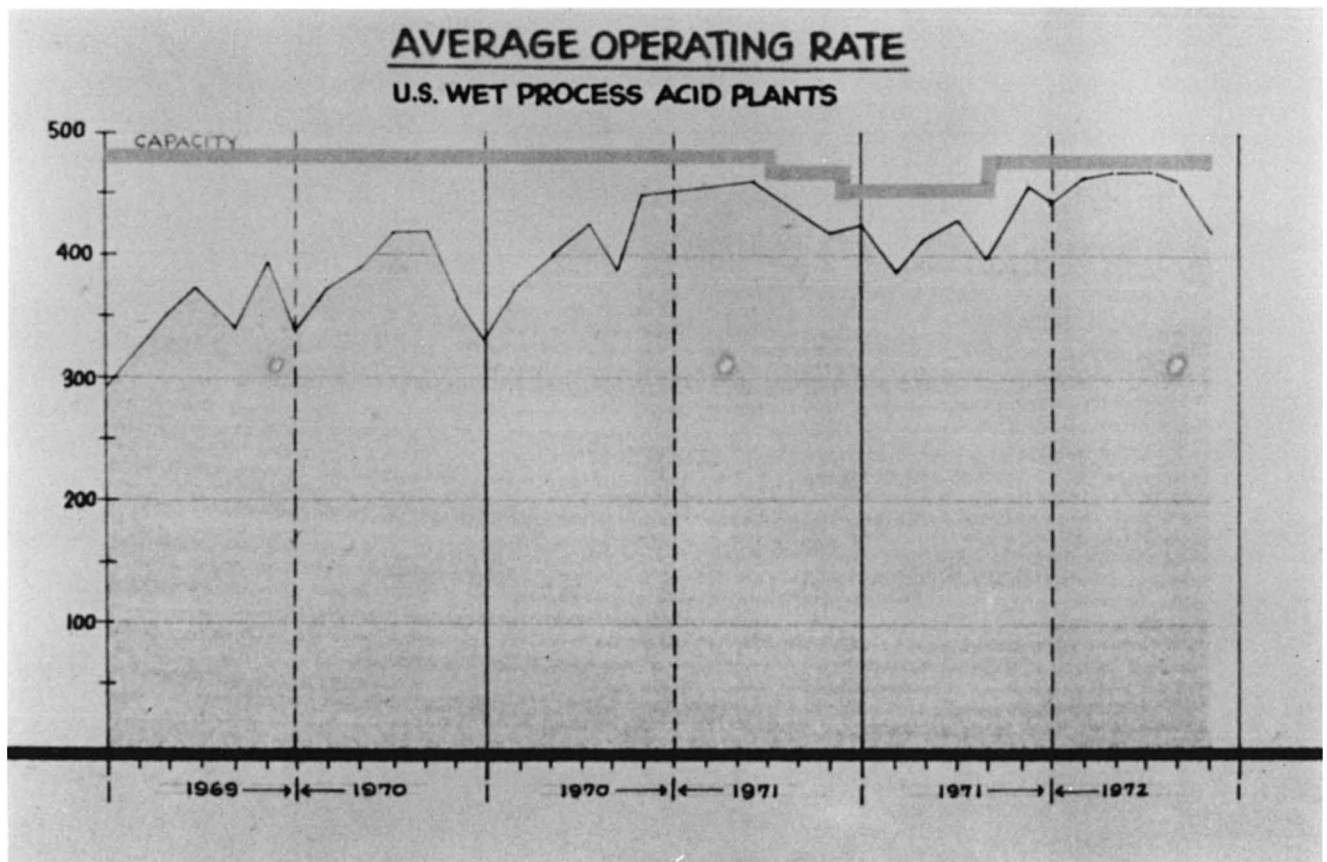


SLIDE 8

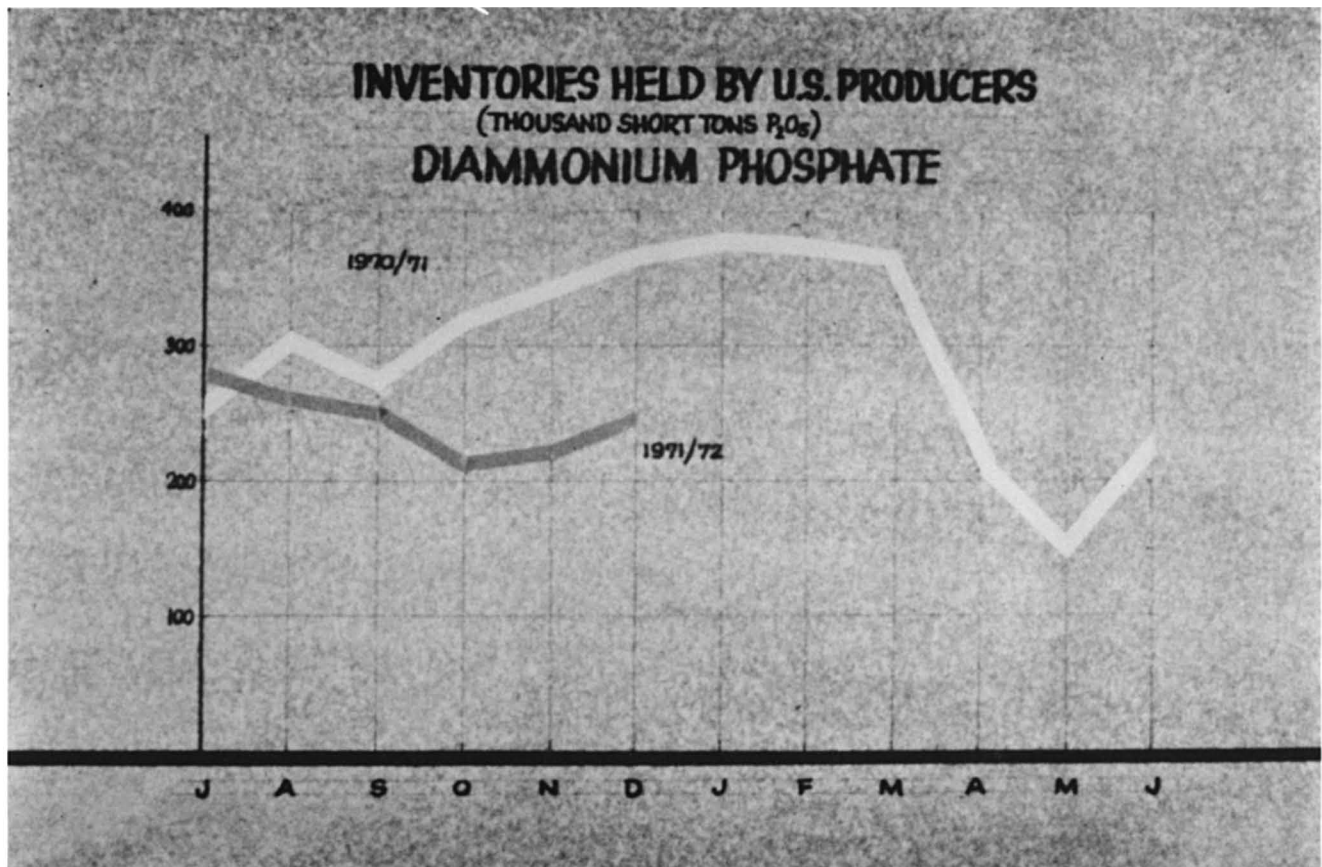
### PHOSPHORIC ACID PLANT SHUTDOWNS

1965	PHILLIPS, TEXAS	50,000
1967	DES PLAINES, ILL.	50,000
	OXY, ILL.	105,000
1968	ALLIED, ILL.	50,000
	ALLIED, PENNA.	35,000
	BORDEN, ILL.	35,000
	BORDEN, TEXAS	40,000
	CENEX, MINN.	35,000
	GRACE, MO.	30,000
	MOBIL, FLA.	210,000
	NIPAK, OKLA.	30,000
	OLIN-MATHIESON, ILL.	130,000
	SWIFT, FLA.	90,000
1971	AMERICAN CYANAMID, FLA.	220,000
	NEW JERSEY ZINC, ILL.	120,000

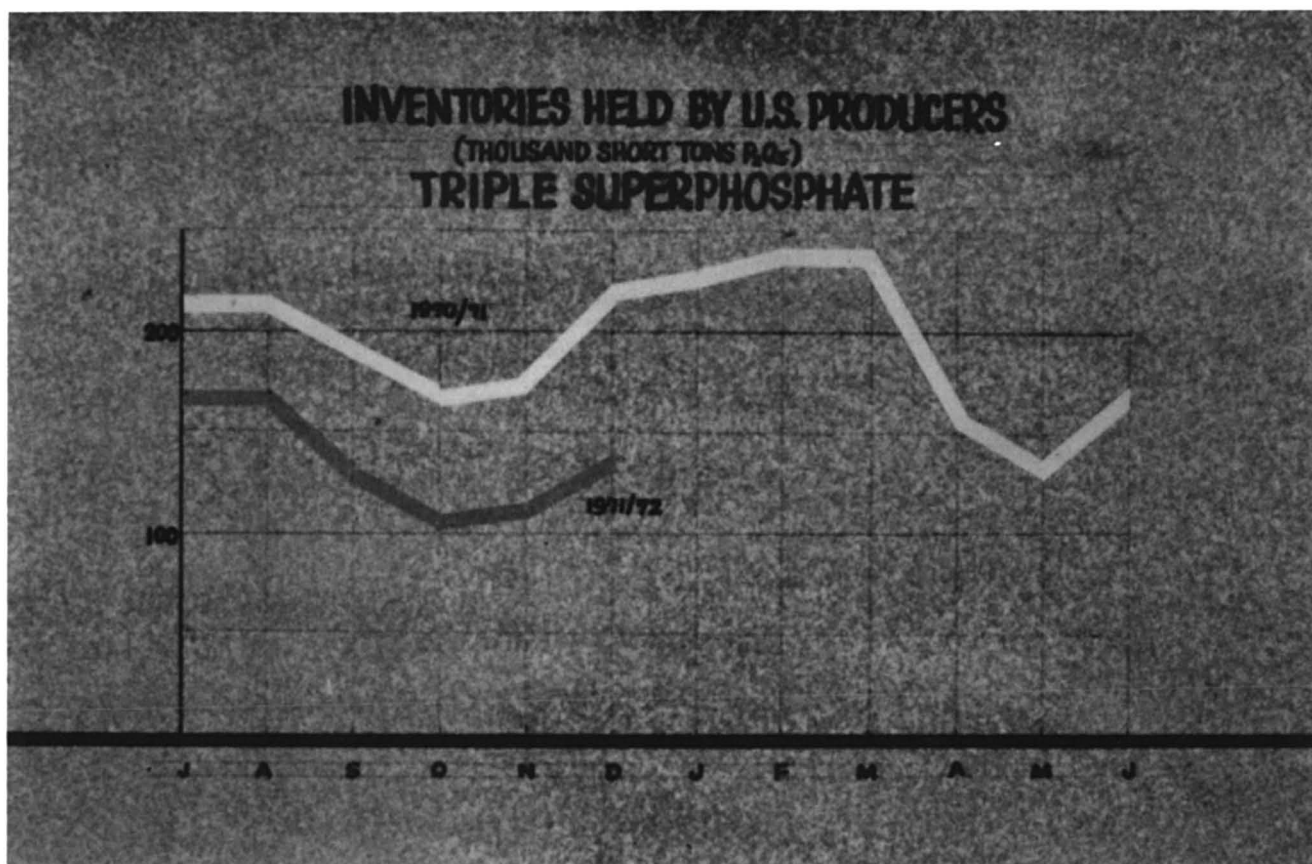
SLIDE 9



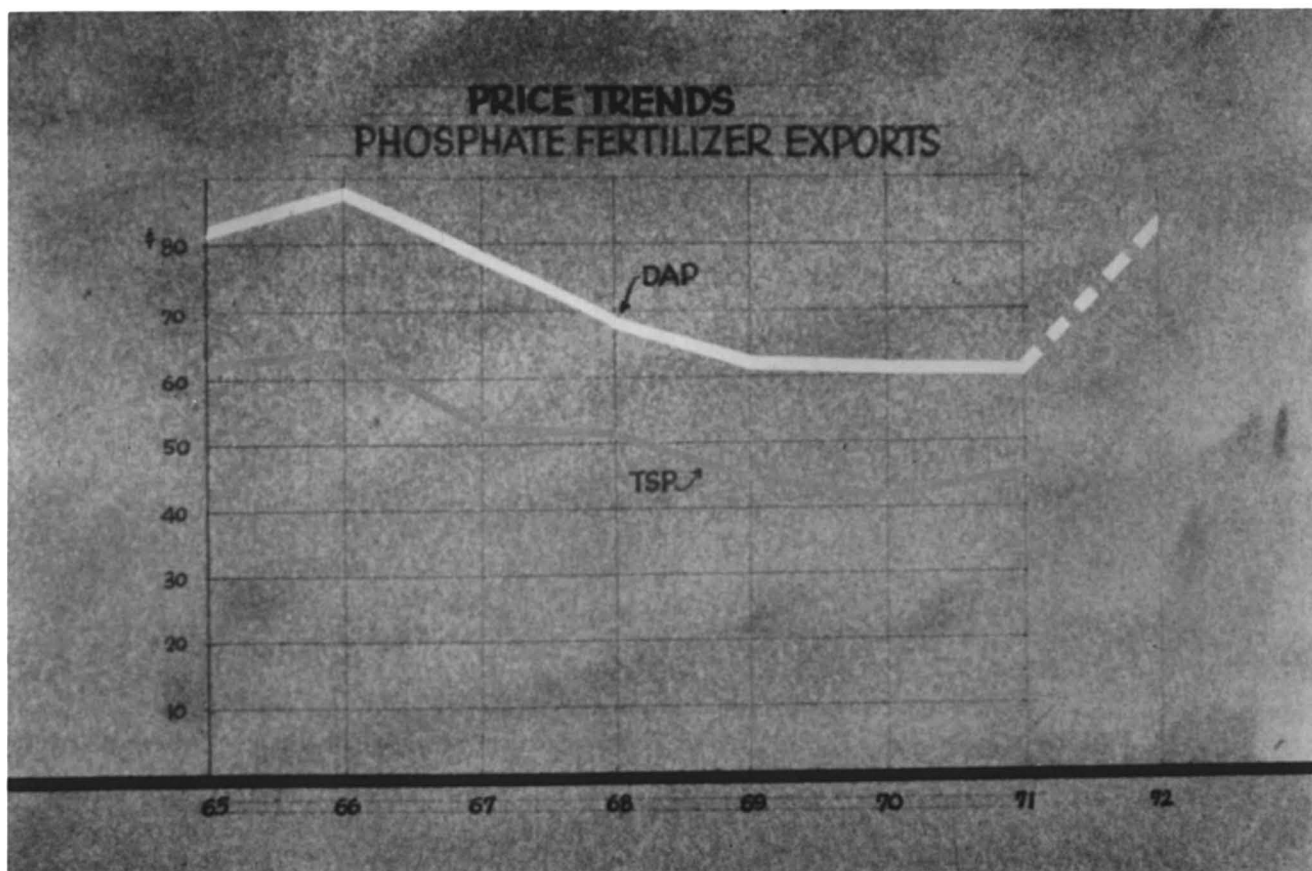
SLIDE 10



SLIDE 11



SLIDE 12

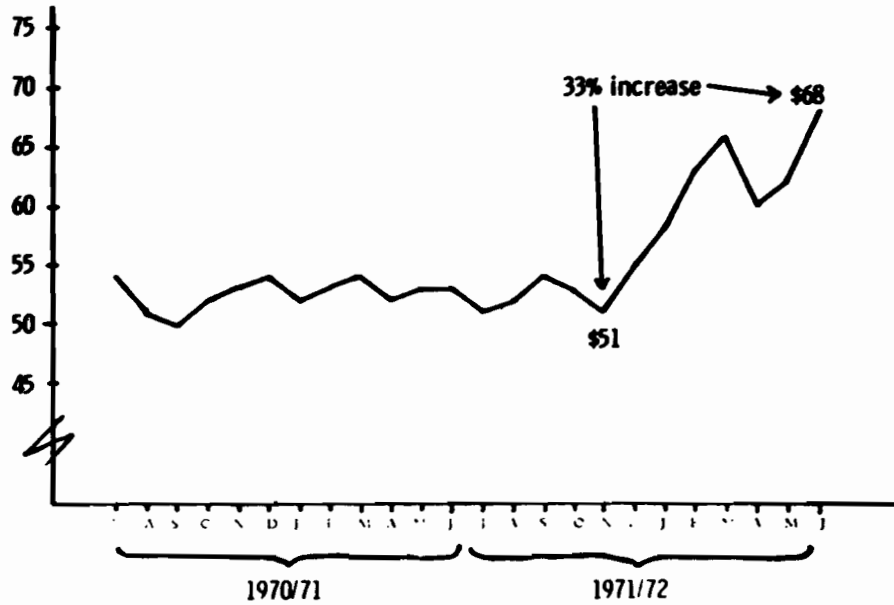


SLIDE 13

### TURNAROUND IN DAP EXPORT PRICES

- Average Price of Ammonium Phosphate  
Exports - U. S. D. C.

#/Short Ton  
FAS Vessel



SLIDE 14

### U.S. SALES PROJECTION

(THOUSAND SHORT TONS  $P_2O_5$ )

	1970/71	1971/72	PERCENT CHANGE
AMMONIUM PHOSPHATE	1,745	1,803	UP 3%
TRIPLE SUPERPHOSPHATE	1,167	1,200	UP 3%

SLIDE 15



## EXPORT SALES PROJECTION

(THOUSAND SHORT TONS  $P_2O_5$ )

	1970/71	1971/72	PERCENT CHANGE
AMMONIUM PHOSPHATE	500	662	UP 32%
TRIPLE SUPERPHOSPHATE	289	330	UP 14%

SLIDE 16

### U. S. EXPORTS OF AMMONIUM PHOSPHATES AND TSP BY REGIONS

(000 short tons product)

<u>Region</u>	<u>Ammonium Phosphates</u>			<u>TSP</u>		
	<u>1969/70</u>	<u>1970/71</u>	<u>1971/72</u>	<u>1969/70</u>	<u>1970/71</u>	<u>1971/72</u>
Latin America	404.2	539.9	631.0	422.0	438.9	363.5
Europe/Africa	259.6	353.7	436.2	136.8	90.5	175.3
Asia/Oceania	<u>267.6</u>	<u>195.7</u>	<u>427.8</u>	<u>127.9</u>	<u>38.6</u>	<u>121.5</u>
Total Overseas	931.4	1,089.3	1,495.0	686.7	568.0	660.3
Canada	<u>54.6</u>	<u>45.7</u>	<u>44.0</u>	<u>23.7</u>	<u>59.0</u>	<u>47.0</u>
Total Exports	986.0	1,135.0	1,539.0	710.4	627.0	707.3

SLIDE 17

# U. S. WET-PHOSPHORIC ACID GROWTH FACTORS

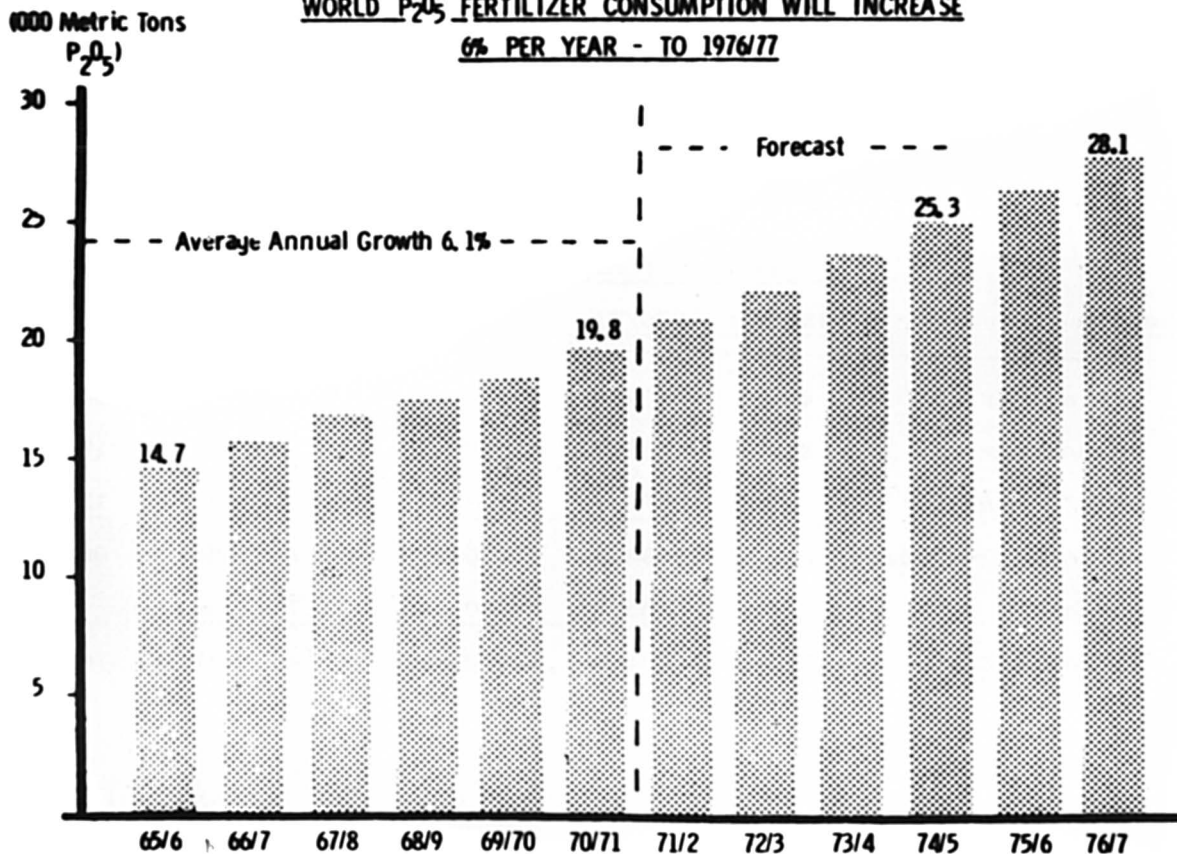
(000 Short Tons  $P_2O_5$ )

			Estimated Production
1971/72	Production		5200
1972/73	Growth in U. S. fertilizer market	200	
	Growth in U. S. non-fertilizer market	30	
	NSP decline	0	
	Growth in exports	0	
		<u>230</u>	5430
1973/74	Growth in U. S. fertilizer market	200	
	Growth in U. S. non-fertilizer market	30	
	NSP decline	40	
	Growth in exports	0	
		<u>270</u>	5700
1974/75	Growth in U. S. fertilizer market	200	
	Growth in U. S. non-fertilizer market	30	
	NSP decline	50	
	Growth in exports	0	
		<u>280</u>	5980
1975/76	Growth in U. S. fertilizer market	200	
	Growth in U. S. non-fertilizer market	30	
	NSP decline	50	
	Growth in exports	0	
		<u>280</u>	6260

SLIDE 18

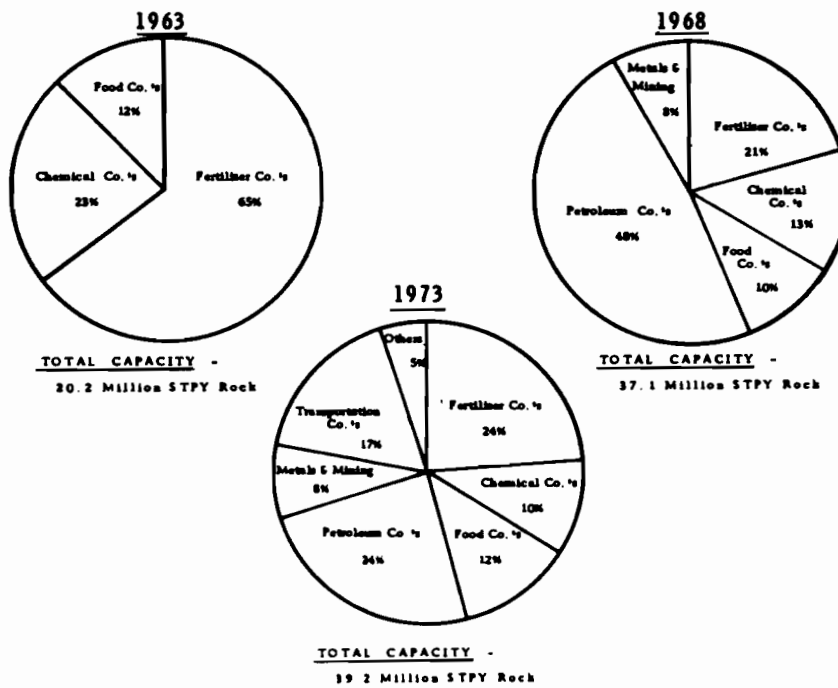
## WORLD $P_2O_5$ FERTILIZER CONSUMPTION WILL INCREASE

6% PER YEAR - TO 1976/77



SLIDE 19

# OWNERSHIP OF FLORIDA PHOSPHATE ROCK CAPACITY



SLIDE 20



SLIDE 21

MODERATOR REYNOLDS: Thank you Frank for those interesting statistics on Phosphates.

Our next paper for discussion is "Controlling In Plant Dust in Fertilizer Plants." Frank P. Achorn will discuss this part of the program. He needs no introduction to this group. Frank has always helped our Round Table and deserves lots of the credit for its success.

Frank is a graduate Chemical Engineer of the Speed Scientific School, University of Louisville, Ky. He has worked with the T.V.A. Authority for about 25 years. During the early part of this period he worked in Research and Development and in the start up of large scale fertilizer plants. For two years he was assistant plant manager for the Coastal Chemical Corporation, a primary producer of Superphosphate, Ammonium Phosphates and Anhydrous Ammonia. Frank is now Head of the Process and Product Improvement Section of the Division of Agricultural Development of the T.V.A. Authority. He is an honorary member of the National Fertilizer Solutions Association. He is listed in American Men of Science and Who's Who in American Education.

## CONTROLLING IN-PLANT DUST IN FERTILIZER PLANTS

Frank P. Achorn and Hubert L. Balay

The recently enacted Occupational Safety and Health Act requires that the working conditions in plants be suitable for employees in the plants. For the past several years TVA field engineers have cooperated with fertilizer manufacturers in attempting to eliminate dust in bulk blending and conventional ammoniation-granulation plants. The Experience gained in these two types of plants is the basis for this paper. However, many of the suggestions can be used in other plants which manufacture solid fertilizers.

### Bulk Blending Plants

A typical bulk blending plant is shown in Figure 1. The granular materials are usually received by hopper-bottom railway cars from which they are removed by a conveyor permanently installed beneath the railway tracks or by a portable conveyor placed between the bottom of the hopper and the top of the tracks. The materials are usually transferred to bins by means of an elevator, as in Figure 1, or a combination of an inclined

screw conveyor and a shuttle conveyor. The bins usually have concrete floors and wooden walls. Materials are removed from the bins with a front-end loader which dumps into an elevator leading to a screen for removal of lumps. The oversize is crushed and recirculated to the screen. Materials passing the screen are loaded into several retaining hoppers, one for each material in the formulation. They are dumped from the retaining hoppers into a weigh hopper where they are individually weighed. From these hoppers they are conveyed by chute to a rotary mixer. The mixer discharges into an elevator which, in turn, dumps into a retaining hopper, a bagging machine, or a bulk truck. The amount of dust in bulk blending plants varies widely from plant to plant, depending upon the materials in the formulation and the equipment used for mixing.

### Improvement in Quality of Materials Used in Blends

Tests in various bulk blending plants have shown that the amount of dust can be held down by using granular materials having a minimum of minus 16-mesh particles. Screen analyses of some of the typical materials used by blenders (Table 1) show that the coarse (cheaper) grades of potash and triple superphosphate contain significantly larger proportions of minus 16-mesh material than the corresponding granular materials. However, the lower price that often prevails on materials containing some minus 16-mesh particles tempts the blender to use the dustier product.

Granular potash and granular superphosphate usually are readily available. When sulfur is required, ammonium sulfate is generally used as a source of both nitrogen and sulfur. The availability of coarse crystalline or compacted ammonium sulfate is usually limited, even when other materials are in plentiful supply. Small crystalline ammonium sulfate is usually available. The screen analyses for compacted and crystalline ammonium sulfate (Table 1) indicate a significant proportion of minus 16-mesh crystals in most crystalline ammonium sulfate. The proportion of particles of this size in the compacted flakes is rather low, and it is recommended that ammonium sulfate of this particle size be used in bulk blending plants to limit the quantity of dust.

It is not always practical to obtain suitable granular materials for use in bulk blending. For example, many

Table 1

Screen Analysis of Typical Materials Used for Granular Bulk Blending

Material	Recommended for Use		Screen Analysis--Tyler--Weight %							
			+6	-6	-8	-10	-16	-20	-25	-30
Potash										
Granular <sup>a</sup>	Yes	-	2	36	52	10	0	-	-	-
Coarse <sup>a</sup>	-	No	0	0	19	51	30	-	-	-
Triple superphosphate										
Granular <sup>b</sup>	Yes	-	<1	29	56	14	<1	-	-	-
Coarse <sup>b</sup>	-	No	1	2	-	-	-	73	25	-
Ammonium sulfate										
Compacted flakes <sup>a</sup>	Yes	-	0	6	46	41	7	-	-	-
Crystal <sup>a</sup>	-	No	0	4	20	51	25	-	-	-

a. Hignett, T. P. "Bulk Blending of Fertilizers: Practices and Problems." Proceedings No. 87, The Fertiliser Society, London, March 25, 1965.

b. American Cyanamid Company.



blenders use dried sewage sludge in bulk blends as a source of organic matter, and others use fine materials such as rice hulls. These materials are byproducts of pollution control systems, and an excellent method of recycling these pollutants back to the land is to use them in fertilizers. Therefore, systems for the use of fine-size materials with a minimum of in-plant dust have been tested and are reported later in this paper.

One of the problems related to dust in bulk blending plants is created by parting agents which have been dusted onto granular materials such as ammonium nitrate, urea, and nitric phosphate. TVA has used a nitric phosphate, 20-20-0 grade, for several years in its field programs. This nitric phosphate is used in some blending plants in the Tennessee Valley region where it is mixed with potash to produce a 15-15-15 grade. Some blenders complained about the amount of dust in their plants when the TVA nitric phosphate was used. This nitric phosphate was conditioned with 1 percent of diatomaceous earth. When the conditioner was omitted, application tests with a 15-15-15 mixture produced from the nitric phosphate and potash showed no difficulty with some types of application equipment, but some stoppages occurred with applicators having augers. Storage tests showed that a satisfactory dust-free product would result if the 20-20-0 grade were conditioned with only 0.2 percent of a kaolinite clay. This material is now being used in several blending plants, and the results is a minimum amount of dusting.

Some basic producers are investigating the addition of lightweight oil to conditioned products such as urea and diammonium phosphate. Preliminary tests indicate that the oil lowers the dust level in bulk blending plants.

TVA is investigating the possibility of conditioning materials such as urea with a wax which has been diluted with lightweight lubricating oil or bunker C fuel oil. This wax-type conditioner seems to be a satisfactory parting agent for prilled urea. Also, no dust should be created during the handling of urea conditioned with this diluted wax agent. One company has tested a water-soluble organic agent by adding it to fertilizer during the manufacture of ammonium phosphates such as diammonium phosphate. They add about 1 pound of the dust depressant per ton of product and report that the treatment lowers dust levels in bulk blending plants which use diammonium phosphate.

One European company produces a dust-free nitric phosphate product by coating the granules with a thin film of polyethylene. This coating is done while the granules are hot. They report little or no dust in their plant. Practically all their products are bagged; however, inspection showed that they are completely dust-free and should not create any dust during bulk handling.

### *Conveying Equipment*

Some bulk blenders use pneumatic systems to convey their granular materials. There is a tendency for an excessive amount of dust to form in these systems. For this

reason, the use of pneumatic conveying equipment in bulk blending plants should be avoided unless the granular materials are treated with some type of dust depressant.

When an inclined screw conveyor is used to move materials from hopper-bottom railway cars to a shuttle conveyor in the plant, dust from the screw conveyor may be a problem. Screw conveyors cause some degradation of weak granular materials. It is recommended that the screw conveyor be connected to the shuttle conveyor by a flexible sock arrangement, such as that shown in Figure 2. This sketch depicts a bulk blending plant especially designed to keep dust to a minimum. Note the exhaust hood above the loading area of the shuttle conveyor. Dust from the hood is removed by the scrubber shown in Figure 3. This scrubber is made of wood and can be constructed in a local shop. Some companies are investigating the installation of prefabricated scrubbers which have high efficiencies. The materials are discharged from the shuttle conveyor through a telescoping chute, such as the one shown in Figure 2, and have little or no free fall to the top of the pile.

Some companies install bin curtains such as those shown in Figure 4 to contain the dust inside the bulk bins. These roll-up sheets are made of polyethylene plastic. Canvas can be used instead of plastic, and canvas is more resistant to tear.

Note also in Figure 2 the exhaust hood above the boot of the elevator into which the front-end loader dumps material from bulk storage. An elevator will emit considerable dust when it is nearly empty. Some companies have installed in the loading boot of the elevator a seal consisting of a vane-type mechanism such as the seal shown in Figure 5. This mechanism is usually driven by the same motor that drives the elevator.

A low-speed perfect-discharge elevator, such as the one shown on the right in Figure 6, is recommended. The slow-speed perfect-discharge elevator has two strands of chain which are snubbed back by an idling sprocket after they have rounded the head sprocket. This gives almost complete upturn of the buckets. The buckets completely empty through the discharge chute, and little or no material showers down to the boot end of the elevator. A considerable amount of material does not empty from the buckets of the high-speed centrifugal-discharge elevator (Figure 6, left) before they pass the discharge chute. Therefore, there is a great deal of recycling of materials within the casing of the elevator. If these materials are excessively dusty, a large quantity of dust will be emitted from the elevator. For this reason a centrifugal-discharge elevator should be connected to an exhaust system so that there will be a slight vacuum within the elevator. The dust can be removed from the exhaust gases by the scrubber which removes dust from the other parts of the exhaust system.

## Mixers

Some mixers are mounted with an inclined axis. The mixer is used on road vehicles for delivering ready-mixed concrete, and blenders salvage mixers from these vehicles. This type of mixer has a reversible drive. It rotates in one direction for mixing and in the opposite direction for discharging. As the end of the mixer remains open during the entire mixing cycle, some dust is evolved into the area surrounding the mixer. It may become necessary to install an exhaust hood above the mixer to remove the dust. Perhaps the spraying of liquid dust depressants into this mixer would help to eliminate the dust.

A minimum of dust is evolved from a mixer of the type shown in Figure 7. This is the mixer most frequently used in the bulk blending industry. It is filled at one end and discharged from the other. During the mixing process the ends of the mixer are closed. It is important that the seals of this mixer be kept repaired and properly lubricated to prevent dusting from the mixer.

Several companies have found that the amount of dust in a plant can be decreased by the spraying of water, motor oil, or a fertilizer solution into the mixer. The fluid is usually sprayed through two TeeJet nozzles located on the center axis of the mixer. The spray bar with the two recommended nozzles is shown in Figure 7. Some companies have found that when water is sprayed into the mixer the amount of dust is greatly decreased, but there is a buildup of caked materials on the walls of the mixer. Therefore, it is recommended that a knocker be installed on the rotary mixer when liquid is sprayed into it. This same procedure has been used to stick fine-size micronutrients onto the individual granules of a bulk blend. Companies that use liquid dust depressants in this manner have reported that there is considerable less dust around the mixing platform and also in the area at which the blend is discharged into an applicator or bagging machine.

In tests in which diesel oil was sprayed onto the bulk blend while mixing was in progress, little or no dust was evolved from the mixer into the surrounding area; neither was dust evolved from the chute which delivers the product from the mixer to the applicator truck.

TVA will continue to develop practical means of controlling dust in and from bulk blending plants. Tests will be conducted in commercial bulk blending plants in an effort to improve the control procedures.

## Ammoniation-Granulation Plants

A typical ammoniation-granulation plant is shown in Figure 8. Plants of this kind have had in-plant dust problems for years, but some ways of minimizing these problems have been developed recently.

## Materials for Ammoniation-Granulation Plants

Probably one of the easiest ways to minimize in-plant dust is to select for use in the process materials which cause less dust in the plant. Some companies have reported that the use of wet-process superphosphoric acid in the

formulations for several grades has significantly decreased dust. They report that they usually use about 150 pounds of superphosphoric acid per ton of product.

Most plant tests have shown that when a large quantity of sulfuric acid is used in the formulation there is usually a considerable amount of dust in the plant. Other tests show that when superphosphoric acid is used in combination with sulfuric acid there is less dust in the plant area. When superphosphoric acid is used, granulation is generally accomplished at a lower moisture level, and the result is a granule which is hard and resistant to degradation.

Plant observations also indicate that there is less dust in the plant when chemical heat for granulation is provided by the use of merchant-grade wet-process phosphoric acid (54 percent  $P_2O_5$ ) instead of sulfuric acid.

Several small granulation plants in Europe use nongranular monoammonium phosphate as a source of phosphate. In these plants it has been observed that there is less dust when monoammonium phosphate, urea, and steam are used instead of ammoniating solution, ammonium sulfate, sulfuric acid, and superphosphate. TVA pilot-plant studies showed that there was very little fume and dust in the plant when grades such as 8-24-24, 10-20-20, and 13-26-13 were produced from ammonia, steam, monoammonium phosphate, ammonium sulfate, and potash. This process was demonstrated in the Ninth TVA Technology Demonstration. The monoammonium phosphate used in the tests was ammoniated to increase its N:P mole ratio from 1.0 to 1.5 (4.8 to 7.2 pounds of ammonia per unit of  $P_2O_5$ ).

Although nongranular monoammonium phosphate is not available in the United States, it is available in other parts of the world (Europe and South America), and several processes can be used for its production. Most of these processes are simple and require a plant with only relatively low capital investment. One European company has found it most convenient to produce its monoammonium phosphate (MAP) in a TVA-type rotary ammoniator from phosphoric acid and ammonia. The MAP discharges from the ammoniator into a rotary granulator where it is granulated with urea and/or ammonium sulfate and potash by the addition of steam and water.

## Equipment

Probably when dusty materials such as run-of-pile normal or triple superphosphate, potash, and byproducts such as dried sewage sludge are to be used in granulation plants they should be treated with a dust depressant before they are sent to storage. In this procedure a stream of fine material is allowed to fall between two spray nozzles as shown in Figure 9.

One European company has found that there is a great deal less dust in its plant and in bulk storage when its products are conditioned with 0.2 percent by weight of oil. This oil has a consistency comparable with that of SAE 10 motor oil. It is added in the equipment shown in Figure 10,

which includes a belt conveyor and a rotary mixer. The oil is first sprayed onto the granules on the moving belt conveyor. The oil-treated material is then thoroughly mixed in a rotary mixer. (The addition of a parting agent is necessary, because an ammonium phosphate product is produced.) This parting agent (1 percent to 2 percent) is also added in the rotary mixer.

Other companies use lightweight oils as dust depressants. They mix the dust depressants with a granular product by means of a covered inclined screw conveyor such as the one shown in Figure 11. They report that no additional mixing is required — that thorough mixing of the oil and the granules occurs in the conveyor. They report that oil between 0.2 and 0.5 percent by weight is used and that there is little or no dusting of the product from this equipment with this quantity of oil.

Each end of the ammoniator-granulator is an area in the plant where there usually is a great deal of dust-laden air. Some companies have found that this dust can be controlled by completely enclosing the feed end of the granulator with a stationary plate and dust seals as shown in Figure 12. This gives a labyrinth-type of seal. The ammoniator-granulator is also equipped with an exhaust hood which covers the upper half of the discharge end of the granulator. Most operators prefer the lower half of the granulator exhaust hood to remain open for continuous observation of the inside of the granulator. To leave this large section open and to ensure that all dust is removed from the discharge end, a rather large exhaust blower is required (usually about 10,000 cfm).

Other areas of the plant where dust accumulates are the discharge ends of the dryers and coolers. These sources of dust can be eliminated by enclosing the discharge ends of this equipment in hoods having good seals between the stationary hood and the rotating equipment. Many companies install manometers on these hoods to help the operator ensure that the seals remain good and that a negative pressure remains on the hoods.

Several companies have tried to improve the efficiency of their dust collectors by increasing the flow or velocity through them. They have found that when the gas velocity through the dryer or cooler exceeds about 400 feet per minute an excessive amount of dust is emitted from the discharge of the dryer or cooler. To avoid excessive velocity through the dryer and cooler and to maintain optimum velocity through the dust collector, an open duct is sometimes installed in the exhaust line between the cyclones and the dryer and cooler. Figure 13 is a sketch of this kind of duct. The velocity of the gas through the dryer and cooler can be adjusted by means of a damper in this duct. The optimum flow of gas is maintained through the cyclones. This duct can serve a dual purpose; it can be connected to the general dust exhaust system of the plant. Figure 14 shows how this exhaust system can be used to remove dust from the screens, elevator, and conveyors (product and recycle conveyors). Exhaust blowers of

sufficient size should be used to meet the design requirement for increased air flow.

Usually a considerable amount of dust collects in the air around the discharge of the cyclones, the conveyor systems for the fines, and the elevator which usually elevates the fines from the dust collector to either the recycle system or the ammoniator-granulator. Some companies have installed a seal for the dust collector similar to the one shown in Figure 15. A tight seal is maintained on the collector discharge, and a minimum amount of dust is evolved as the dust is emptied from the collector into the recycle.

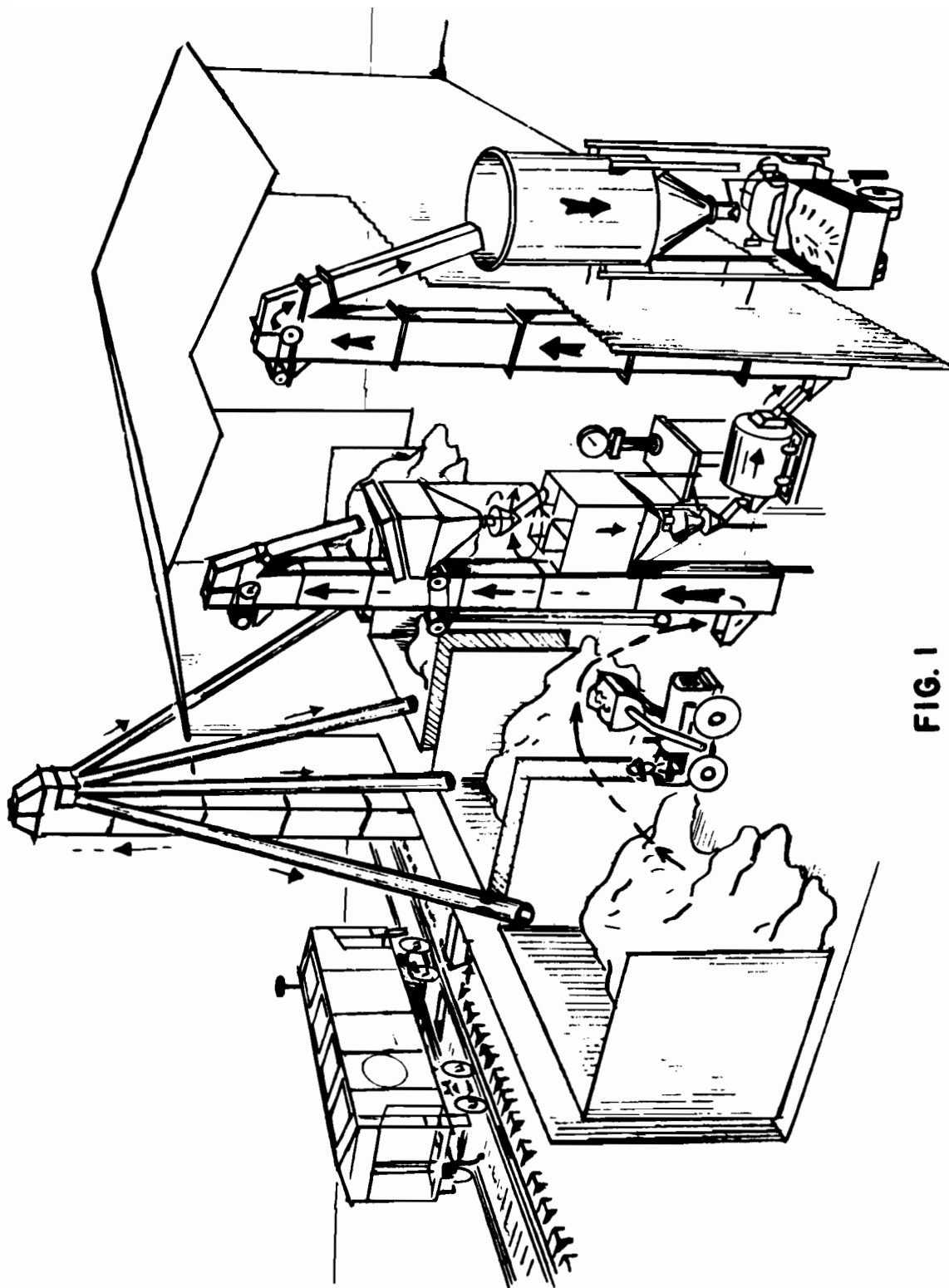
Several types of molded rubber seals have been used for dust collectors. Some companies report that these seals have caused difficulty by not emptying properly or by not sealing the discharge of the collector. A new type of molded rubber seal is shown in Figure 16. This seal is different, because the discharge from the dust collector is elliptical, as shown in view A-A in Figure 16. The rubber seal is molded in an elliptical shape. A company that uses dust seals of this configuration reports that they have worked well for several years. When the dust collector is empty, a seal of this kind prevents the flow of air into or out of the dust collector, because the rubber is molded in the center to form a good seal. The dust collector can be operated at maximum efficiency, because the discharge end is well sealed. When a sufficient amount of dust is accumulated in the bottom of the collector, the rubber seal is forced open by the weight of the material, and the dust is discharged into a covered sealed screw conveyor. The company reports that when this system is used little or no dust is accumulated in the air around the discharge end of the collector.

### *Summary*

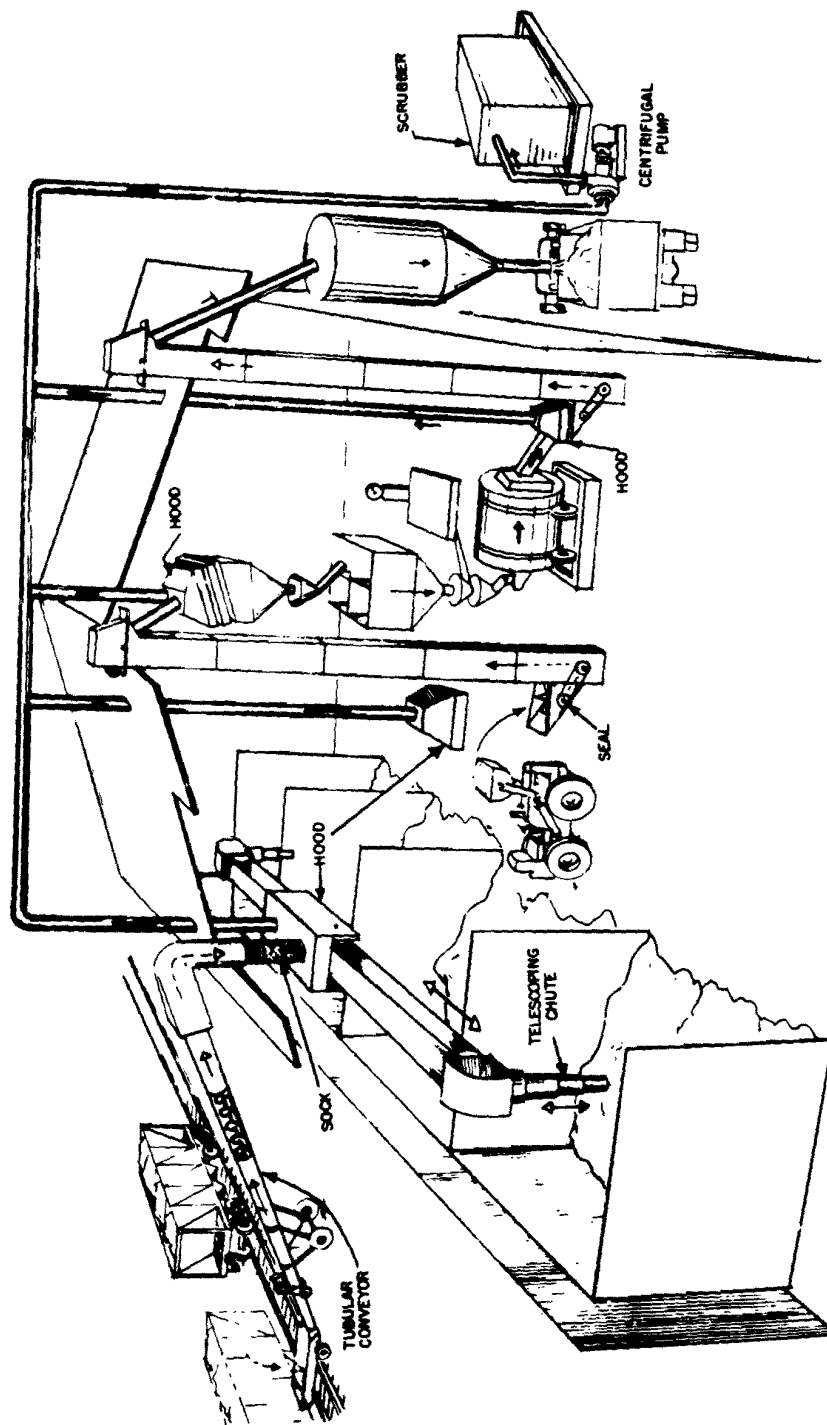
Dust in bulk blending plants can be minimized in several ways. Probably the most convenient method is to select raw materials which do not contain fine particles or dust. Tests in bulk blending plants show that treating materials with dust depressants is also effective. This addition can be accomplished best in the rotary mixer. Several companies are now using dust depressants when bulk blends are produced.

Dust in conventional granulation plants can be decreased by the use of dust depressants on the raw materials and on the products. Various kinds of equipment for the addition of dust depressants have been developed. Also, the operation of a plant can be improved so that the quality of dust will be further decreased. Improved operating techniques include the use of materials such as phosphoric acid and superphosphoric acid instead of sulfuric acid. The use of urea and monoammonium phosphate may also help to reduce the amount of dust. Elevators and conveyors of granulation plants should be sealed in the same way as those of bulk blending plants.

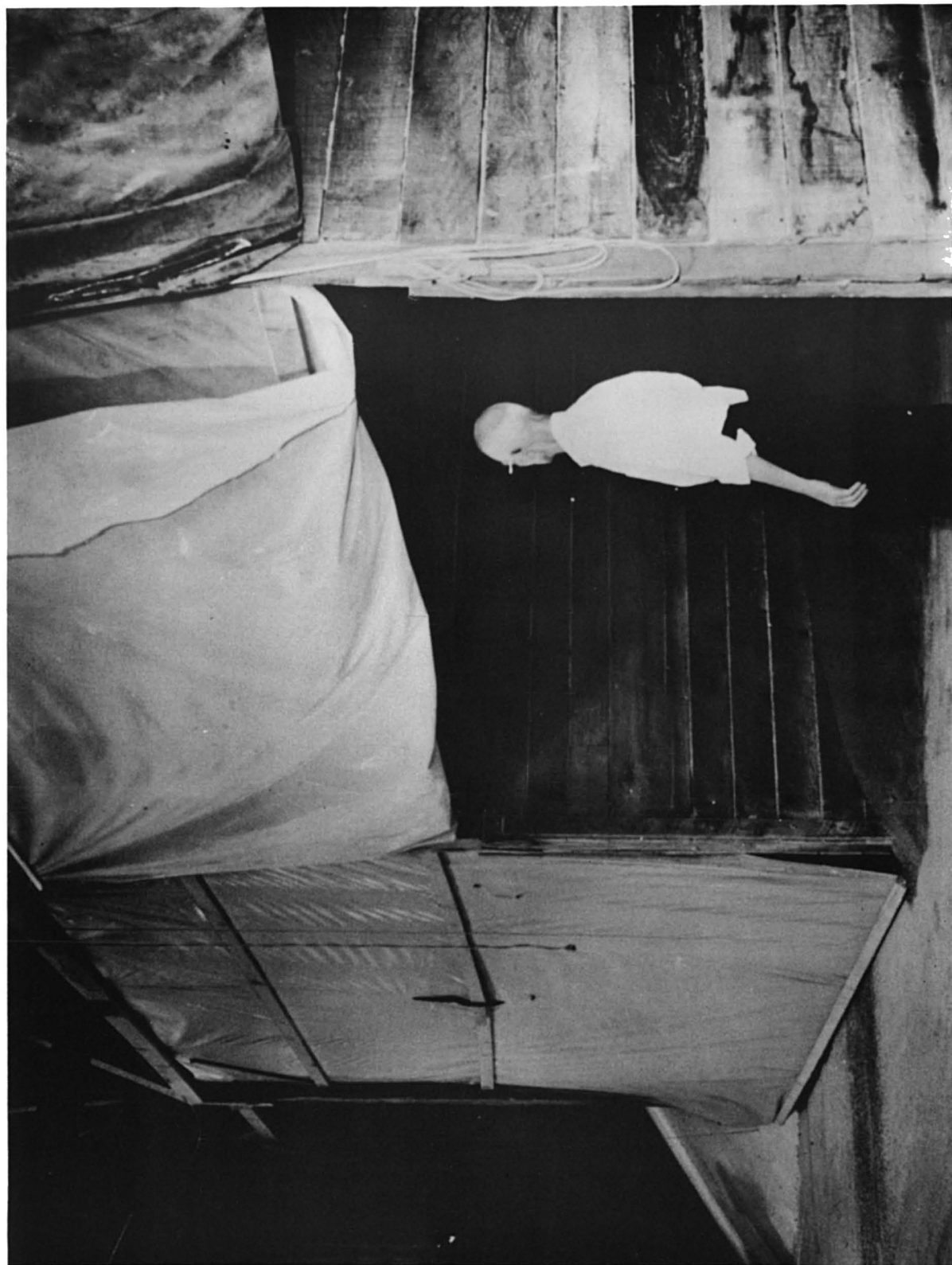
In-plant dust-exhausting systems have been developed for both bulk blending and granulation plants.



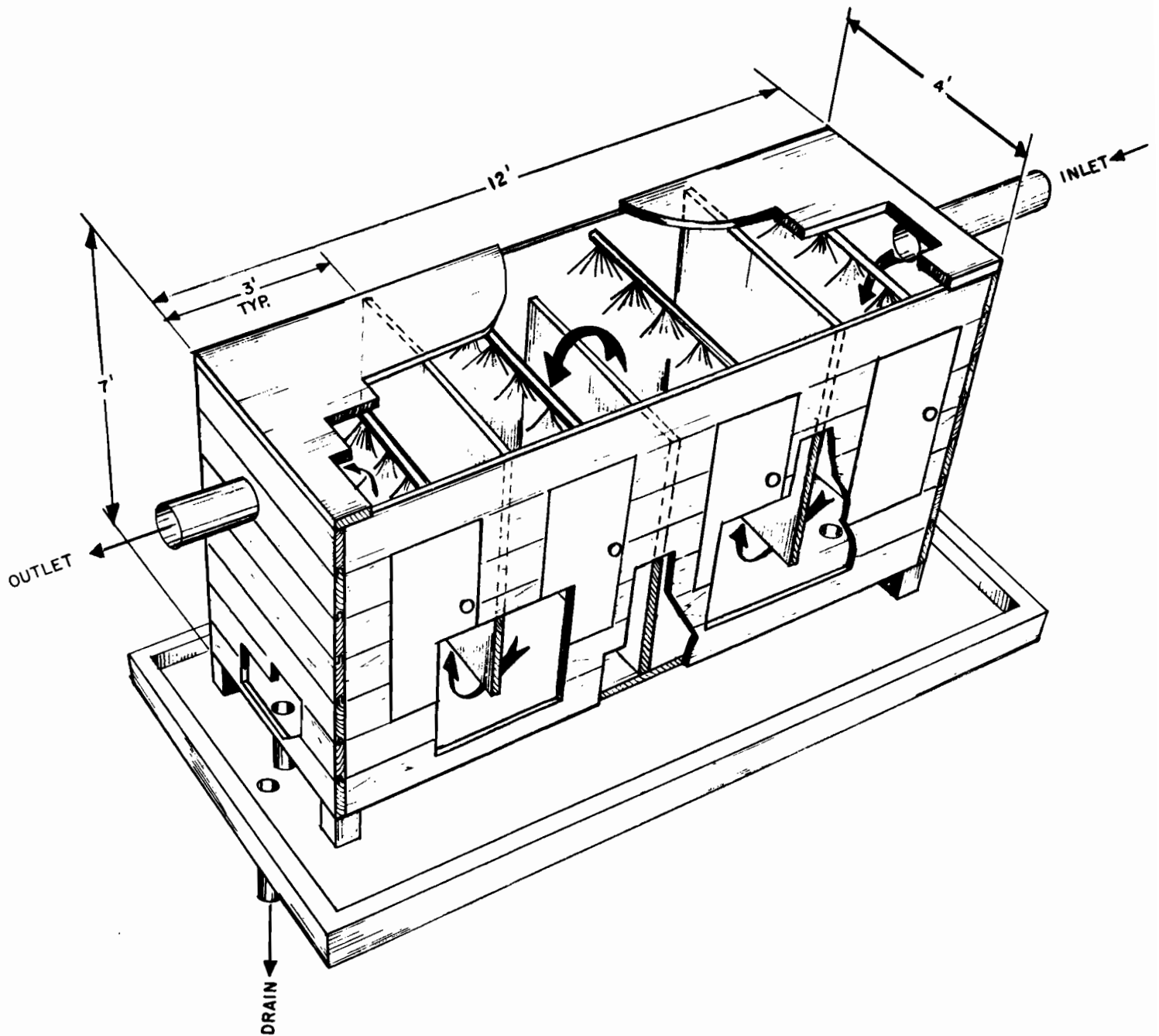
**FIG. 1**  
**TYPICAL BULK BLENDING PLANT**



**FIGURE 2**  
**BULK BLEND PLANT EQUIPPED WITH DUST CONTROL**

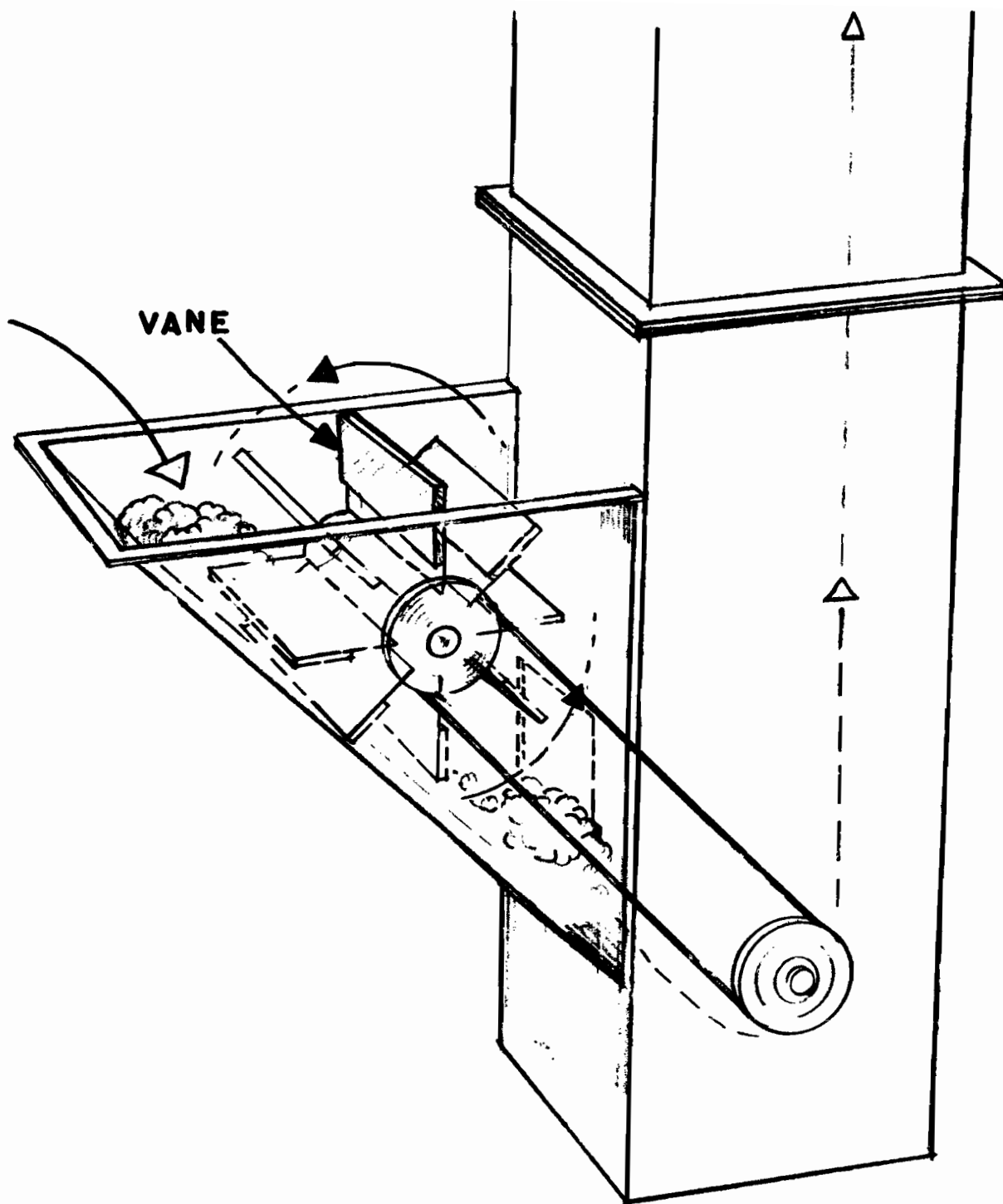


**FIGURE 4**  
**FERTILIZER BINS WITH PLASTIC ROLL-UP DUST CURTAINS**



**FIGURE 3**  
**SIMPLE SCRUBBER FOR DUST CONTROL IN BULK BLEND PLANTS**





**FIGURE 5**  
**VANE TYPE SEAL FOR BUCKET ELEVATOR**



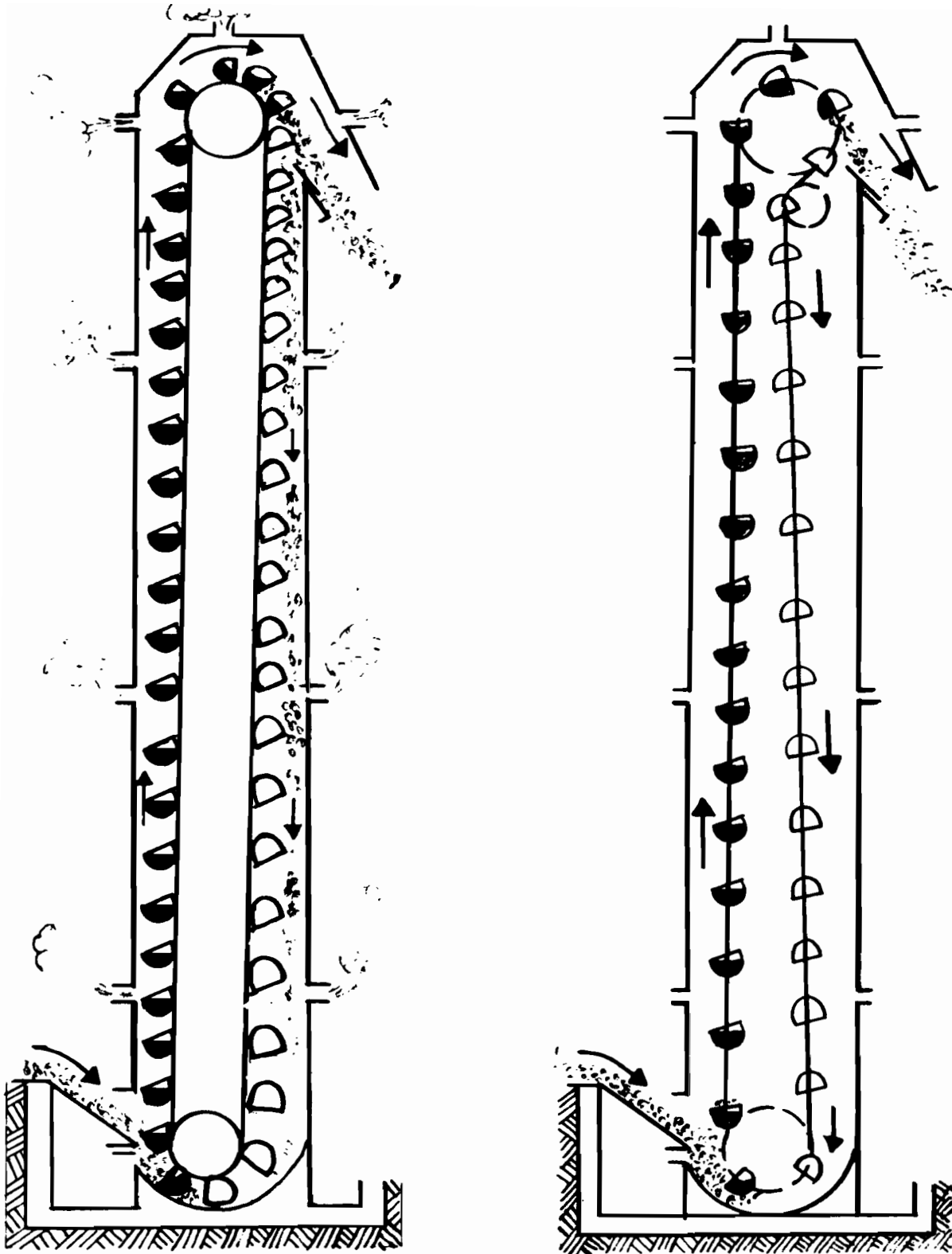
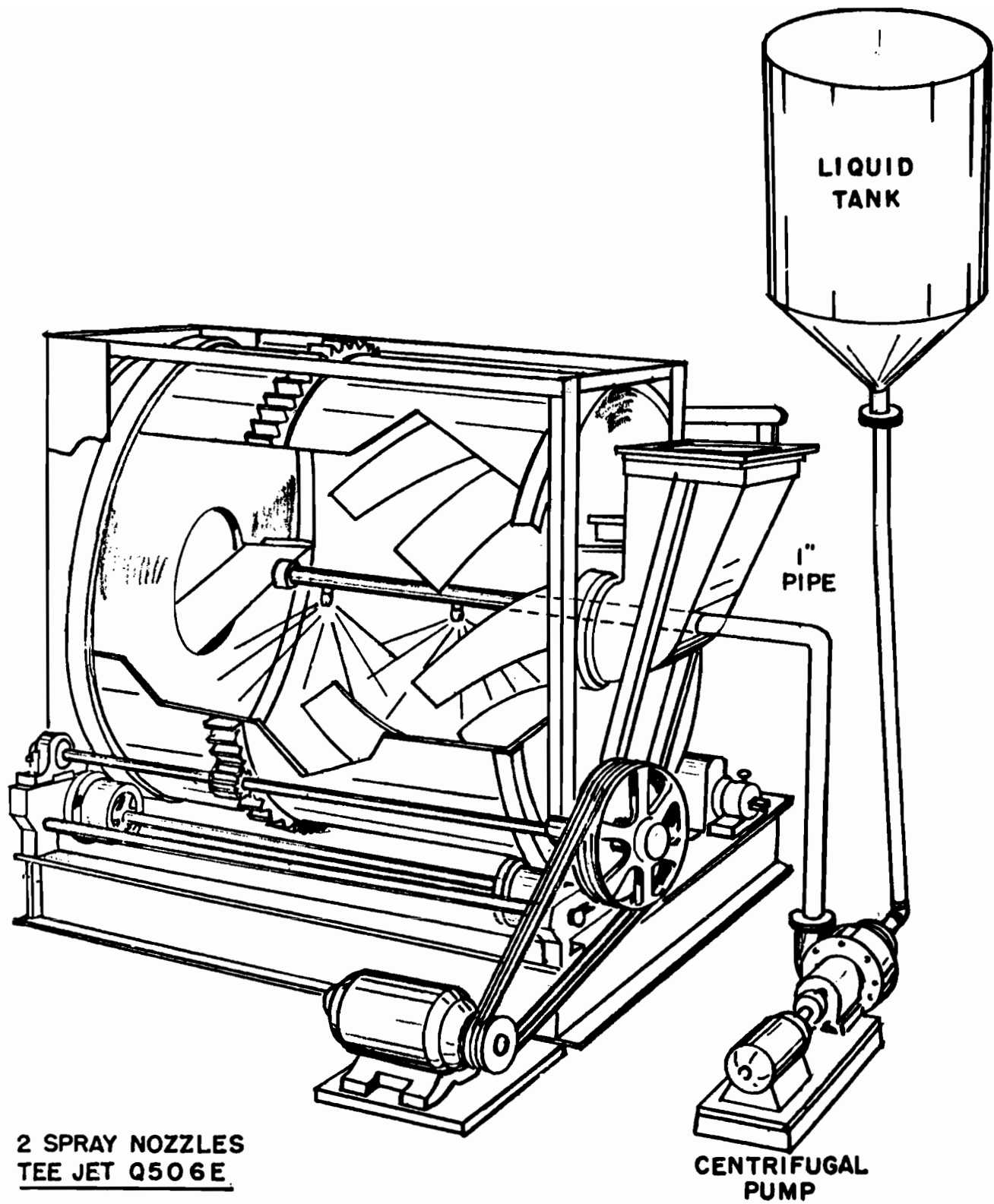


FIGURE 6  
**BUCKET ELEVATORS USED IN BULK BLENDING PLANTS**



**FIGURE 7**  
**RECOMMENDED ROTARY MIXER WITH SPRAY BAR**

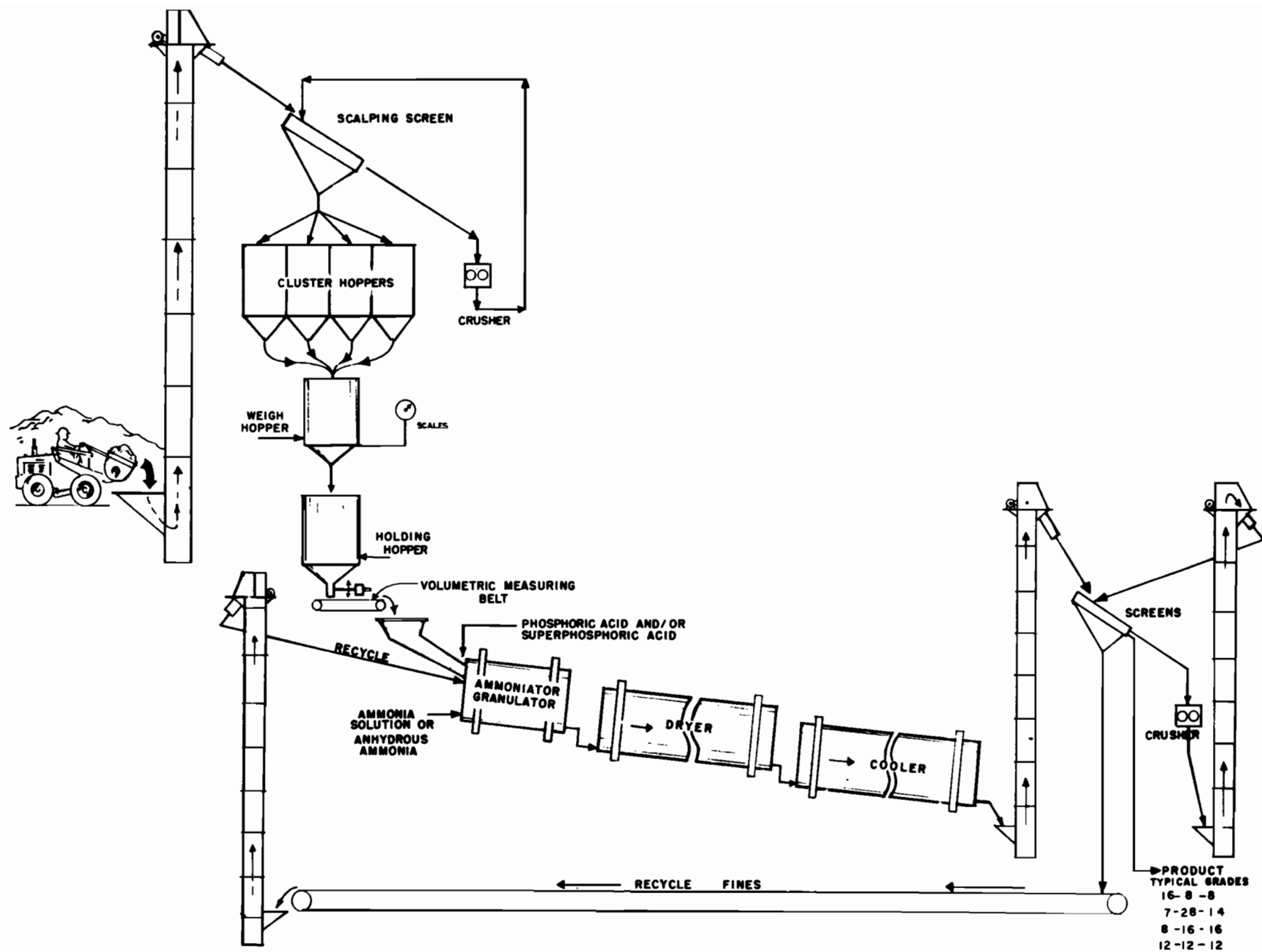


FIGURE 8  
TYPICAL CONVENTIONAL AMMONIATION-GRANULATION PLANT

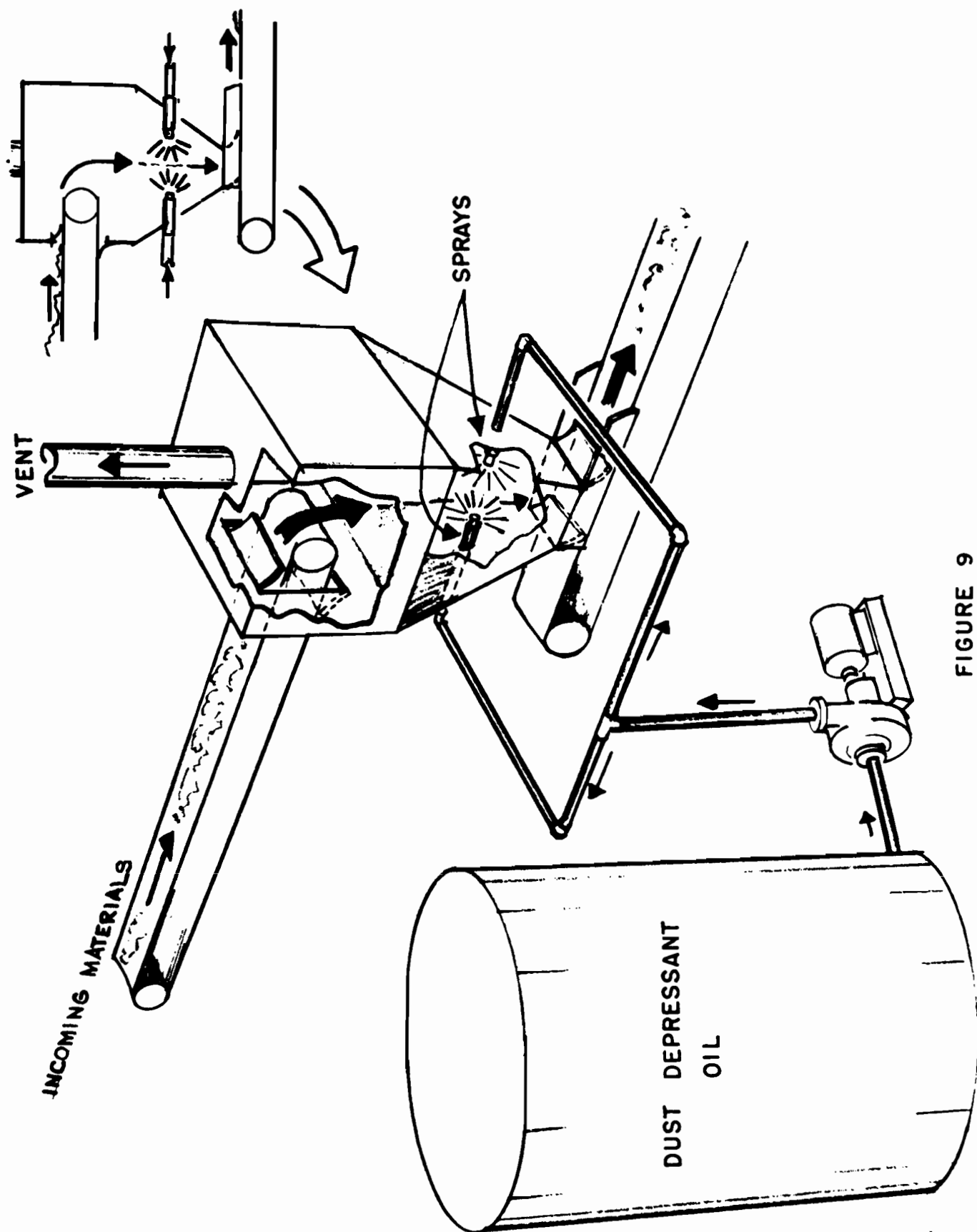


FIGURE 9  
SPRAYING DUST DEPRESSANT ON FERTILIZER MATERIALS

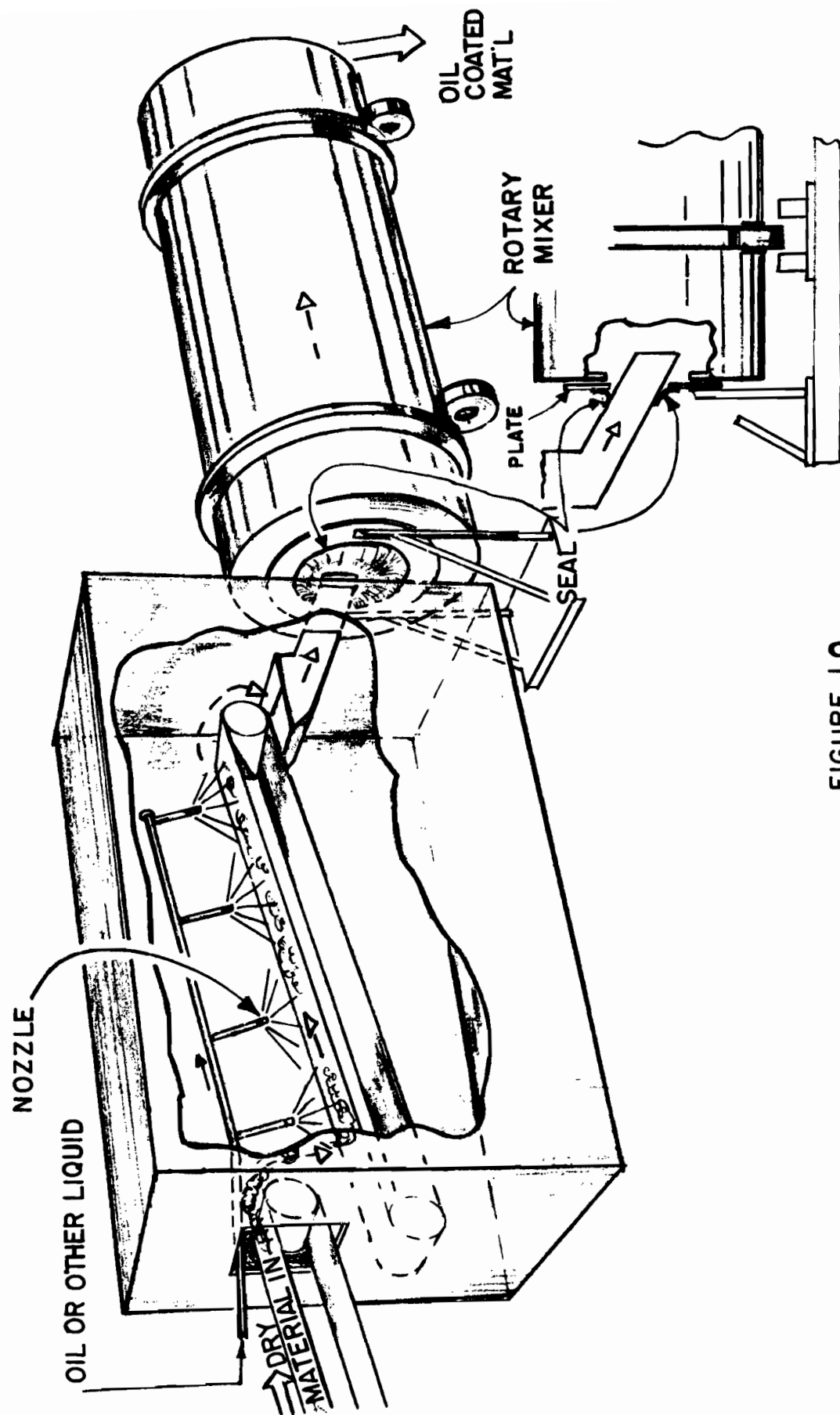


FIGURE 10  
ADDING OIL TO FERTILIZER ON COVERED BELT CONVEYOR

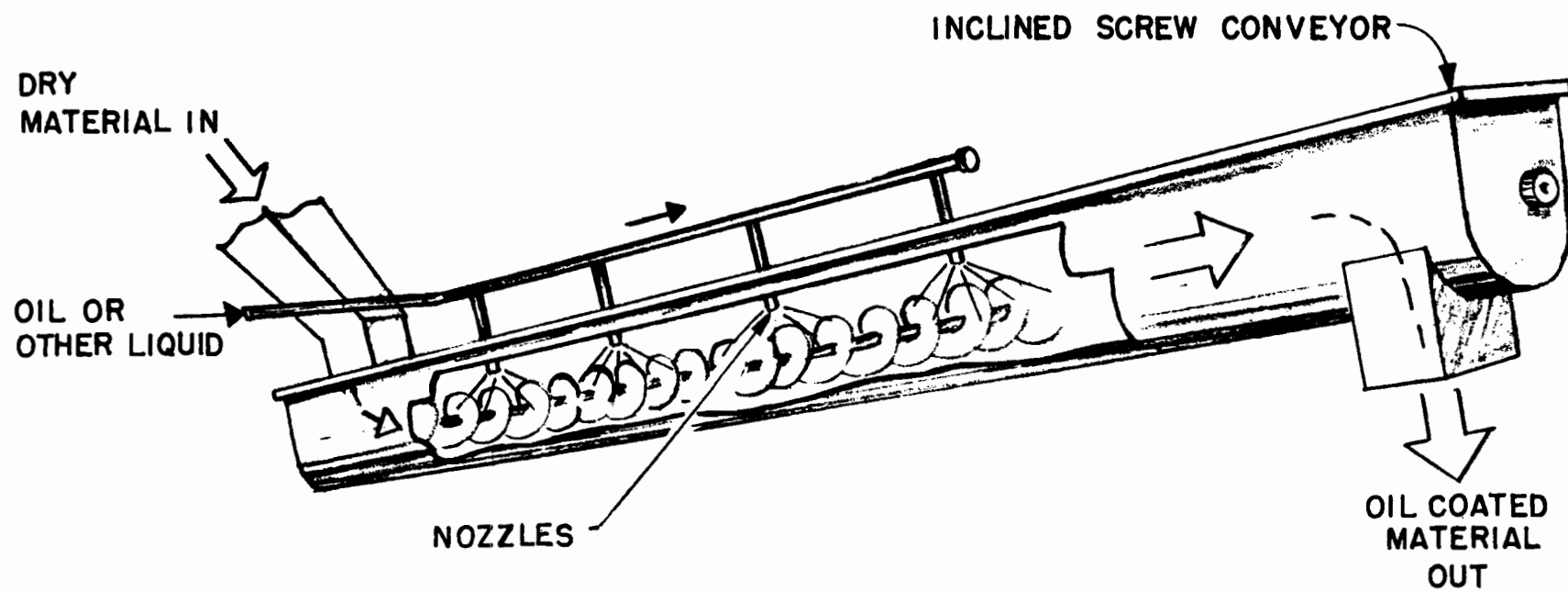
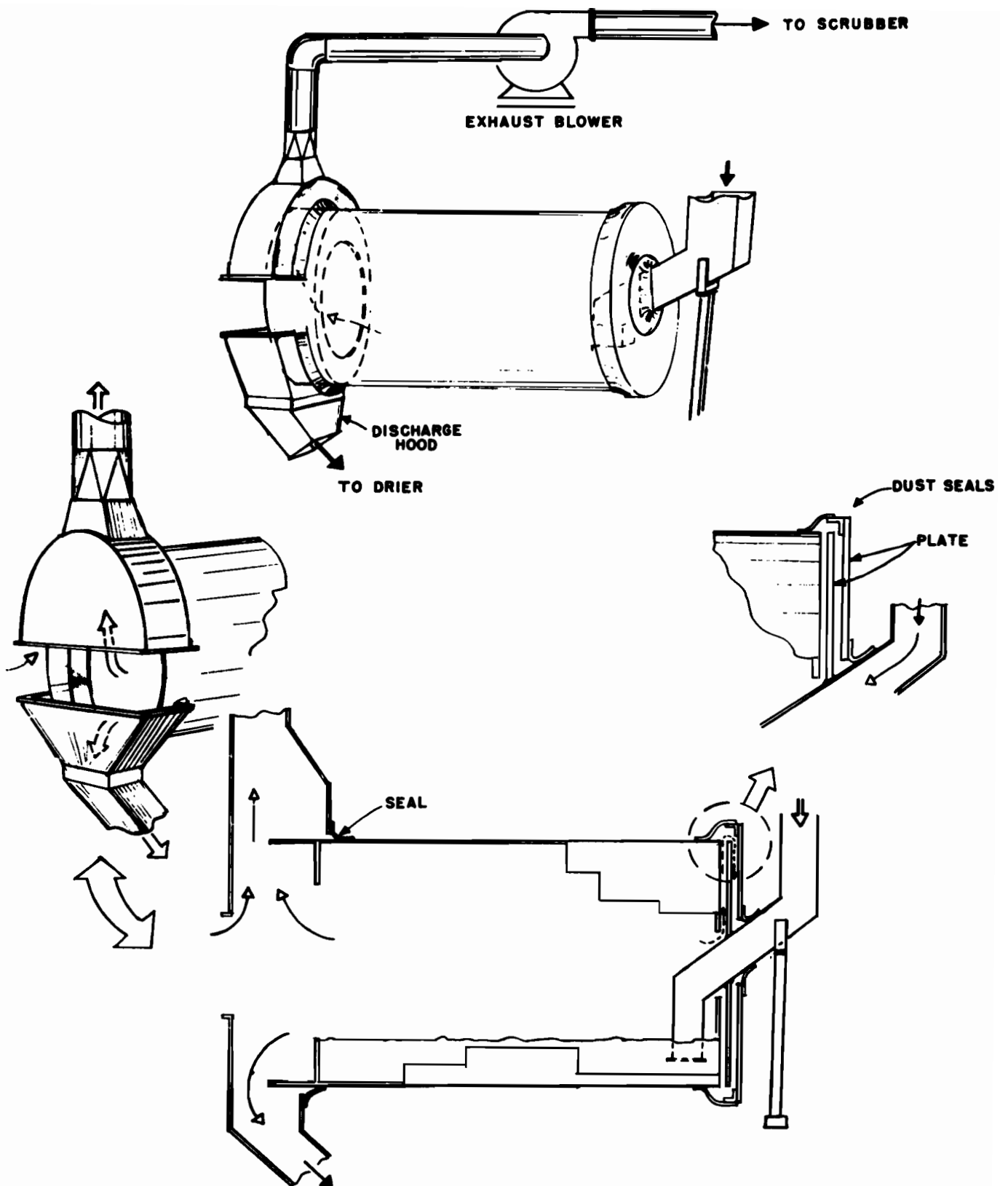


FIGURE 11  
ADDING OIL TO FERTILIZER IN COVERED SCREW CONVEYOR



**FIGURE 12**  
**AMMONIATOR-GRANULATOR EQUIPPED WITH DUST SEALS**

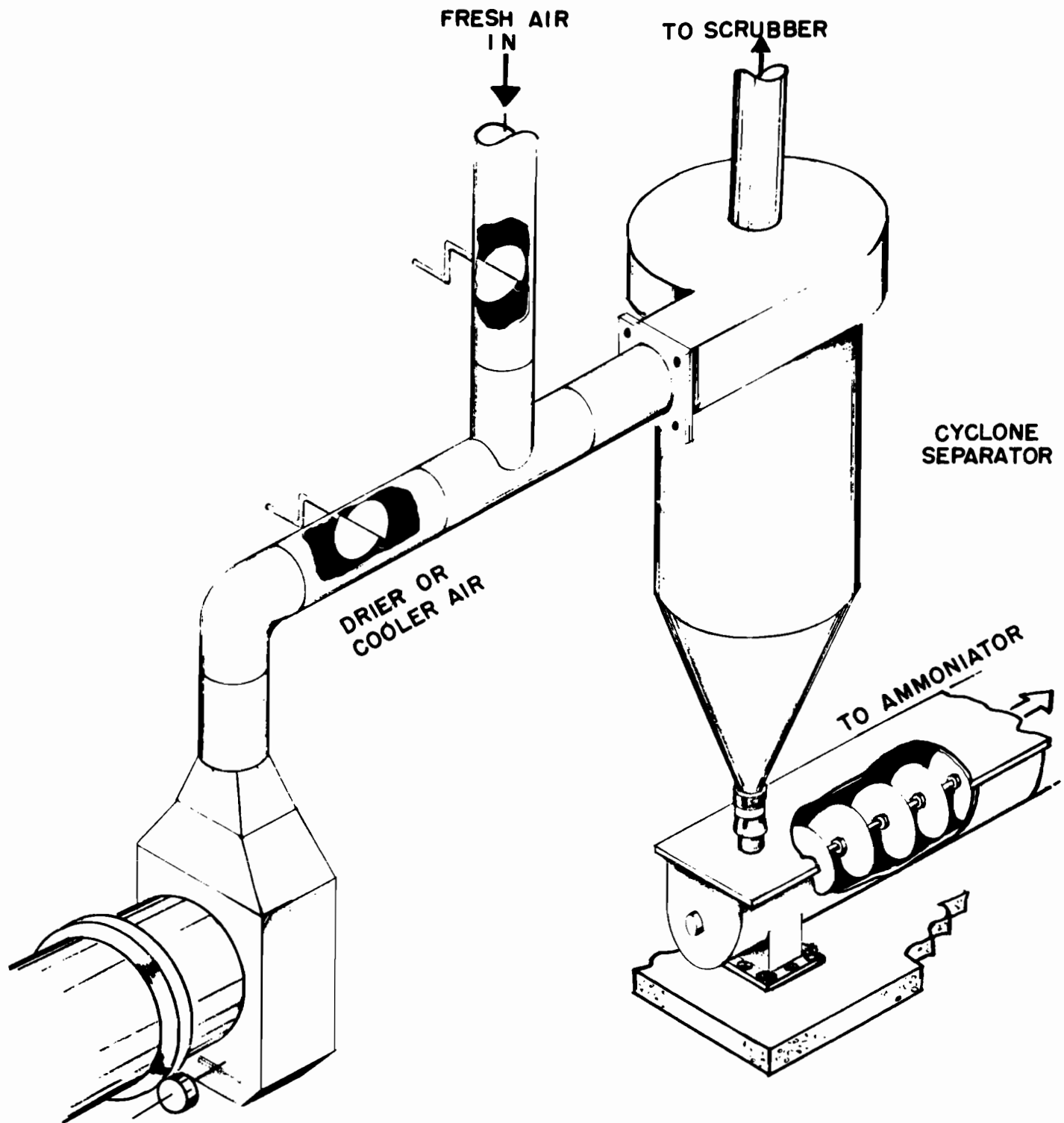


FIGURE 13  
CYCLONE GAS VELOCITY CONTROL



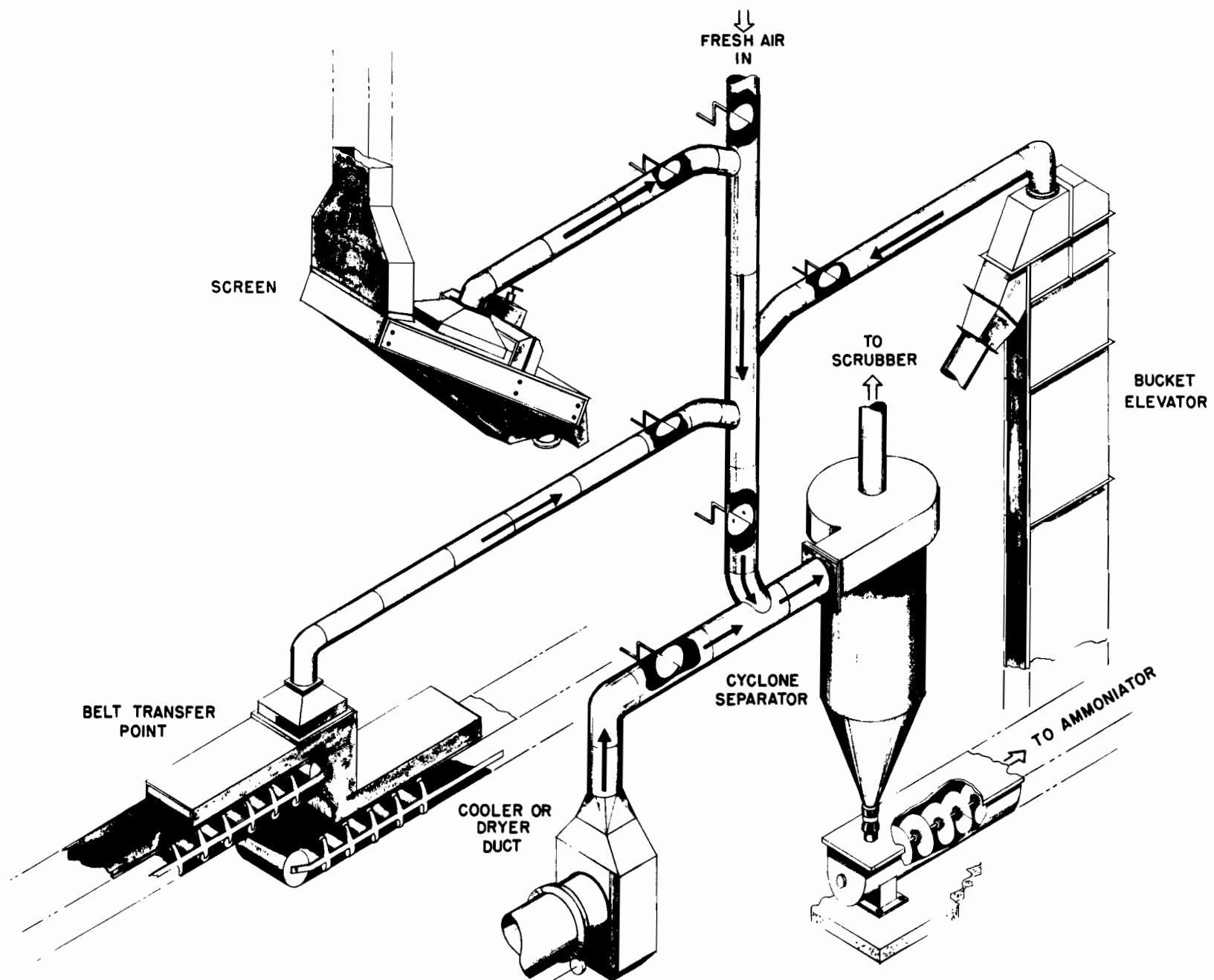


FIGURE 14  
CYCLONE GAS VELOCITY CONTROL USED TO REMOVE DUST FROM OTHER PLANT EQUIPMENT

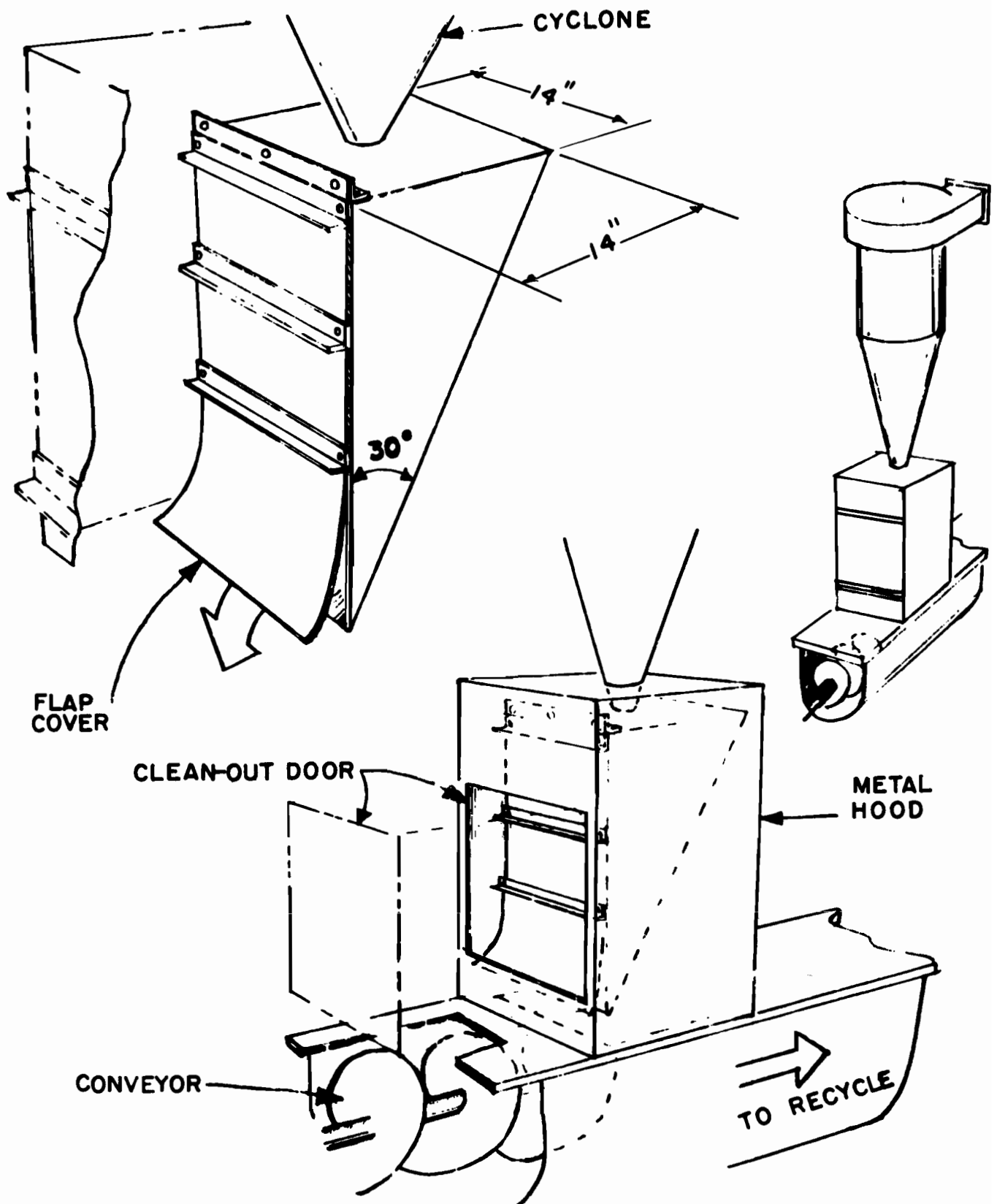
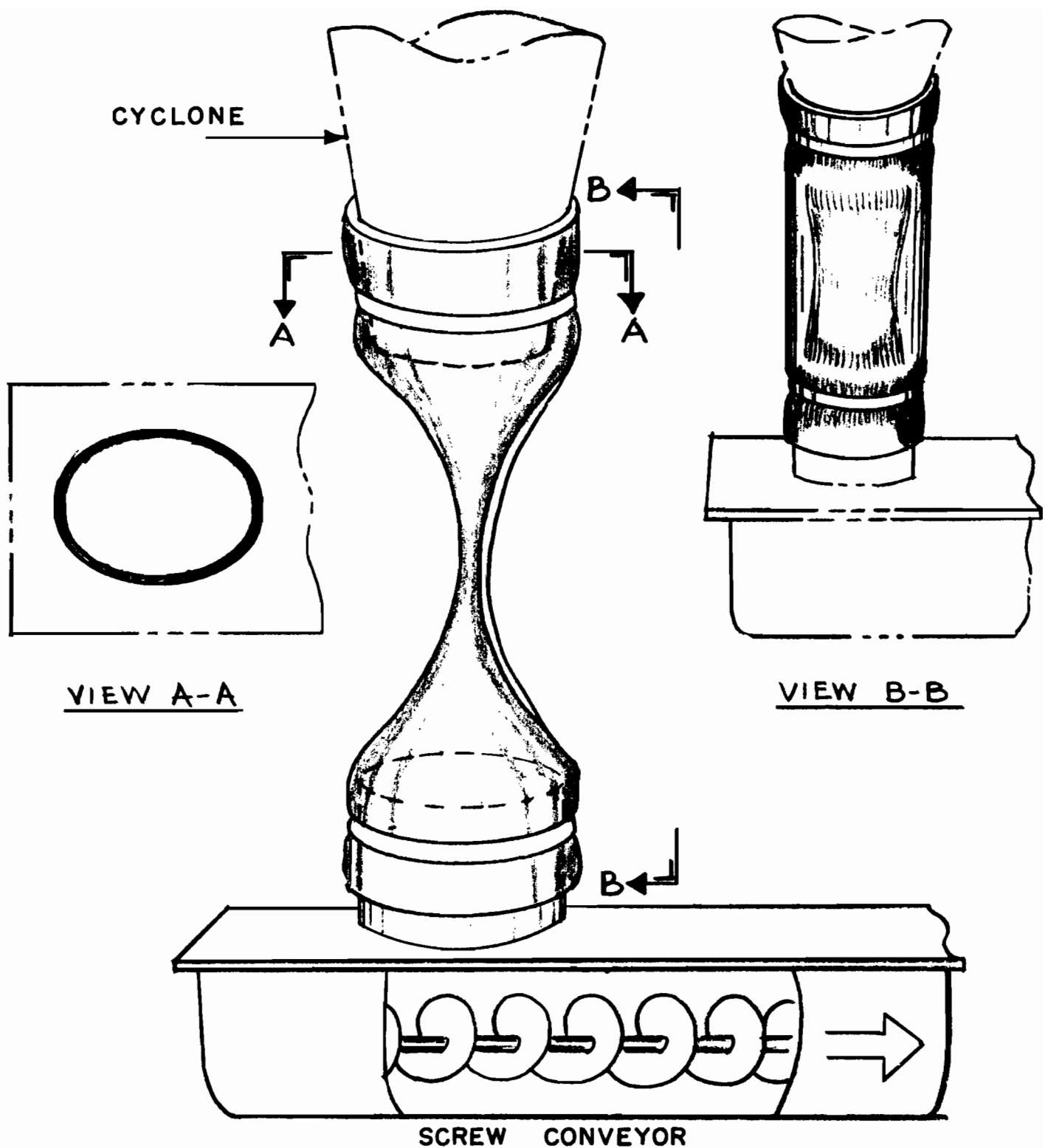


FIGURE 15  
DUST COLLECTOR SEAL



**FIGURE 16**  
DUST-TIGHT CYCLONE-CLOSURE-MOLDED RUBBER SEAL

**MODERATOR REYNOLDS:** Thank you Frank for your excellent paper and suggestions on "Plant Dust Control". Yesterday we had several discussion papers relating to the Occupational Safety and health Act. We are very fortunate today to have Mr. William A. Wilson, Compliance Officer of the U.S. Department of labor, Area Office, Nashville, Tenn. Mr. Wilson works in the area of "OSHA" and he will discuss "Occupational Safety and Health Act." This afternoon, before our Informal Round Table Discussions begin, Mr. Wilson will show an "OSHA" Film Titled "Typical Work Place Inspection".

#### **OCCUPATIONAL SAFETY AND HEALTH ACT "OSHA"**

*William A. Wilson*

[Editor's Note:] — Sorry, we do not have a final copy of Mr. Wilson's discussion. Due to an oversight in communication, our Recorder Operator was not notified to keep the machine running, that Mr. Wilson was giving his paper extemporaneously from notes.

Mr. Wilson gave an excellent interpretation of the "OSHA Act", signed into law by President Nixon the later part of 1970, including details covering deletions and additions. He recommended that all plants keep in touch

with their "OSHA" Compliance Office to be certain they have on hand complete up-to-date information.

Contacting Mr. Wilson for a final paper he advised us that his remarks, for the most part, were specific in nature, and because of his previous, many years in the Fertilizer Industry, his remarks also were of a personal nature and opinion. He told us that the Table Discussions on "OSHA" were well attended and that the questions and answers concerned mostly with "OSHA" standards in Fertilizer Plants.

Mr. Wilson was very sorry that (1) The recorder was not running and (2) several Gentlemen taking notes at the Informal Round Table discussions did not come up with the "Copy" for his checking to complete a final detailed paper for inclusion in our "Proceedings."

**MODERATOR REYNOLDS:** You have been a good, attentive audience. I wish to thank all of the Panelists for their excellent, interesting and valuable discussions.

Our program this afternoon looks exceptionally good and with your kind permission we shall start at 1:30 P.M. — sharp — instead of 2 P.M.

Please do not forget the cocktail party at 6:30 this evening.

# Thursday, November 2, 1972

## Afternoon Session

Moderators: Herman G. Powers, Wayne W. King, Albert Spillman

**CHAIRMAN POWERS:** We have a panel of three experienced "Fertilizer Operators" who will give us separately their close working knowledge on "Operation of Mixed Granulation Plants as Related to Environmental Problems".

Dick Perkins, Process and Quality Supervisor, W. R. Grace; D. L. Dibble, Director of Production Operations, Rainbow Division, International Minerals Chemical Corporation and Dick Tayloe, Assistant Manager, Fertilizer Section, Smith Douglas Division, Borden are on the platform. Shortly they will also lead Table No. 6, "Informal Round Table Discussions at which time you will have an opportunity to ask questions.

### **FERTILIZER GRANULATION PLANTS AS RELATED TO ENVIRONMENTAL PROBLEMS**

*Panel: Dick Perkins, D. L. Dibble, Dick Tayloe*

**PANELIST R. H. PERKINS:** How Can We Design Equipment For Better Control Of Emission Or For Less Generation of Emissions?

- I. Much is published about control systems for removal of particulate from plant airstreams. Have we done all we can to avoid or minimize pickup of particulate in air flows?
  - A. How much dry material and recycle do you allow to go through the plant before liquid flows are added? Dust pickup at such times is very high.
  - B. Are dryer and cooler air outlet hoods sized amply enough to prevent excessive pickup of particulate? A small hood frequently is a problem due to the high air velocity which carries much more particulate out of the vessel than a lower air velocity could carry.
  - C. Are flights at the discharge end of dryer and cooler designed to avoid placing excess dust in the airstream? Many vessels have flights omitted on the last foot or two of the shell to minimize this problem.
  - D. Excessive air velocities through dryer or cooler shells can increase particulate load in airstreams.

- E. Are dry cyclone collectors designed for greatest possible efficiency of recovery? Cyclones that recover more than 95% of the airstream particulate as dry dust are a real asset in reducing the dust loading on a wet scrubber and insure recovery of more material as dry recycle.
- F. Maintenance – are cyclone flaps sealed well and working properly? Are cyclones clean on inside without heavy scale buildup to reduce efficiency? Are cyclones inspected regularly while operating to insure they are operating properly?

### **II. What Can We Do To Reduce The Possibility Of Generating Fumes Which Contribute To Emission And Increased Losses?**

- A. Operate ammoniator properly.
  1. Inspect spargers daily.
  2. Maintain good bed depth.
  3. Avoid over granulation.
  4. Good control of granulation aids (steam, water, recycle) to reduce "cycling" to a minimum. Alternate wet and dry operation is a serious problem in many plants. Good controls are essential.
  5. Use minimum  $H_2SO_4$ . Rely on steam and pre-mixing of anhydrous, solution and water as much as possible for heat.
  6. Do not operate at production rates that will cause increased emissions.
- B. Insure good dryer operation.
  1. Design combustion chamber and burner for reduced temperatures (short flame burner, long combustion chamber, possibly pressurized combustion chamber.)
  2. Best available automatic temperature control system. An erratic or slowly responsive control system will cause problems in overheating and/or inadequate drying.
  3. Adequate air flow to obtain drying without too high temperature.

4. Avoid overloading capacity of dryer. Maintain production rates that do not increase furnace temperatures.
5. Avoid excessive material temperatures. Maximum of 180°–190° F on grades with diammonium-phosphate in them. Maximum of 180°–200° F on grades with considerable amounts of phosphoric acid and/or triple superphosphate. Maximum temperatures usually maintained on other grades are 210°–220° F.

### III. What Can Be Done To Reduce Generation Of "In-Plant" Dust?

Much has already been said on this. It is essential that plant supervision be concerned about the problem and that operating personnel be concerned.

Survey plant to see where dust is coming from. Correct obvious generation points. Design collection system for areas that cannot be controlled by other means.

1. Cooler shell discharge. (Dust hood to catch "float.")
2. Screens. (Tight covers — usually need some dust control, too.)
3. Crushers. (O.S. can sometimes be helped by dropping discharge chute into end of cooler rather than elevator boot. Cooler strips out fine dust.)
4. R/M feed elevator. (Usually requires hood and some form of dust control.)
5. R/M conveying and recycle conveying; utilize drag conveyors or similar closed systems where possible.)
6. Cover tops of all hoppers, etc.

Receiving areas for solid raw materials are a particularly bad problem. Some reduction in dust results from use of drag conveyors or screw conveyors for materials that can be handled in hopper cars. This eliminates most elevator blowback experienced with payloader unloading. In one or two plants where extremely dusty potash is received, we have used very small amounts of water sprayed on the potash inside a screw conveyor. This reduced the amount of airborne dust in the plant substantially where it dropped into storage bins.

To summarize our presentation, I would like to make a few remarks:

1. Avoid generation of emissions as much as possible.
2. Contain unavoidable particulate and fume using well-designed equipment.
3. Recover as much dry particulate as possible through use of good cyclones or bag collectors and well-maintained and operated equipment.

4. Complete control of emissions through use of wet scrubbers.
5. Reduce airflows to a minimum through most costly collection devices.
6. Achieve full recycle of scrubber water using the best method available for each set of circumstances.
  - a. Some plants can use relatively large amounts of scrubbing water. In this case, only a surge tank is usually needed.
  - b. Some plants can use large amounts of scrubbing water on only some grades and not in others. In this case, a pond may be needed. Concrete ponds with vertical pumps help in using the water back and agitating to prevent solids settling.
  - c. In plants where only high-analysis grades are made, a different type pond operation may be required. Scrubber water may be recycled from a pond large enough to allow settling of most solids. We have such a pond in Michigan. The solids which settle out are mostly recovered through use of a double-diaphragm Wilden air-operated pump that pumps one to three gpm of concentrated sludge from full sections of the pond a distance of 500 feet to the ammoniator. This small flow rate of heavy sludge can be tolerated in the ammoniator on most grades where a higher rate of flow of liquid from a scrubber could not. It does take some effort now and then to move the sludge pump suction hose to a new location since the heavy sludge will not flow to the pump.
  - d. Another possible solution on high-analysis grades would be scrubbing with about 40% phosphoric acid solution. This is done in some plants where phosphoric is the only or principal source of phosphate.
  - e. When scrubber water is successfully used in a closed system, another problem is frequently encountered. The ammonia recovered from plant airstreams raises the ph of scrubbing water. On closed systems this water may attain a ph of 8 or 9, at which point recovery of additional ammonia stops. In order to control ammonia emissions, it is sometimes necessary to add sulfuric acid to the scrubbing water to maintain the ph at a level of 6 to 7. This is best accomplished through use of an automated ph con-

troller operating a small sulfuric acid control valve. Acid is added to the scrubber surge tank as required to maintain a set pH level.

The best emission control system available will not accomplish the purpose unless our operating people are concerned and knowledgeable. We must maintain the equipment and process conditions and design the facilities to minimize emissions.

## ECOLOGY OF A MIXED FERTILIZER PLANT

*Panelist: D. L. Dibble*

International Minerals and Chemical Corporation has been very much aware and especially concerned with the ecology of mixed fertilizer plant operations since it entered the granulation of the mixed fertilizer field early in 1950. We have installed over the years, as has the majority of the industry, equipment for the handling of dry and liquid waste which was as effective as technology would permit.

Fortunately, at the majority of our locations, we had land area which would permit the ponding of waste water and we, therefore, elected to use wet scrubbing methods for particulates and silica-tetra-fluoride. This did not, however, control to any appreciable degree the dense white plume from our dryer-cooler stacks and ammoniator stacks, which were still a nuisance factor to the neighborhoods in which we operate.

We thought, at first, that we would tackle the ammoniator stack by the installation of a pre-neutralizer using phosphoric acid as the scrubbing media. However, we first decided to check with TVA as to their experiences with pre-neutralization in a typical granulation plant and were advised that we could more effectively minimize dryer-cooler and ammoniator stack problems by the use of super-phosphoric acid or other phosphoric acid. We, therefore, decided to try this method at our Augusta, Georgia plant by formulating with phosphoric acid. This location was chosen because this plant does not manufacture superphosphate, and at the time of the test, delivered normal superphosphate costs compared to ortho phosphoric acid costs were practically identical. The tests that we are reviewing this morning were made at the Augusta, Georgia plant under the same conditions of weather.

We started up on our usual formula of 5-10-15 Formula No. 1 manufactured all from nitrogen solution No. 448 and 45 lbs. of 66° Be' sulfuric acid. The acid is added to aid granulation. We then changed to formula No. 2. This formula has 25 lbs. of anhydrous ammonia, the remainder nitrogen from solution No. 448, and 59 lbs. of 66° Be' sulfuric acid. This formula made more fumes than formula No. 1.

We then changed to formula No. 3 which was 40 lbs. of anhydrous ammonia, 161 lbs. of nitrogen from 448 solution, 200 lbs of wet process ortho phosphoric acid 54%  $P_2O_5$ , and 66 lbs. of 66° Be' sulfuric acid. Even though we

used ammonia the fumes were less.

The formula was then changed to formula No. 4, which was 16 lbs. of anhydrous ammonia, 204 lbs. of No. 448 solution, 371 lbs. of ortho phosphoric acid wet process 54%  $P_2O_5$ , 996 lbs of filler (coarse sand) and 500 lbs of potash. Otherwise, all  $P_2O_5$  sources were from wet 54% ortho phosphoric acid. Until this test, I believe it was unheard of to make a 5-10-15 entirely out of ortho phosphoric acid.

Formula No. 4 did not produce any fumes from the dryer stack or the ammoniator. In my opinion, this test is an excellent example of how phosphoric acid can contribute to the minimizing of visible plume from granulation stacks.

Our Fort Worth, Texas plant operates in a very high analysis area and therefore, uses phosphoric acid extensively. We used Ortho Phosphate Acids during a normal production run of 12-12-12. This particular formula had 230 lbs. of phosphoric acid, 3 units of nitrogen from sulfate of ammonia and 9 units from No. 448 solution.

Today the decision to use ortho phosphoric acid as a control of plume depends a great deal on the availability and the unit cost of  $P_2O_5$  compared to the overall per ton cost of mechanical methods of control. I do not have any test information to back-up this theory, but from experience it is doubtful to me that ortho phosphoric acid will reduce the particulates other than ammonium chloride unless the formula used produces a granule more on size and a better quality of hardness, thus reducing the recycle ratio.

Due to changing standards of Federal, State, and County EPA Agencies, it is evident to us that we are sooner or later going to be forced to do something other than ponding with liquid and solid waste from our operations. In the manufacturing of normal superphosphate, our process to control fluorides is to scrub the gases with water, and to concentrate the hydrofluosilicic acid to a 23 - 25% strength with Venturi-type scrubbers. This acid is sold as a source of fluorine to city water supplies. However, there is always clean-up water, filter press washings, and the silica solids from the filter presses which present a liquid and solid waste problem.

Rather than pond these waters, we constructed a small reservoir for the accumulation of the liquids. We installed a small paddle wheel in this reservoir to keep the silica in the bottom suspended. The suspension of very weak acid and silica is then pumped into the sulfuric acid diluting box as a diluent along with water. The diluted sulfuric acid is then used to acidulate the phosphate rock. The silica from the filter press is dumped into a payload bucket and returned to the normal superphosphate storage pile and covered up with normal superphosphate production. As of now these salts have not caused any problems in using the superphosphate in granulation.

Not only from an ecology point of view, but from an efficiency or economic factor, it has long bothered us that

the waste from our wet scrubber was not being recovered and we were losing several pounds of plant food to the pond. In one of our plants several years ago, we had used a wet cyclone called a hydro-gritter which gave us the idea of installing the same type of operation on our present wet box scrubbers. We simply pump the scrubber water through a wet cyclone and return the effluent back to the wet scrubber. The high solids water is accumulated in a sloped slurried tank and then pumped with a Moyno pump back to the ammoniator.

We now have a complete recycle system, other than the particulates that do escape the wet scrubber, thru the stack. I might add at this point, however, that testing we have done thus far with the State of Georgia, North and South Carolina, and Texas shows that our scrubbers are comfortably within the present limits of allowable particulate emission.

During the afternoon we will be at one of the tables and can discuss the controls we have just received in more detail; however, if there are any questions from the floor at this time, I will try to answer them.

#### FORMULA 1

5-10-15

NIT. SOL. 448	230 lbs.
SUPERPHOSPHATE	1,035 lbs.
MUR. POTASH	500 lbs.
SUL. ACID 66°	45 lbs.
FILLER	242 lbs.
<b>TOTAL</b>	<b>2,052 lbs.</b>

#### FORMULA 3

5-10-15

ANHY. AMMONIA	40 lbs.
NIT. SOL. 448	161 lbs.
SUPERPHOSPHATE	475 lbs.
PHOS. ACID(W.P.)	200 lbs.
MUR. POTASH	500 lbs.
SUL. ACID 66°	66 lbs.
FILLER	630 lbs.
<b>TOTAL</b>	<b>2,072 lbs.</b>

#### FORMULA 2

5-10-15

ANHY. AMMONIA	25 lbs.
NIT. SOL. 448	191 lbs.
SUPERPHOSPHATE	1,035 lbs.
MUR. POTASH	500 lbs.
SUL. ACID 66°	50 lbs.
FILLER	251 lbs.
<b>TOTAL</b>	<b>2,052 lbs.</b>

#### FORMULA 4

5-10-15

ANHY. AMMONIA	16 lbs.
NIT. SOL. 448	204 lbs.
PHOS. ACID (W.P.)	371 lbs.
MUR. POTASH	500 lbs.
FILLER	996 lbs.
<b>TOTAL</b>	<b>2,087 lbs.</b>

#### FORMULA #5

12-12-12

NIT. SOL. 448	410 lbs.
AMMO. SULFATE	290 lbs.
PHOS. ACID(W.P.)	230 lbs.
SUPERPHOSPHATE	670 lbs.
MUR. POTASH	407 lbs.
SUL. ACID 60°	107 lbs.
<b>TOTAL</b>	<b>2,114 lbs.</b>



## MAINTENANCE OF EQUIPMENT AND PROCESS

*Panelist: R. O. Tayloe*

Elmer Perrine said here in 1957 "Deterioration of equipment and the creeping tendencies of plant operation account for much loss of nitrogen." You start out full of ignorance and vigor, with your plant set up just so. Five years later you are ten years wiser and ten years older and so is your plant. You must fight always to maintain that new plant efficiency. And that is my magic cone-word solution to the problem.

Let me enlarge on that new plant efficiency. By now we have learned how to design and build plants with reasonably good material recovery capability. We know the size relationship between production rate and equipment. We know how to scrub fumes and collect dust. But the problems still are with us. A major reason for this is the thing Perrine was talking about, deterioration and that creeping tendency of operation.

Take a critical look at that ten year old plant you started up five years ago. You will see as you approach that the screen area is dusty. The screen covers may not be on, or they may be bent a little and not fit tightly. The oversize mill cleanout door leaks a little and dust blows out there. There is a place up the elevator casing where the fit is off and some dust blows out there. Here and there in the mill there are these little leaks.

Check the cyclone discharges — is the flap valve sealing and discharging properly? Any dents in the cyclone itself? In the ductwork at the cyclone?

If you have an in-plant dust pickup system, tap a few of its ducts, especially horizontal runs. Sound pretty solid?

Now go over the granulator drum and the meters feeding it. Can you see through the granulator while it is running? How is the retaining ring — any holes in it or clean-out doors left out? How does its height compare to the original design? Spargers where you thought they'd be?

The operating man will tell you that the original ring maintained too deep a bed, that he got overagglomeration, loaded up his screens and crusher, so he lowered his bed, either by cutting down on the ring or by getting openings in it.

How is the draft into the granulator hood? Is some fume escaping out the back end of the granulator? This leads into a study of the scrubber, — is the level of water at just the right height to give good contact without blocking air flow, is the pH right, is the flow-through enough to stay below saturation, what becomes of the excess scrubber liquor? Or is the liquid thick and low.

Take a good look at the liquid meters. Are the tubes cloudy? How long have they been in use? *Annual* replacement of the tubes and floats is good insurance that the meters will stay somewhere near right. Don't forget to check on the settings used most often; if your meter is generally on about 25% of capacity, replace it with a smaller unit.

Is there a set of replacement sparger pipes in a corner

near the granulator? Are they clean or have they been there for a month? Is the hole arrangement the way you set it up five years ago or has someone figured out a better way?

Do the furnace controls draw a nice even line or do you get the five-year Dow Jones results? Ditto for your phos acid meter. How often do you check the meter delivery to be certain you are in calibration? This isn't Al Beehler talking — I know those mag meters can drift off and be misleading if you don't check them, and you should at every opportunity. As you should all your liquid meters. And your batch scales or continuous weigh feeders.

The point I am belaboring here is that no matter how well designed your plant is, no matter how effective the dust and fume control equipment is when installed, plants age, dust seals stop sealing, changes are made, equipment wears, something is tried that "works better" (which being interpreted means "makes the operation easier on the operator"), that maul for shaking loose build-up makes its mark, and the drift is so gradual the line boss may not be aware of some of it.

And he will be mighty glad to see you take your check list and go home. If that's all you do with it you might as well have stayed there in the first place. Effective action requires maintenance, everlasting follow-up, more maintenance. The snapper is that neither I nor anyone else can tell you how to accomplish the maintenance and rebuilding program required on a fertilizer plant budget. You, we all, just have to keep forever trying to hang on to that new plant efficiency.

**CHAIRMAN POWERS;** Mr. Thomas Hogan, Farmers Chemical Association, Inc., Tunis, North Carolina Complex Fertilizer Plant, wishes to make a statement telling us why Mr. W. E. Samuels and Mr. E. C. Bingham will not be able to discuss tomorrow morning their assignment "Pollution Control Interpretation Of Regulations, Engineering Approach and Plant Experiences." Possibly this paper can be presented and updated at Our Round Table in the near future.

**MR. THOMAS HOGAN:** Gentlemen: On behalf of Mr. Samuels and Mr. Bingham it is regrettable they have to cancel out their commitment tomorrow morning to discuss "Pollution Control" including some operating experience at Tunis. They have been very busy during the past several weeks, on account of "Consent Decree" Superior Court of North Carolina, to begin a phase shutdown of the Tunis Plant. Reason: To reconsider some of the pollution control designs in "The Complex" and to look into operating procedures that have been used in the past, in order to satisfy the State Board of Water and Air Resources' requirements in the future.

We are fortunate to have with us Mr. Elvis Lee, an Officer of Farmers Chemical, and Mr. Jack Seahunt, Plant Superintendent. Since the program this morning is running late, and these Gentlemen cannot be here tomorrow, Mr. Lee and Mr. Seahunt have offered to meet today between 5

and 6 P.M. in their Suite in this Hotel. They will discuss some of the events which lead up to this "Consent Decree" and to fill you in on some of the details.

**CHAIRMAN POWERS:** Thank you Mr. Hogan, Mr. Lee and Mr. Seahunt for your kind cooperation. We understand your problems and I am sure a good number of the folks here will appreciate your offer and attend the meeting in your suite between 5 and 6 P.M.

Prior to starting the Informal Round Tables and turning the program over to Wayne and Al, we will call on William A. Wilson to show the film by "OSHA".

#### **FILM: TYPICAL WORK PLACE INSPECTION**

*William A. Wilson*

**EDITOR'S NOTES:** The film gave an excellent illustration showing an "OSHA" Representative making a typical plant inspection. Mr. Wilson pointed out that the people in charge of handling Safety and Environmental at your plant be sure, before the "OSHA" Inspector leaves, that a detailed copy of any health or safety recommendations are clearly understood. Mr. Wilson also announced that the film was available, with some advanced notice, at no cost. Arrangements to be made with "OSHA" in your area.

#### **INFORMAL ROUND TABLE DISCUSSIONS**

*Moderators: Wayne W. King and Albert Spillman*

Mr. King's and Mr. Spillman's remarks: We have 8 tables and the Leaders are now at their respective stations ready to go. The attendance this afternoon is good and we are sure all of you will enjoy listening, questioning and answering many important day to day operating problems at the plant level. You will note several large posters on the walls identifying each table and topics.

You are invited this evening, at 6:30, for cocktails in The Venetian Room. Courtesy of Good Friends. Mr. Tom Athey, tomorrow morning at the Business Session, will give recognition to the people hosting the party. Thank you all!

#### **TABLE NO. 1**

##### **HIGHLIGHTS OF T.V.A. DEMONSTRATIONS**

*Leaders: Travis P. Hignett, Ronald D. Young and Milton R. Siegel*

There was a short discussion of a TVA process for production of nongranular monoammonium phosphate. This process involves feeding partially neutralized acid to a pipe reactor where additional ammonia is added. The melt discharged from the pipe is fed to a pug mill along with recycle fines. The process has not been fully developed, and cost estimates of the process have not been made. For new plants, it is likely that investment costs would be higher than for other processes that do not require recycle. The process might be of particular interest to plants with existing pug mills. Physical properties of the product appear to be quite good. One potential problem is control of dust emission during production and handling. Perhaps this might be controlled by addition of a small amount of oil.

The question was asked about TVA's plans for

production of ammonium polyphosphate after production of electric-furnace acid is discontinued at Muscle Shoals. TVA has been producing ammonium polyphosphate of 50 to 55% polyphosphate level from electric-furnace superphosphoric acid and from mixed superphosphoric acid (20% of  $P_2O_5$  from wet-process acid and 80% from elemental phosphorus). Nearly all of the ammonium polyphosphate has been shipped for use in production of clear liquid fertilizer. TVA has carried out research with the objective of producing a similar product from wet-process acid or wet-process superphosphoric acid. In recent years, most of the effort has been with the direct process in which ammonium polyphosphate is produced by reaction of unpurified merchant-grade acid and ammonia. Storage life of ammonium polyphosphate liquid fertilizers made by this route is rather short due to precipitation of impurities. Ways of lessening this problem are under study. TVA plans demonstration production of ammonium polyphosphate of 30 to 35% polyphosphate level by the direct process. At polyphosphate levels above about 35%, granulation is very difficult when wet-process acid is used. Development work is continuing with the objective of producing material with at least 50% of the  $P_2O_5$  as polyphosphate.

Another discussion centered around the need for purified wet-process acid for use in production of liquid fertilizer solutions. The pipe-reactor process (which involves conversion of low-polyphosphate superphosphoric acid to high-polyphosphate ammonium polyphosphate liquid fertilizers) is expected to lessen the need for high-purity acid. Further development of the pipe-reactor process is needed, however, as well as more information on the effect of impurity level on storage quality of the product liquid fertilizer. One benefit of purified acid is the increased sequestering value of the polyphosphate liquid fertilizer produced from it. This allows increased amounts of unpurified wet-process acid in the final formulation.

#### **TABLE NO. 2**

##### **NITRO - TOP PROCESS**

*Leaders: Geoffrey Drake and Wm. F. Sheldrick*

The following summary consolidates the answers to the many questions asked during the discussion period.

In the process as Fisons operate, drops are formed by slow dripping. The product is basically designed to behave like the granular compound products made by Fisons in the United Kingdom. However, streaming can be used if required. The process operates satisfactorily with nozzles streaming but the size distribution of particles is much wider. The process need not be restricted to making drops of the size of Fisons currently marketed products: other sized products can be made by using appropriately sized nozzles.

The prill head reservoirs contain fairly small quantities of ammonium nitrate melt a few degrees above the melting point. In order to get the correct dropping rate the head of liquor is only a few inches compared with a few feet normally used in other prilling processes. The pH of

the ammonium nitrate melt is adjusted to be about 5.0 after evaporation and before prilling: only small quantities of ammonia are required. The residence time in the prill head is only a few minutes.

Nearly all the cooling takes place in the dense phase and because of this the air temperature rises only a few degrees between leaving the dense phase and entering the cyclones. A typical dense phase temperature is 50°C. The dense phase height is not critical and is largely determined by how the cooling surfaces are arranged. Various types of cooling surfaces can be used to remove the heat from the tower, for instance banks of tubes, coils, or assemblies of plates. The air velocity up the tower is about 2 ft/sec. The dust particles are below 50 micron in size and large quantities are thrown up by the air into the lean phase. Dust not absorbed on the particles is returned to the bed.

The dust recirculation rate is high compared to the amount of dust being removed on the product at any one time. However, the recirculation rate is not critical. All that is needed is for there to be plenty of dust in the lean phase to give sufficient coating.

The air used in the process is drawn directly from the atmosphere, no air conditioning or refrigeration is required. Air could in principle be recirculated through the tower but this would involve expense and would give no benefit. There are no problems of condensation in the tower or the bag filters during short shut-downs. For shut-downs of several days the bag filters would be kept warm with a small flow of warmed air. Fumes do not penetrate bags and blind them. Material used for bags is carefully chosen and will last for a few years without problems. There is no effluent problem with the prilling tower.

It was pointed out that in an air prilling tower wet melts can be dried to some extent: the same can occur in the dust prilling process. Wet melts are dried but extremely dry melts could pick up limited amounts of moisture. The process is easy to start up and shut down. Initially the bed is brought to a proper state of fluidisation which takes only a short time, then ammonium nitrate is brought up to strength and fed to the plates. To shut down, the ammonium nitrate flow to the prill heads is stopped and the fluidising air turned off.

In the montmorillonite/talc system of dusts the pick-up can be as high as 16%. With talc alone the pick-up is so low that the process is not really satisfactory. For ammonium nitrate a pick-up of about 1% in the lean phase is the minimum necessary to form the rigid shell: the range 3½-5% is the normal operating figure which allows a reasonable operating margin.

The production plants at Immingham are designed for 13 tons per hour each, the plant at Avonmouth is designed for 25 tons per hour. On present knowledge it should be possible to design units of capacities up to 50 tons per hour and possibly more. The Avonmouth fluidised bed has an area of 120 sq. ft., and is rectangular in shape. The beds on the Immingham plant are circular.

Product properties such as crushing strength, caking

and thermal cycling are very good, and there is a substantial experience of use in the field. The hygroscopicity of the products is very much less than air prilled products containing magnesium nitrate. Nitro-Top is transported in bulk between Fisons factories in the UK without difficulty: bulk blending on the American pattern is not practised in the UK.

The spreading properties of Nitro-Top are very good, this being due to a combination of size and surface texture. The surface texture of Nitro-Top is quite different from air-prilled products and this is of assistance in use in fertilizer distributors. The coating dust is integrally bound and does not detach as do some loose dust coatings on air prilled products. There was some discussion on capital and operating costs: Fisons believe that both these would be very competitive with other processes producing a product of equivalent quality. Questions were asked about the possibility of the use of other materials, such as urea, in the process. Laboratory work has been done on urea with some success. Fisons main interest has been in ammonium nitrate, because the major part of the Company fertilizer nitrogen is in this form only minimal quantities of urea are used. Running factories handling both the ammonium nitrate and urea is known to be difficult and because of certain practices in the UK the use of urea could lead to agronomic difficulties in certain weather conditions. For these reasons Fisons interest in urea is not great.

Ammonium nitrate/ammonium phosphate melts could be prilled in the process provided that a thermal acid was used. The impurities in wet process acid caused difficulties with the prilling nozzles. Using thermal acid products of about 25-10-10 analyses have been made. Of common fertilizer materials, phosphate rock, potash, and MAP are suitable dusts for the process. All have been used at the pilot plant, and phosphate rock has been tried on the full-scale. Some fertilizer dusts, particularly those which are hygroscopic, are quite unsuitable for use in the bed and ammonium nitrate is such a dust. Prilling into sulphur dust has been considered but rejected on the basis of the hazards. Polyphosphate melts have not yet been attempted. On a question of engineering detail the rotary valves used have seals which could be replaced with a minimum of interruption to the process — a few minutes only. The design of the valve is important — particularly the size and position of the bearings.

### TABLE NO. 3 WORLD P<sub>2</sub>O<sub>5</sub> SUPPLY

*Frank Nielsson*

The world P<sub>2</sub>O<sub>5</sub> supply. Apparently Frank Nielsson did a good job thoroughly discussing this paper on Wednesday Morning. Very few questions were asked. Several of the group were interested in the U.S. supply of the various types of P<sub>2</sub>O<sub>5</sub> mixtures made and if supplies were sufficient to meet the demands in the U.S. Frank had a limited supply of reprints covering most of the slides discussed on Wednesday. This information was passed on to those who wanted a copy.

#### **TABLE NO. 4 IN-PLANT DUST CONTROL**

*Leaders: Frank P. Achorn, Hubert L. Balay  
Allen Jackson, Philip Nungesser*

There was a great deal of discussion by various company representatives concerning the addition of oil as a dust depressant. They were told that the quantity of oil most frequently used is between 0.2 and 0.5 percent. Representatives of the Coastal Chemical Corporation stated that they were using 0.3 percent by weight oil and that the dust within their plant was significantly decreased. They also reported that there was much less dust in their bagging room area.

There was some discussion of dust in rock grinding. One company reported that it was installing air-conditioned cabs on the front-end loaders used in its phosphate rock storage area.

There was some discussion of the danger of using oil on materials which would be later used in bulk blends. It was agreed that the oil content was so low that it probably would not cause any danger when materials coated with oil were mixed with ammonium nitrate. It was recommended that when a dedusting agent is to be used on ammonium nitrate some consideration be given to the use of a liquid fertilizer such as 10-34-0, 11-37-0, or urea-ammonium nitrate solution. Also, some companies reported some success in using water as a dedusting agent on ammonium nitrate. This procedure is good if the ammonium nitrate is to be applied soon after it is treated with water. It is an unsatisfactory procedure if the product is to be bagged or stored in bulk for several months.

There was a very lengthy discussion of the operation of venturi-type scrubbers. The representative of one company said that his company had excellent results in the use of a venturi-type scrubber to scrub the exhaust fumes from its dryer and cooler as well as from the granulator. He reported that there was little or no plume from the plant and that there was no ammonium chloride in the exhaust fumes. He stated that his company had used bag filters and other devices but had found that the venturi scrubber was the best type of equipment for the removal of ammonium chloride fumes from ammoniation-granulation plant stacks. He stated, however, that the operating and maintenance costs are high for this scrubber. Utilities for the equipment typically cost about \$8,000 per year, and \$2,000 is required for maintenance. Therefore, if this type of scrubbing equipment is to be used, it is necessary for the plant to have a high annual production.

Allen Jackson, of Fesco, Doraville, Georgia, discussed the theory in designing efficient venturi-type scrubbers. Philip Nungesser, Pollution Control Specialist, Georgia Department of Public Health, discussed the various pollution control laws in the state of Georgia. He also gave information pertinent to companies that are complying with the Georgia law. He indicated that his organization is very interested in cooperating with the fertilizer industry in

correcting plants which are not now in compliance with the pollution control laws of that state. He said that they prefer to work on a cooperative basis. Several questions were asked about the tolerances allowed by the state of Georgia. The tolerances in other states were also discussed.

There was some discussion of the use of bag filters for the removal of in-plant dust and dust to plant stacks. One company reported very poor results in the use of bag filters. According to the report, it was very difficult to keep the bags clean and their maintenance cost was high. However, representatives of other companies reported that they had received excellent results with the bag filters, provided the air were preheated well above its dew point prior to its entry into the bag filters. Several companies reported that they planned to install bag filters on their bagging units and to install exhaust systems inside their plants to remove in-plant dust. A representative of a company that had already installed filters of this type reported that the dust was returned from the bag filters to the elevators for the solid raw material feed to the granulators and that there was considerable difficulty with dust in this area. He said that the company was not satisfied with this means of recirculating the dust from the bag filters back to the processing plant and was investigating other methods of returning it to the process.

There was some discussion concerning the installation of a slurry system by which dust would be dissolved in scrubber water and returned as a slurry to the process. TVA representatives reported that TVA had had considerable success in using this type of system in one of its large demonstration plants.

It was agreed that the use of dust depressants is very helpful in limiting the amount of in-plant dust, and some company representatives planned to make limited tests for the use of dust depressants.

Commercial dedusting agents were discussed. It was reported that at present their cost is too high. It was agreed that probably the most practical dedusting agent is a 50-50 mixture of diesel oil and used motor oil. All those present agreed that further testing with dedusting agents is necessary, and many requested that TVA conduct these tests. TVA representatives recommended that the requests be directed to The Fertilizer Institute so that necessary money can be appropriated for this testing.

#### **TABLE NO. 5 OCCUPATIONAL SAFETY AND HEALTH ACT**

*Leader: William A. Wilson*

EDITOR'S NOTE: Mr. Wilson had no notes of the questions and answers. He was under the impression this information would be taken care of. He advised us his table was fully attended throughout the afternoon and that the questions and answers principally on "OSHA" were well handled.

Shortly before the meeting adjourned your Editor came to Mr. Wilson's table. A member was explaining his

plant's safety program and stated they had an interesting bulletin in several places in the plant. In large 2 inch letters "TEN BASIC SAFETY RULES". I copied these excellent quotes for your information.

#### **TEN BASIC SAFETY RULES**

- 1- REPORT ALL INJURIES NO MATTER HOW SLIGHT.
- 2- FOLLOW INSTRUCTIONS, USE PROPER TOOLS AND EQUIPMENT.
- 3- WEAR SAFE CLOTHING, GOOD SHOES, EYE, FACE AND HAND PROTECTION WHERE NEEDED.
- 4- NAILS - PULL THEM OUT OR BEND THEM DOWN.
- 5- LIFT PROPERLY - BEND KNEES AND USE LEGS. GET HELP FOR HEAVY LOADS.
- 6- REPORT FAULTY SCAFFOLDS, LADDERS, TOOLS, AND UNSAFE CONDITIONS AT ONCE.
- 7- DO NOT RIDE MATERIAL HOIST AT ANY TIME.
- 8- NO HORSEPLAY ALLOWED. SOMEONE MAY BE HURT.
- 9- A CLEAN JOB IS A SAFE JOB. KEEP IT SAFE.
- 10- THINK! IS IT SAFE? DO NOT TAKE CHANCES. IT HURTS TO GET HURT.

#### **TABLE NO. 6 ENVIRONMENTAL PROBLEMS - GRANULATION PLANTS**

*Leaders: R. H. Perkins, D. L. Dibble  
and R. D. Tayloe*

Topics covered in discussion period:

1. Recovery systems for hydroflusilicic acid from superphosphate plants.
2. Use of adequately designed cyclones, hoods, etc. for dryers and coolers.
3. Sparger design, location and maintenance for low emission operation.
4. Control systems for good dryer flame temperatures.
5. Importance of steady-state operation of plant to avoid increased emissions during starting and intermittant operation.
6. Effects of various raw materials on plant emissions.
7. Importance of good attitude of hourly and supervisory personnel.

#### **TABLE NO. 7 COST OF DOING BUSINESS**

*Leader: Jon L. Nevins*

The discussion was opened with a review of the various cost of doing business studies conducted by TVA in conjunction with various fertilizer industry associations. These included:

1. The Cost of Doing Business In Agricultural Ammonia for Direct Application (Agricultural Ammonia Institute)

2. Cost of Doing Business in Fluid Fertilizers (National Fertilizer Solutions Association)
3. A Report on Cost of Doing Business in Dry Fertilizers (The Fertilizer Institute)

In addition to a discussion of the findings of these studies, considerable time was spent discussing the methodology of such cost studies. It was generally agreed that the factual detail of these studies represented an important contribution to the fertilizer industry, but that the allocation of joint costs was a general problem. It was explained that these studies used a fully allocated cost basis. It was agreed that individual retailers should acquaint themselves with the methodology of these studies before making direct comparisons with their own cost statements. Several discussants expressed a desire to see more firm-by-firm detail. It was explained that this would be possible to some degree, but that disclosure is a real problem. Several discussants expressed an interest in an updated version of the cost of doing business in anhydrous ammonia as most equipment has aged since the first study, and that the rulings and regulations of OSHA may have an impact on maintenance costs and equipment-scraping decisions.

#### **TABLE NO. 8 COMPARISON LANDSKRONA TRAVELLING BELT FILTER WITH TILTING PAN AND TABLE FILTERS FOR WET PROCESS PHOSPHORIC ACID PRODUCTION**

*Leader: Robert L. Sommerville*

The modern Lanskrone Traveling Belt Filter is an outgrowth of perhaps the oldest type filter to be used for phosphoric acid production. New materials of construction combined with ingenious and expert engineering by Mr. Rolf Nordengren of landskrone, Sweden, have resulted in a superior machine for separating gypsum or hemihydrate from wet process phosphoric acid. These advantages are enumerated here. First the *Process Comparison*, then a *Mechanical* and *Maintenance Comparison*, and finally, a *Construction and Capital Cost Comparison*.

The Landskrone is the only truly continuous filter. All others have pans or panel with the result that in effect, the process involves many small batch filtrations. Since in spite of all operating and maintenance effort, some pans are less effective than others. The entire operation must compromise between the best and the worst units of the filter.

All other filters have cloths fixed in place on the panel or pan and must be washed from the filter cake side. As the cloth flexes with the cloth blow, the cloth moves constantly against the same point on the pan resulting in rapid wear and puncturing if a sharp or abrasive bit of scale lodges between the grid and the pan. By contrast, the Landskrone filter cloth is completely independent of the traveling belt and its grooved supporting surface. The filter cloth is about 10% longer than the belt and at the end of a



filtration cycle, it separates from the belt and is washed from the opposite side from the filtering surface. There is ample time and room for a thorough washing followed by complete drainage and if necessary, cloth drying. Concurrently, the ribbed surface of the belt is washed to remove any traces of gypsum or scale which may be forming. Thus as the filter cloth returns for the next cycle, it is precisely laid on the clean filter belt at a new location. Consequently full advantage can be taken of the properties of high strength monofilament polyester filter cloth with chemically cemented intersecting fibers which makes it dimensionally stable so that it will not fray or ravel.

As a consequence of these factors, the following process advantages accrue:

## I PROCESS COMPARISON

1. Mother liquor dilution is eliminated since there is ample time to remove all wash water from the belt surface and the cloth. Typical operation of other filters results in a product acid dilution of 5% resulting in a decrease in the product acid analysis from 32%  $P_2O_5$  to 30%  $P_2O_5$ . This means that for every ton  $P_2O_5$  produced, 0.15 tons of additional water must be evaporated. If steam is worth \$1.50 per ton and the steam evaporation ratio is 1.5, it is evident that this factor will result in a saving of \$0.35 per ton  $P_2O_5$  produced. For a 45 square meter filter processing 100,000 tons per year  $P_2O_5$ , this saving is estimated at \$35,000.

2. The filtration efficiency remains uniformly high since fresh slurry always sees fresh clean filter media. Since the flow is continuous and steady, wash liquors can be uniformly and gently distributed across the traveling cake. Wash dams of soft rubber effectively seal one wash area from another and it is quite practical to operate with totally flooded wash areas. In fact, liquid level control above the cake for this is practical. The overall result is that substantially higher washing efficiency is reported where the same slurry is filtered on Landskrona filters in parallel with other types and the analyses were made in the gypsum repulp tank.

There is another contributing factor in this reduction of  $P_2O_5$  loss. Much of the washing inefficiency takes place at the edge of the filter pan, panel or belt. If we assume that 20 mm (3/16") is affected by the edge, then the edge effect for a large landskrona filter is 2.16%. The equivalent area for a 24C Bird Prayon is 4.12% and larger for smaller filters. The reported improvement in washing efficiency amounts to a reduction in water soluble  $P_2O_5$  loss of from 0.4 to 0.7% of production.

If we assign a value to this  $P_2O_5$  of \$100 per ton of  $P_2O_5$  in product acid, then the savings from a 45 square meter filter processing 100,000 tons per year amount to \$40,000 assuming a reduction of water soluble losses of 0.4%.

3. The onstream factor is higher since rarely if ever must

the filter itself be shut down for washing. The suction box under the belt is hinged so that scale accumulating in the box can be mechanically removed with a 45 minute shut down at less frequent intervals than is required to clean scale from the central valve of either tilting pan or panel filters. Since large plants will have two or more Landskrona filters where a single large tilting pan is usually installed, the digestion system need not be shut down during filter and pipeline cleaning.

4. There is greater freedom to adjust operating conditions to suit process requirements. The long suction box makes it possible and easy to relocate filtrate separation dams so that we can change the filter washing system as may be required. If product clarity is important, a cloudy filtrate section can readily be included.

Conversion from 3 to 4 or 5 filtrates is simple. Since it is a continuous unit, there is no mechanical limitation to the speed of belt travel. 1½ minute cycles are common with Landskrona filters and faster speeds are practical. large tilting pan filters are usually limited mechanically to a speed of about 2½ minutes per cycle. There is also a process limitation on the speed of large tilting pan filters since there is a long flow path from the pan to the valve and high speeds make filtrate separations difficult and complete drainage of acid from the pan before overturning may not be possible. By contrast, the maximum distance filtrate must travel with a Landskrona is from the edge of the belt to the vacuum box, a distance of only 3 feet, less than one meter.

5. A Landskrona filter makes possible plant modifications to take advantage of advanced technology. It is possible and practical to operate a hemihydrate plant using Landskrona filters. Modern vacuum cooler technology makes possible cooling the filter feed slurry to 80 to 85°C (176 to 185°F.) which is well within the permissible limits for satisfactory belt life. The Landskrona filter will perform satisfactorily in this service which a tilting pan or table panel type filter probably will not. This again is due to the superior washing and descaling of the filter cloth and belt.

There probably is no such thing as "stable hemihydrate." Probably all hemihydrate will recrystallize slowly. This means that any residual filter cake which accumulates in the corners and in the grids of a typical pan filter will hydrate to gypsum and fairly rapidly reduce the filter effectiveness. Once formed, this scale is difficult and expensive to remove.

Hemihydrate cakes while free filtering are notoriously thixotropic. These bulky cakes hold an excessive amount of liquid making washing difficult. Landskrona filters can be equipped with mechanical or electromagnetic vibrators to densify and dewater these cakes if necessary.

6. Vacuum costs are less. Since it is neither necessary nor desirable to have the filter cake go dry between wash areas, no air need be pulled through the cake except at the end of the cycle where the cake is dried. Under these conditions, the pressure drop across the cloth and filter cake is

approximately equal to the pressure drop across the cloth and cake of a tilting pan filter connected to a vacuum pump operating at 24" vacuum (assuming a standard 30" barometer.) For phosphoric acid service, our usual rule of thumb for estimating vacuum pump requirements is 1½ cubic meters per minute pump displacement capacity per square meter active filtration area. In English units, this is 4.92 ACFM per square foot active area.

## II

### MECHANICAL AND MAINTENANCE COMPARISON

The Landskrona is an inherently simple machine consisting of a special rubber conveyor belt reinforced with about eight plies of heavy polyester (Terylene) fiber requiring about 11 mm (7/16") thickness, protected on either side by 5 to 7 mm (0.20 to 0.275") of rubber and having raised transverse ridges about 20 mm high resembling large gear teeth. These ridges support the filter cloth and provide a filtrate drainage channel from the edges of the belt to the center where each groove has a hole punched through the belt to permit passage of filtrate and air to the suction box. The edges of the belt have a vertical strip of soft rubber vulcanized to the belt to form a slurry channel about 150 mm (6") deep. The stiffness of the belt and the integral edge strips dictate the use of large driving and idler pulleys (1400 mm or 4' 7" diameter) to carry the belt. The belt is supported between the driven and driving pulleys by the suction box and by wetted polished stainless steel slide beams. On the return path it is supported by large rubber covered pulleys.

The filter cloth also is in the form of a spliced belt somewhat longer than the filter belt. The cloth is precisely fed onto the filter belt by two tracking tensioning mechanisms which sense and control each edge of the filter cloth.

After the cake has discharged from the filter at the driving sheave, the filter cloth separates from the filter belt and each is washed with high pressure spray systems. Each then drips dry during the return passage to the feed end of the filter over a separate set of support rollers. All wetted parts are rubber stainless steel or rubber covered steel.

The vacuum box is of Avesta 832L stainless steel, a steel similar to but having higher molybdenum content than 317. (If it should be manufactured in the U.S.A., it will be type 317L.) The flanges of this vacuum box are faced with smooth, heavy, replaceable teflon strips to seal against the moving belt. In turn, the belt has replaceable wear strips cemented to the belt. These wear strips consist of two plies, one red and one black. When the wear strip shows red on the return passage, the operator knows that field replacement of the strip will be required within six to ten weeks.

All structural frame members are coated with 300 microns (0.012") high build epoxy resin primer and paint.

A fully variable speed hydraulic drive system is included providing a 10 to 1 speed range as specified. This

usually will make possible filtration cycles from 1 to 10 minutes.

The filter wash boxes and wash separation dams are mounted on rails with a gear rack on either side of the filter which runs the length of the filter. Pinion gears mounted on the wash boxes make it easy to re-position wash boxes and filtrate dams. Stainless steel drip troughs run the full length of the filter on either side to catch any inadvertent spill or splash.

As a consequence of these mechanical design features, all parts of the filter are readily accessible for inspection and maintenance. Filter belt and cloth wash nozzles are visible and easily reached. Should a structural member be subject to rapid attack, it is easy to apply extra protection as required. There are no bearings, rollers or moving parts directly or continuously subjected to water or acid spray except of course the rubber covered belt return idler rollers.

In the newer designs, there are no exposed gears, axles, etc. The pulley is driven from both sides through fully enclosed triple reduction gear boxes directly coupled to the drum. The two reducers are driven by Sundstrand hydraulic motors connected in parallel to a single hydraulic power unit. This arrangement provides precisely equal division of torque to both sides of the driving sheave so that no twisting stress is thrown into the filter frame. These hydraulic motors are designed for 25,000 to 40,000 hours B 10 life. This arrangement permits precise speed control for the filter over the entire operating range of 45 second to 7.5 minute filtration cycles. There are no vee belt drives, particularly no variable speed vee belt drives.

The quantity of stainless steel involved in the filter construction is relatively small, therefore there is little incentive to economize on quality. Consequently, the vacuum box and all stainless steel in contact with phosphoric acid is the best material to be found – Avesta 832S if Swedish, type 317L if U.S. fabricated.

As previously stated, the filter design makes it possible to take full advantage of the superior properties of thermofixed monofilament polyester filter fabric. As a result, the filter cloth lasts 4 to 6 times as long as the cloth on a tilting pan filter and punctures, holes, etc. are rarely seen. Furthermore, cloth replacement is easily and rapidly accomplished by a team of two men in about two hours. This contrasts with 6 to 8 hours with a six man crew required to change cloths on a 24C Prayon.

The plant at Landskrona, Sweden, had a traveling pan filter in parallel with a Landskrona filter for some time. Landskrona maintenance was about 30% of the traveling pan maintenance. Other plants have reported similar experience.

Existing operating experience indicates that belt life of 5 to 7 years is probable. The belt is ordinarily fabricated from natural rubber and the usual rubber techniques can be used to repair accidental damage to the belt. The one area subject to considerable wear is the contact point between the belt and the vacuum box and this is protected by a

replaceable wear strip. Replacement of these strips is probably required annually and may require a 48 to 72 hour shut down. At the same time that the wear strips are replaced the teflon surface on the vacuum box should be replaced.

### III CONSTRUCTION AND CAPITAL COST COMPARISON

A Landskrona filter having 45 square meters active area (484 sq. ft.) is the most economical unit available per square meter filter area. Consequently for large installations, we propose multiple installations. Two 45 square meter Landskrona units are equivalent to one Bird Prayon 24C (950 sq. ft. = 88.3 M<sup>2</sup>.) Three square meter Landskronas are equivalent to one Bird Prayon 30C (1500 sq. ft. = 139.4 M<sup>2</sup>) and 45 square meter units are equivalent to one Bird Prayon 30D (1700 sq. ft. = 158 M<sup>2</sup>.) In addition to the obvious process advantages are some capital cost savings and construction advantages:

1. The delivered bare equipment cost of two or three 45M<sup>2</sup> filters is believed to be slightly lower than the equivalent cost of a 24C or 30C Bird Prayon.

2. The structural design of the filter building is much simpler. A 45M<sup>2</sup> Landskrona filter fits very nicely into a building measuring 20 feet wide by 120 feet long. Thus a building having 20 foot square bays is quite appropriate and thus we require 2400 square feet of floor area per filter.

3. There is no need to construct all of the foreseeable desired filter area at one time. If market requirements can be satisfied by two filters now, leave space to construct the

third building bay and filter in the future.

By contrast with simple structure for a Landskrona filter, a Bird 24C requires building approximately 70 feet on a side having 4900 square feet area as contrasted with 4800 square feet required for two 45 square meter Landskrona filters. But we require on the top floor of the Bird Prayon building a 70 foot clear span structure with beams heavy enough for a maintenance monorail. Also the framing below the filter floor is complicated by the circular structure of the filter.

If barometric leg discharges from the filtrate receivers to filtrate sumps are used, then the filtering surface can be 5 to 8 feet lower for a Landskrona installation than for a Prayon. This results from the arrangement of filtrate receivers clustered below the central valve of a Prayon where the barometric leg starts about 10 to 11 feet below the filtering surface. By contrast the landskrona separators are off to one side of the filter and the barometric leg can start about 3 feet from the filtering surface.

If we compare three 45 square meter filters with one Bird Prayon 30 C filter, then the building is either 120' x 60' or 85' square and the areas respectively are 7200 and 7225 square feet, but the Bird Prayon building must have an 85 foot clear span.

Gypsum disposal is much simpler with a Landskrona installation since it discharges continuously and uniformly into a narrow trough which can run past all of the filters and on out to the disposal system. There is no impact shock as a whole pan full of gypsum weighing perhaps 1500 lbs. crashing into a hopper. This advantage is particularly great if a dry cake discharge is to be used since it is simple to run a conveyor belt past the filter discharges.



# Friday, November 3, 1972

## Morning Session Moderator: Billy E. Adams

MODERATOR ADAMS: I will sketch over the program quickly to tell you what we expect to discuss this morning.

Business Meeting, Secretary-Treasurer Report, Various Committee Reports and 3 Technical Papers, Viz:

"Wyflo 46" in place of the "Pollution Control Discussion" which was cancelled, "Status of Liquid Fertilizers" and "Improving The Analyses of Bulk Blends." Business Meeting.  
Secretary-Treasurer's Report  
Paul J. Prosser, Jr.

## SECRETARY-TREASURER'S REPORT

*Paul J. Prosser, Jr.*

### FINANCIAL STATEMENT

November 1, 1971 to October 31, 1972

CASH BALANCE - November 1, 1971 \$139.02

#### Income 1971 - 1972

Registrations - 1971 Meeting	\$6,000.00	
Sale of 1971 Membership Lists	56.00	
Sale of Proceedings, 1971 and Prior	919.00	
Repayment of Loan to Entertainment Committee	100.00	
Total Income		<u>\$7,075.00</u>

Total Funds Available  
November 1, 1971 to October 31, 1972 \$7,264.02

#### Disbursements 1971 - 1972

1971 Meeting Expenses	\$1,434.87	
Expenses - Directors Meetings	590.78	
Membership Letters	609.76	
Preparation of Round Table Master Mailing List	218.00	
Preparation of 1971 Attendance Lists	127.00	
1971 Meeting Proceedings including Printing, Mailing Costs, Postage, etc.	3,077.31	
Proceedings refund	10.00	
Miscellaneous Expenses including Postage, Mailing of Back Issues of Proceedings, etc.	187.72	
1972 Meeting Expenses - preliminary	317.55	
Total Disbursements		<u>\$6,572.99</u>

CASH BALANCE October 31, 1972 \$691.03

At this meeting we have registered slightly over 200. The income from this meeting is about \$5500.00, and since we spent \$6600.00 last year, we are going to run a little tight this year. I am sure, however, there will not be any major financial problems. We had an income last year of \$1000.00 from "Proceedings". Please keep in mind that we have a supply of past years' "Proceedings". We would like to sell them to help our expenses.

I would appreciate each of our Speakers to have a copy of his paper to me as early as you can. We already have about half of the papers. We will try to get this year's "Proceedings" to you as early as possible. I am also requesting the Gentlemen in charge of "Taping" that we wish to take the tapes back with us today. Thank You.

Wayne W. King, Chairman  
Nominating Committee

There will be no election of Officers this year.

We are recommending the following Members for our Board of Directors'

Harold E. Hoon, President,  
Envirotech,  
Cleveland, Ohio

A. Meredith Morris, Plant Manager,  
Southern States Cooperative  
Russellville, Ky.

John S. Neild, Jr., Plant Supt.  
Kerr-McGee,  
Cambridge, Md.

I shall now ask Walter J. Sackett, Jr. and Al Spillman to come to the rostrum. Walter you take over please.

Walter J. Sackett, Jr., Chairman  
Public Relations

This morning our Organization has given me the high privilege of making a presentation to one of its founders and a close personal friend. I am not a speech maker, however, I could go on for a long time going over this man's accomplishments and my own personal warm reflections. Suffice to say that he is the most tireless, selfless man that I every met and no award could adequately express the feelings of a grateful Organization, or even to begin to repay the debt that we all owe to Al Spillman, one of the Round Table Founders and it's past Chairman. Gentlemen, I give you Al Spillman.

ALBERT SPILLMAN: Walter, this is really a surprise. I do not know what to say. First, my thanks to you, Walter, for your kind and warm expressions and compliments. My thanks to our Board of Directors, Officers and Members for

the beautiful "Plaque" just presented to me. It reads.

FERTILIZER INDUSTRY  
ROUND TABLE  
ALBERT SPILLMAN  
CHAIRMAN  
1969-71

It has been a real pleasure to have worked with the Round Table for the past 21 years and I am looking forward to do what I can for this very fine organization in the future. I have enjoyed every minute of my activities with our Round Table and I have been especially fortunate to have had the opportunity to have met many of the "Fine Gentlemen", "Panelists" and "Members" who have attended our yearly meetings. I assure you it has been a real thrill for me and I thank you all for your kind cooperation. I thank you again for your kindness.

Cocktail Party.

Tom Athey, Chairman,  
Entertainment Committee.

On behalf of our members, our Board of Directors and our Officers, I wish to thank our "Hosts" for that beautiful "Cocktail Party" last night. Needless to tell you that we enjoyed all of it.

ATLANTA UTILITY WORKS  
CAREY MACHINERY & SUPPLY CO., INC.  
EDWIN COX ASSOCIATES  
FERTILIZER ENGINEERING & EQUIPMENT CO., INC.  
FERTILIZER EQUIPMENT SALES CORPORATION  
HOWE RICHARDSON SCALE COMPANY  
JEFFREY MANUFACTURING COMPANY  
NORTH AMERICAN MANUFACTURING COMPANY  
KIERNAN-GREGORY CORP.  
THE PROSSER COMPANY, INC.  
EDW. RENNEBURG & SONS CO.  
THE A.J. SACKETT & SONS CO.  
ST. REGIS PAPER COMPANY  
STEDMAN FOUNDRY & MACHINE  
WEBSTER INDUSTRIES INC.  
WELLMAN-POWER GAS, INC.  
WESTINGHOUSE ELECTRIC CORPORATION

Joseph E. Reynolds, Chairman  
Meeting Location and Dates

Your Committee has selected the Shoreham Hotel, Washington, D.C., for our 23rd Annual Meeting. We will not need to vote approval because last year, at Memphis, our Members agreed to have "This 22nd. Annual Meeting in Memphis and to meet in Washington for our 23rd Annual Meeting.

The dates are Tuesday, November 6, Wednesday, November 7 and Thursday, November 8, 1973. This is the first time the meeting is being held on Tuesday, Wednesday and Thursday. Many of our Members asked for trying this change to give them an opportunity to leave for home Thursday Afternoon instead of Friday Afternoon.

MODERATOR ADAMS: We shall now continue with the remainder of Our Program and move on to "Improvements in Product Analysis of Blends. Julius Silverberg and George Hoffmeister, Chemical Engineers at T.V.A., have prepared this paper and George Hoffmeister

will give the talk.

George is a native of New Jersey, Graduate Chemical Engineer from Rice University, Houston, Texas. Presently he is Project Engineer in Applied Research. A large part of his time has been working with Julius Silverberg who has been with T.V.A. 30 years. All of us know Julius' excellent work and fine cooperation. I might mention if George hits a few notes while he is giving the paper, that is a little of his background, as he is probably as much a musician as he is a fertilizer technician, along with his wife.

## IMPROVING THE ANALYSES OF BULK BLENDS

*Julius Silverberg and George Hoffmeister*

Bulk blending has, in recent years, shown phenomenal growth as a method of marketing and distributing fertilizer. This growth is evident in Figure 1, which shows the year-by-year increase in number of blending plants in number of blending plants in the two major Midwest areas and the total for the country; the total is now slightly over 5000 plants. It shows also that this represents an average construction rate of just about one new plant every day since 1955. So, if you are a basic fertilizer producer, it may be consoling when you go to bed tonight to realize that by tomorrow night there will be one more bulk-blending plant in the country to help you distribute your product. The volume of bulk blends now is estimated to represent almost 70% of all dry-mixed fertilizer or about 55% of all mixed fertilizers, if liquids and suspensions are included.

In this popular and growing segment of the industry, however, there has been, and continues to be, a considerable problem in obtaining homogeneous blends. Failure to achieve such uniformity most frequently manifests itself in offgrade analyses by the state inspectors, with resultant penalties. In other instances, nonuniform field application and crop streaking have been observed, which may be due at least in part to nonuniform analysis. Published reports of state inspectors have, during the last several years, indicated an increase in the number of deficient blend analyses to the extent that there has been increasing concern. The "proceedings" of last year's Round Table indicate that there was considerable discussion of the subject. More recently, The Fertilizer Institute has appointed a task force that is looking into the problem.

The several possible causes of offgrade analyses that immediately come to mind are as follows:

1. Inaccurate weighing of ingredients
2. Poor mixing
3. Segregation during handling

In the majority of cases, however, we can rule out causes 1 and 2. Weighing equipment is usually quite accurate; also reasonable overages are commonly used. Likewise, poor mixing appears to be only a minor cause. Some mixers do present problems of "demixing" during discharge; however, the more widely used types are generally quite efficient. So, we can quickly conclude that the real problem of "improving the analyses of bulk blends" is the problem of

eliminating or at least reducing, segregation during handling. In too many plants the efforts of good mixing are being wasted because segregation or "unmixing" is allowed to occur.

The causes for segregation of blends have been demonstrated many times by TVA and others and by now are well known by you people in the business. There are only two major causes, as follows:

1. Mismatch of particle size of ingredients
2. Mishandling of blend (mainly "coning")

The interesting thing about these causes is that both have to be in action for segregation to occur. Therefore, segregation can be reduced by attacking either or both. For example, if a blend were made with all ingredients perfectly matched in size, no amount of handling of any kind would cause serious segregation. On the other hand, if the size match is not perfect, or even rather poor, much can be done to reduce segregation by simply reducing the amount of handling of the blend or by using "gentle" handling methods. Other factors, such as particle shape and particle density, are sometimes suggested as causes of segregation, but it has been shown rather conclusively that these are only very minor causes. We at TVA are convinced that whatever present day troubles there are with blend analyses are due about equally to these two causes shown above for segregation. There is evidence, which I will show, that too little attention is being paid to the selection of size-matched ingredients for blending. Likewise, it is apparent that only very little effort has been exerted in modifying handling equipment and procedures to eliminate coning and other sources of segregation. Today, I will discuss first the problem of size matching, and then will indicate some better handling practices that we feel could be adopted to reduce segregation problems.

Size matching is a responsibility of the blender. He is usually a free agent to purchase whatever materials he wishes for his blends; therefore, he must, in doing so, assume the responsibility of selecting and purchasing ingredients of reasonably close size match. It is the responsibility of the basic producers of these materials to produce materials of suitable size, to advertise their size specifications, and to adhere to these advertised standards. Both the basic producer and the blender have the additional responsibility of handling these materials with due precautions so that handling will not spoil their size distribution before blending.

Probably the greatest disregard for size matching among blenders has been the frequent use of "coarse" grade potash instead of the more favorably sized "granular" grade. This was cited at last year's Round Table as a major cause of trouble. This use of the coarse grade has been encouraged both by a small price differential in its favor and by shortages of granular grade. The coarse grade generally contains far much too much fines to match other blending materials. Typically, it contains about 50% minus 12 mesh and close to 20% minus 16 mesh. This grade, as

you probably know, was not designed or intended, initially, for use in blending but rather for granulation. Its small size, in comparison to other blend ingredients, is apparent from the size data given in Figure 2.

The data in the figure are average sizes of blending materials, reported recently by Dr. W. L. Baker, Chief Control Official of the State of Missouri, as being representative of the materials used in that state during the 1971-72 season. Each curve represents the average of a large number of samples taken from the storage bins of blending plants; the number of samples is indicated in the legend of the figure. The more complete data, as released by Dr. Baker, showed that individual samples varied rather widely from these averages, so that both better and poorer size matches than those shown undoubtedly were encountered in individual cases. From the averages shown, however, it is obvious that the coarse potash was much finer than the other materials. It averaged less than 5% plus 8 mesh, only about 45% minus 8 plus 12, and almost 50% minus 12 mesh. Also, since the number of samples of the coarse grade analyzed was 83, it is obvious that there was considerable use of this material by blenders. Both of the major phosphates, triple superphosphate and diammonium phosphate, were of about the same average particle size (20-25% +8 mesh, about 65% -8 +12 mesh, and 10% -12 mesh). These materials also were a fairly close match with the major nitrogen material, prilled ammonium nitrate, which averaged about 15% plus 8 mesh, 75% minus 8 plus 12 mesh, and about 10% minus 12 mesh. Granular potash, on the average, contained more plus 8-mesh fraction and less 8- to 12-mesh fraction than the phosphate and nitrogen materials, but, as I will show later, was a much better choice than the coarse grade. Blenders who used the granular grade are said to have had fewer analysis troubles. Urea generally was too small to be a good match with the average phosphate or granular potash. It averaged less than 5% plus 8 mesh and contained over 20% minus 12 mesh.

Some of the size differences shown by these data make rather poor blends, and we have recently confirmed this with some laboratory tests at TVA. The procedure used was one that we devised for our early work reported in 1964.

In making a test, we first carefully size and weigh the raw materials for a 1-kilogram batch of blend and blend the ingredients well in a small mixer. The blend then is subjected to rather severe segregating conditions by pouring it into the form of a conical pile section in a specially designed, clear plastic sampling box about 11 inches high by 16 inches wide and 1 inch deep.

Figure 3 is a view of the box after pouring a demonstration blend. This blend was a 50:50 mixture of minus 6- plus 8- mesh granules with smaller, darker-colored granules of minus 10 plus 14 mesh. The lines and letters indicate 10 segments into which we then divided the pile for analysis. The way in which the actual dividing was done can be seen from Figure 4, which is a detail drawing of the

sample box. This shows that the box is equipped with eight aluminum blades that can be inserted through slots in the back wall to cut the pile into the nine segments for analysis. After the vanes are inserted, the apparatus is opened, and the samples are removed for analysis.

One of the recent series of tests that we have made is of 0-26-26 grade blends made with a typically sized triple superphosphate and several sizes of potash. Results of these tests are shown in Figure 5.

The first blend was made with a typical coarse potash. The resultant chemical analyses of the pile segments showed very wide variation. The segments near the top of the pile, which contained the finer particles, were high in potash because of the relative fineness of that material. Grade in this area of the pile was 0-22-32, as compared with the desired 0-26-26. Grade in the lowest segment, where the larger particles predominated, was 0-33-17. Of course with multipoint sampling, such as most inspectors use, the variation would be less. Nevertheless, this degree of segregation indicates what I call a "wild" blend; that is to say, one that cannot be handled much at all without causing serious segregation.

In the second test, the same superphosphate was blended with a typical granular potash. The result was considerable decrease in segregation. maximum analysis variation was only 3 percentage points (0-23-29; segment A). With multipoint sampling, the analysis deviation would be less than 3 percentage points and the blend would probably pass most state tolerances even when handled as severely as in this laboratory test.

The third blend covered by Figure 5 illustrates about the ultimate in size matching. A potash was selected from manufacturer's specification sheets to match the superphosphate almost exactly. As a result, the analysis deviation was reduced further to a maximum of 2 percentage points. The small deviations shown probably were a result of the irregular particle shape of potash, which does give it a slight tendency to behave like a larger sized material.

A second series of tests that we made concerned the size-matching problem that is being encountered with the increasing use of urea in blends and the small size of the urea presently available. To measure the effect of this fineness on segregation in blends, we made a series of tests of 19-19-19 grade blends containing urea, diammonium phosphate, and potash. Results of this test series are given in Figure 6. To simplify this study, we selected a finer-than-average diammonium phosphate that closely matched the size of the urea. The only variable therefore was the size of the potash, which was a typical coarse material in the first test, a typical granular in the second, and a specially tailored "matching" size in the last test. The results show that the urea was not a very satisfactory match with either the coarse or granular potash. Analysis deviations up to about 6 percentage points occurred with both materials. Only use of the specially sized matching potash prevented serious segregation. Hopefully, attempts

by urea producers to increase the size of the product by improved prilling or by other granulation methods will bring the size to a better match with granular potash and most diammonium phosphates. Some prills and granulated urea of improved size distribution are already on the market.

In view of these important effects of particle size on segregation, blenders must continually strive to obtain matching materials, and must not be tempted by "bargain" prices of offsize materials. Basic producers on the other hand must strive to provide adequate supplies of materials of suitable size. In addition, careful handling of the raw materials into and out of storage is important. Suppose, for example, that a blender has purchased two raw materials of perfect size match but, in loading his storage bins, has allowed these materials to cascade down the pile surfaces, as in an all too common practice. This causes severe size segregation. Later, if materials are used from the piles at different rates, the size analyses of materials coming from the piles are widely different and an unmatched blend results. Remedies that have been suggested for this particular problem are multipoint filling of the bins or use of a telescoping fill pipe. A few blenders are using these or similar practices, and the effort has been found to be worthwhile.

Blenders also can fight the segregation problem by taking a little special care in handling the final blends. This is especially important now, when size-matched materials seem to be in short supply. Every handling between the mixer and the field is a potential source of segregation. Frequently, blend moves from the mixer into a holding bin before being dropped into the spreader truck or put into bags. If the blend is allowed to come during filling of this

bin, serious segregation can result, as shown in Figure 7. The finer size material congregates down the center of the hopper. Then, on discharge, this material leaves the bin first and the larger material comes out last. If the material is bagged as it discharges, successive bags are found to vary considerably in analysis. Some baffle system or feed distributor always should be used to prevent coning in such a bin; some methods that have been successful are shown in Figure 8. Method A involves simply placing a deflector under the incoming spout. This deflector, which can be a cone, or series of cones, simply scatters the incoming material so that it does not all fall in one spot, thus no cone is formed. Method B involves use of bin partitions that interfere with cone formation.

Finally, the filling of the spreader hopper itself is a likely source of serious segregation of the final blend if coning is allowed. However, a simple and effective cure for segregation at this point is readily available, if the blender is willing to make the effort. This consists in the use of a flexible sock or hose on the fill pipe. A little effort in spreading this hose throughout the bed to prevent coning is most effective in avoiding segregation.

In summary, I would conclude that the prospects for improving the analysis record of bulk blends are very good and that this can and will be done by:

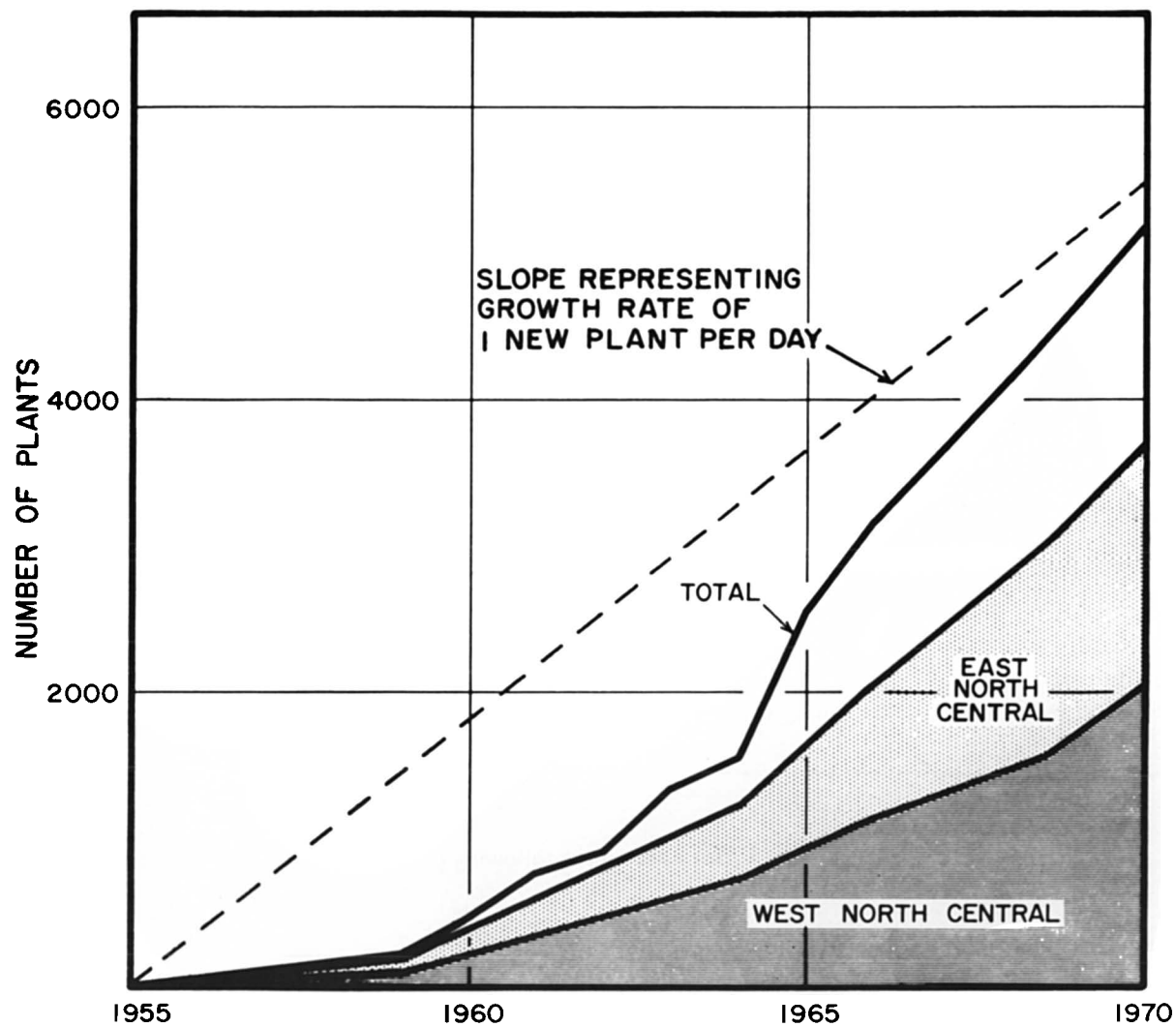
*First:*

Paying greater attention to the particle-size matching of the basic materials, and

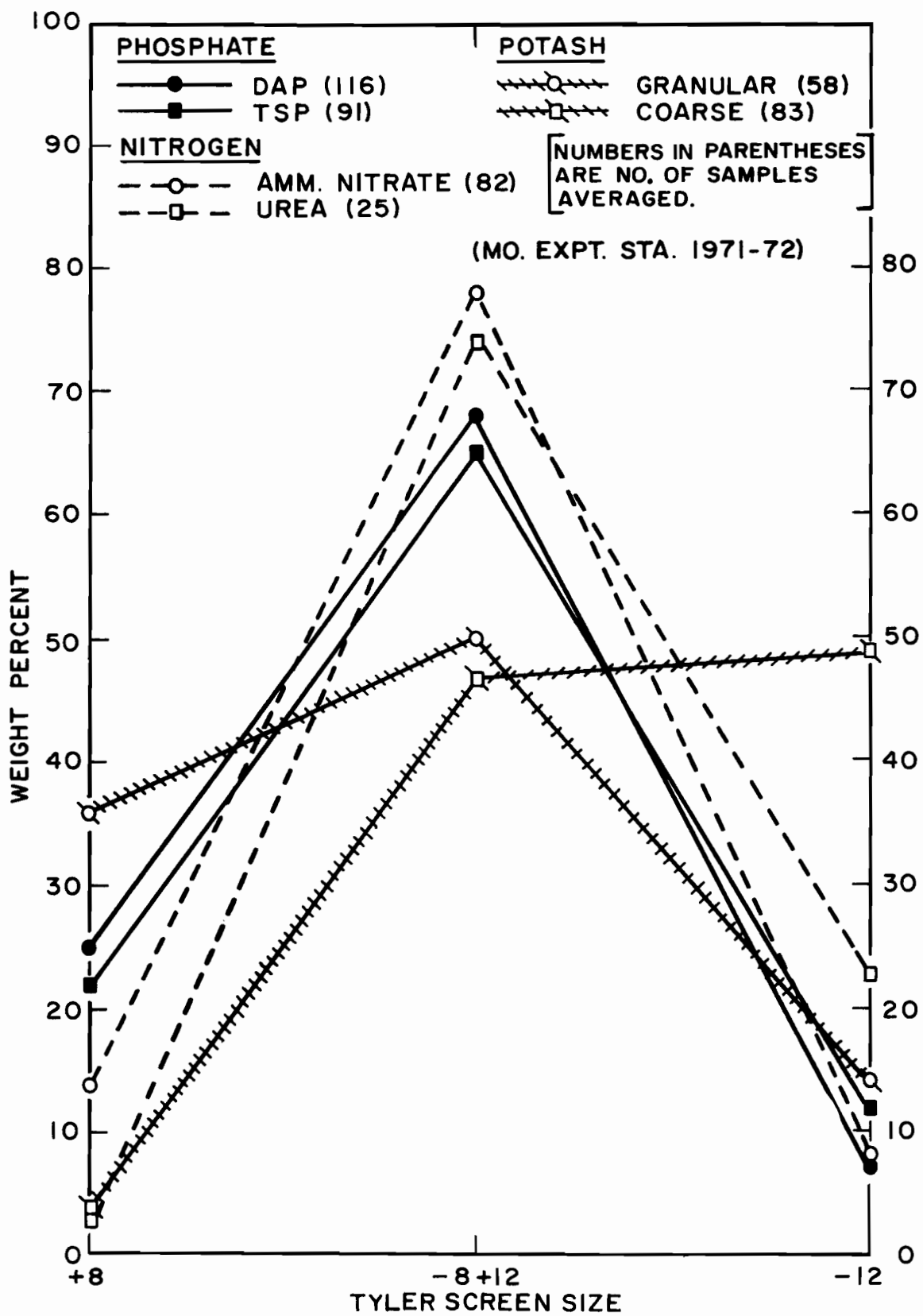
*Second:*

By taking seriously the need for special devices and procedures in handling both the basic materials and blends.

NOTE: Figures 1 thru 8 are on the following pages.



**FIGURE I**  
**GROWTH OF BULK BLENDING IN THE UNITED STATES**



**FIGURE 2**  
**AVERAGE PARTICLE SIZE OF BLENDING MATERIALS SAMPLED**  
**IN MISSOURI BLENDING PLANTS--1971-72**



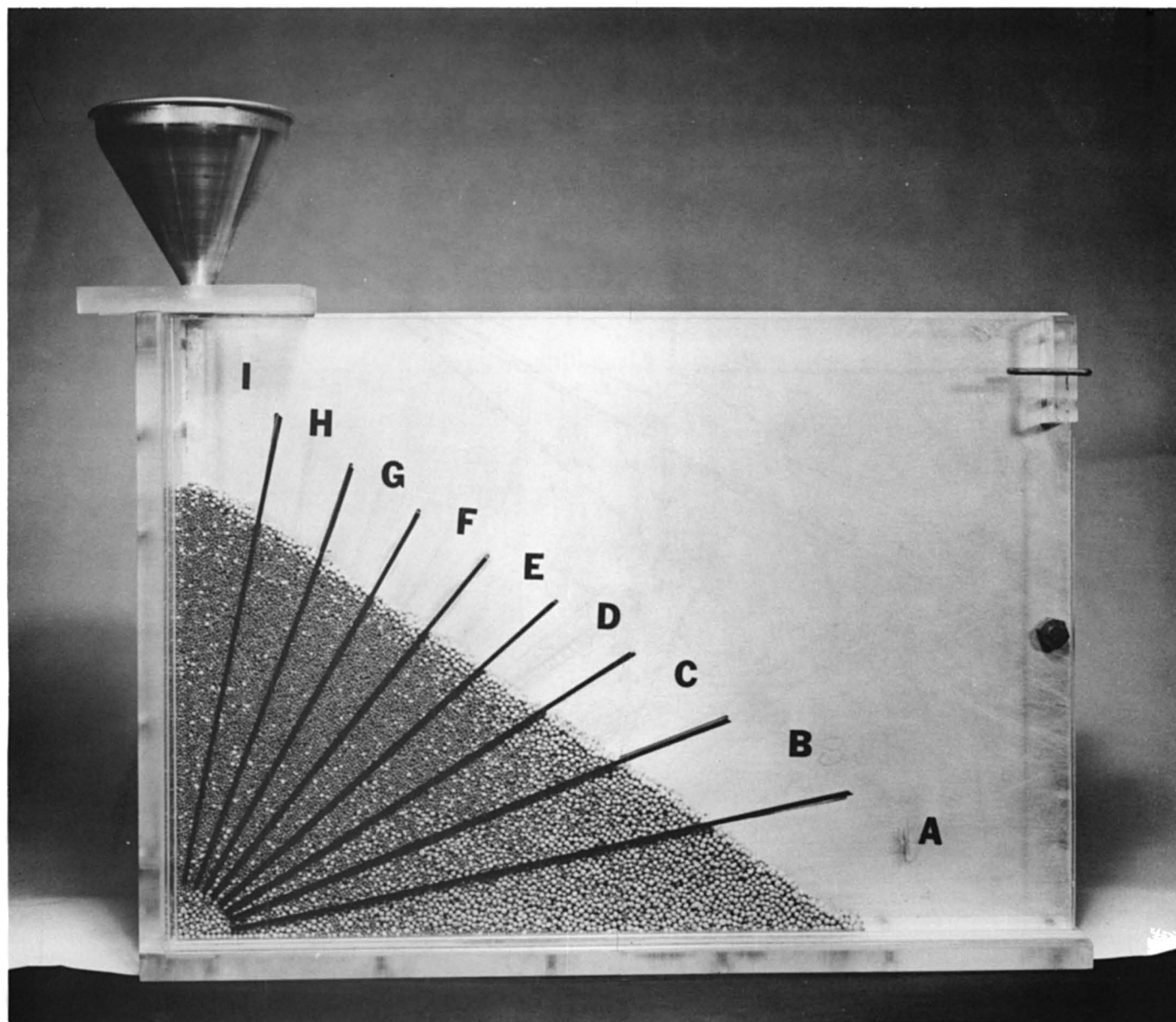
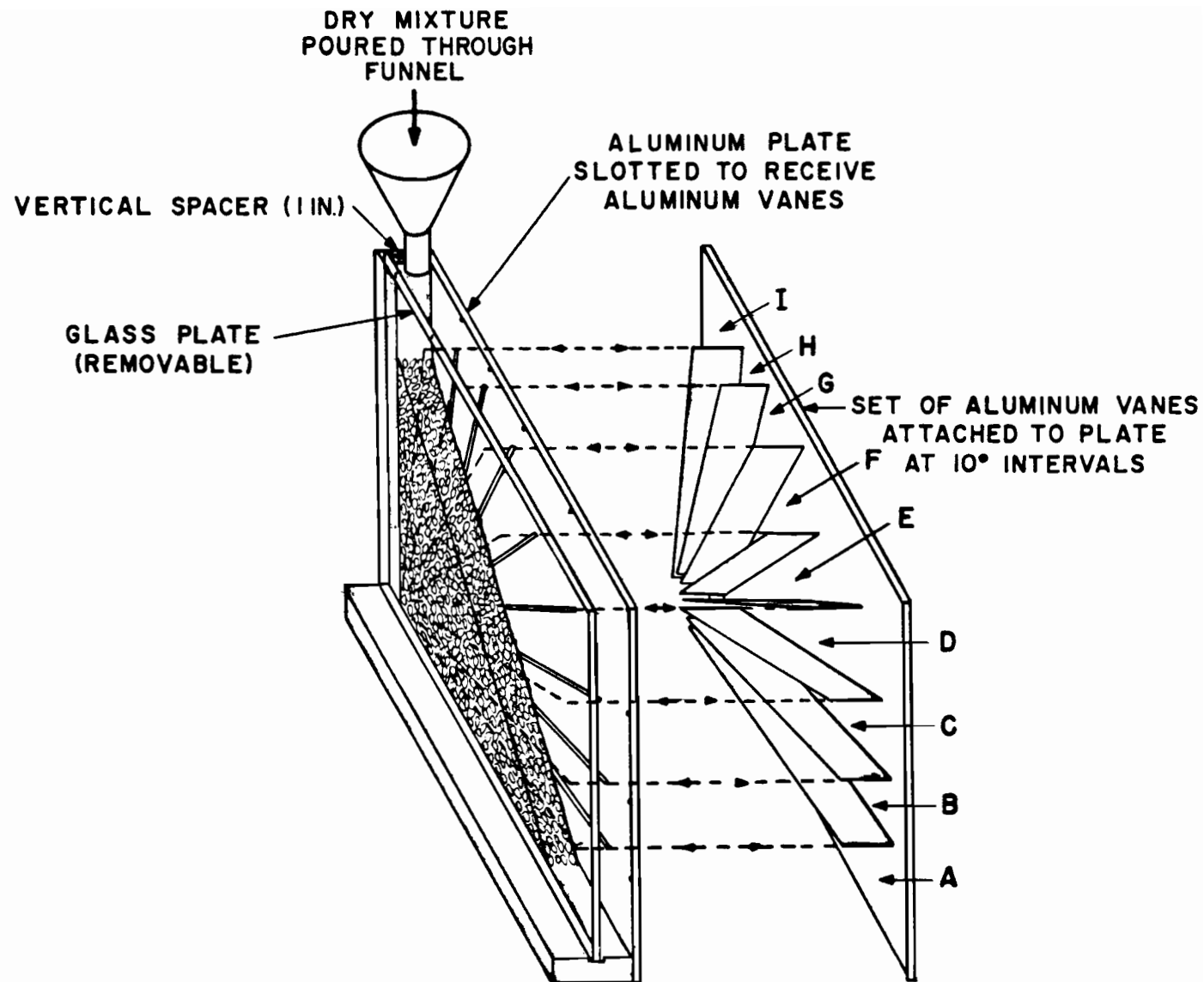


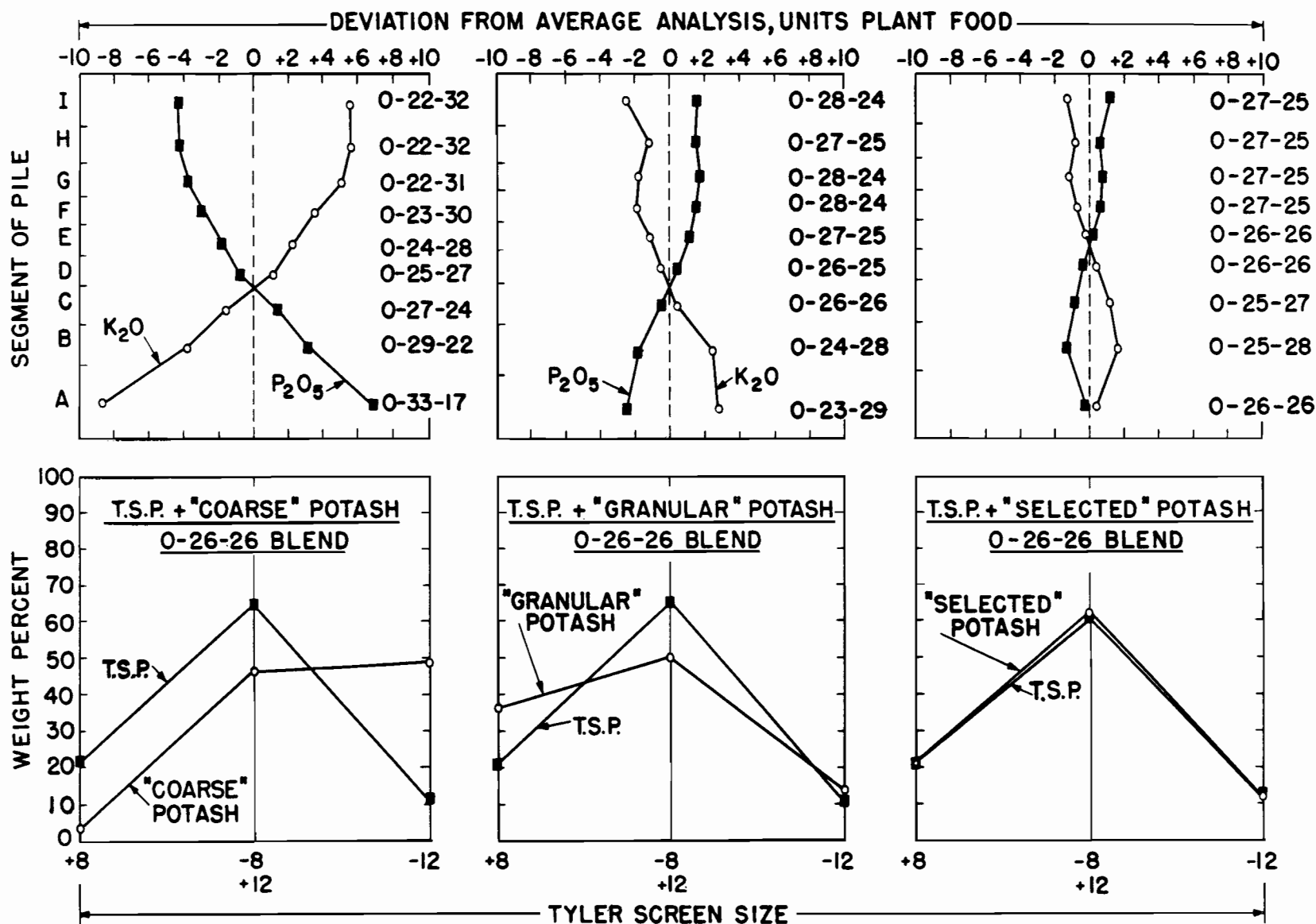
FIGURE 3

BULK BLEND SEGREGATED BY POURING INTO  
LABORATORY SEGREGATION BOX





**FIGURE 4**  
**APPARATUS USED TO MEASURE SEGREGATION DUE TO CONING**



**FIGURE 5**  
**EFFECT OF PARTICLE SIZE MATCHING ON SEGREGATION OF 0-26-26 BLEND**

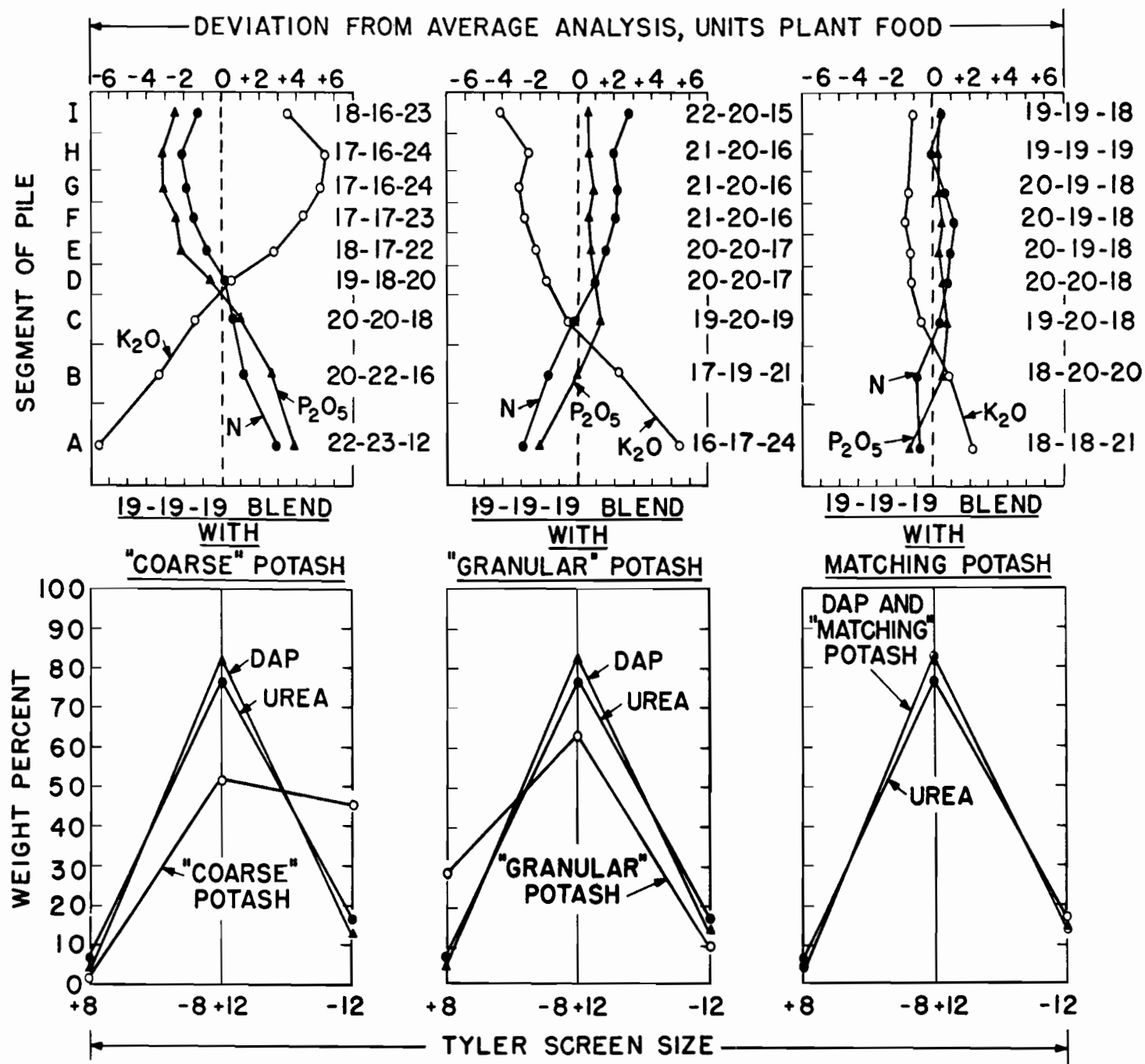


FIGURE 6

EFFECT OF PARTICLE SIZE MATCHING ON SEGREGATION OF 19-19-19 BLEND

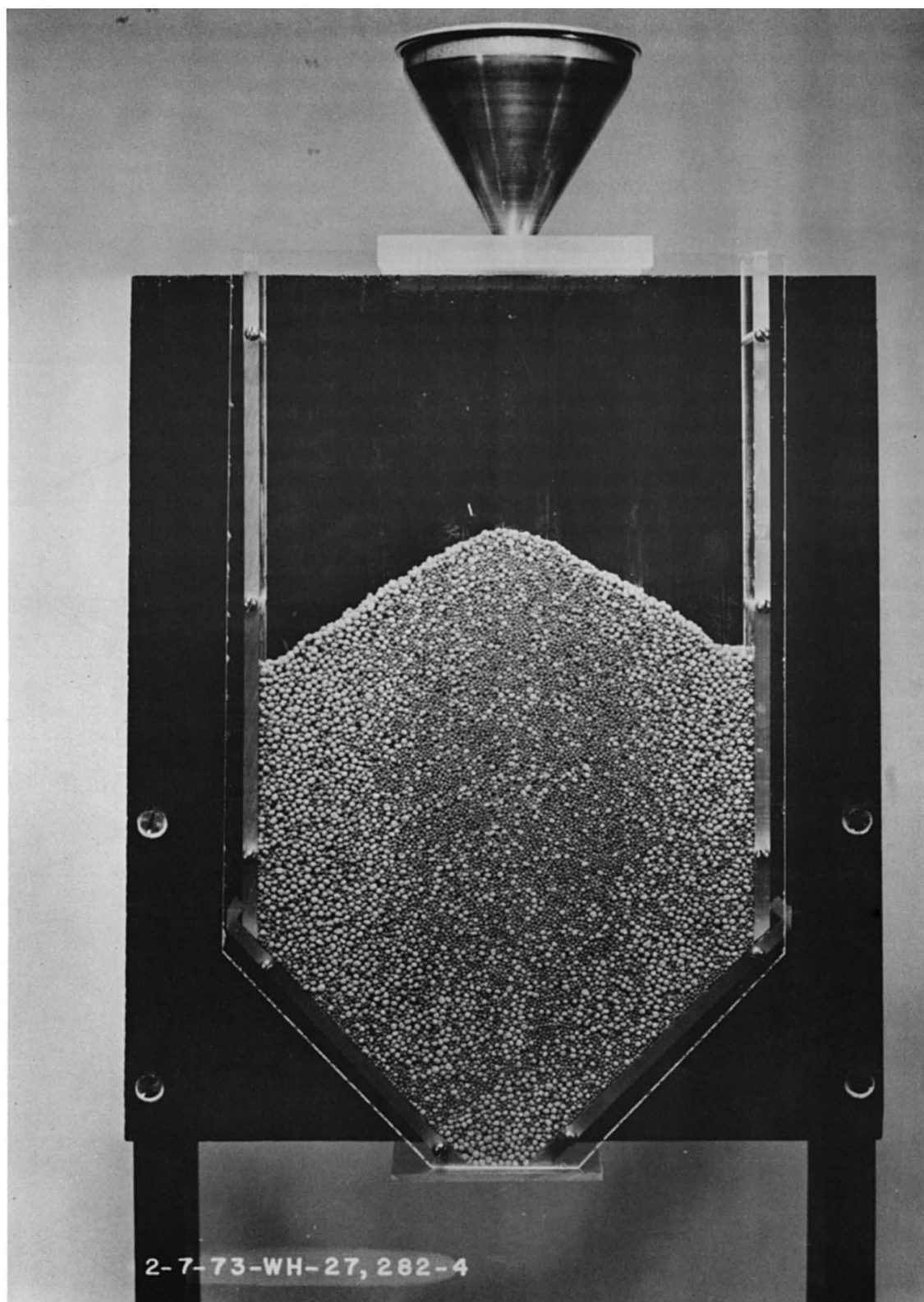
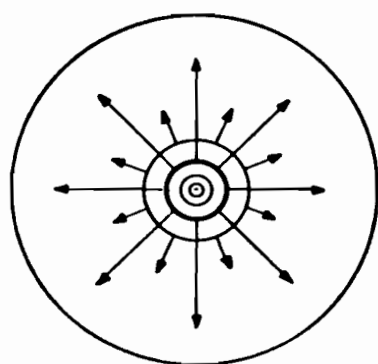
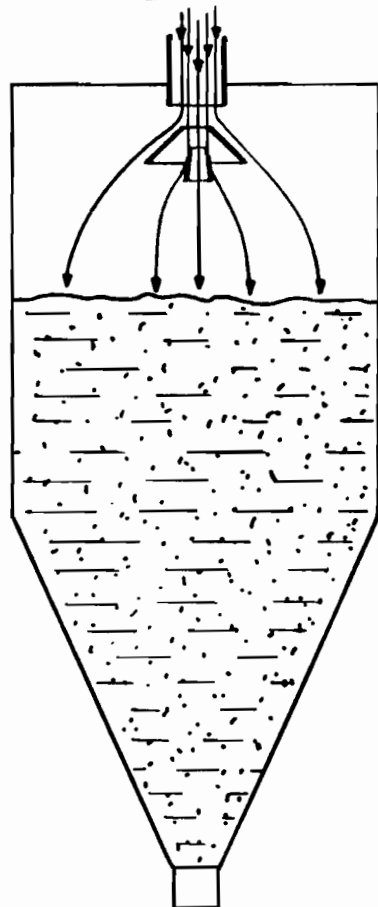


FIGURE 7

SEGREGATION OF BULK BLEND DUE TO  
CONING DURING FILLING OF HOPPER

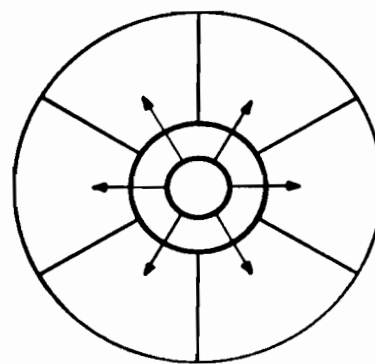


BLEND IN

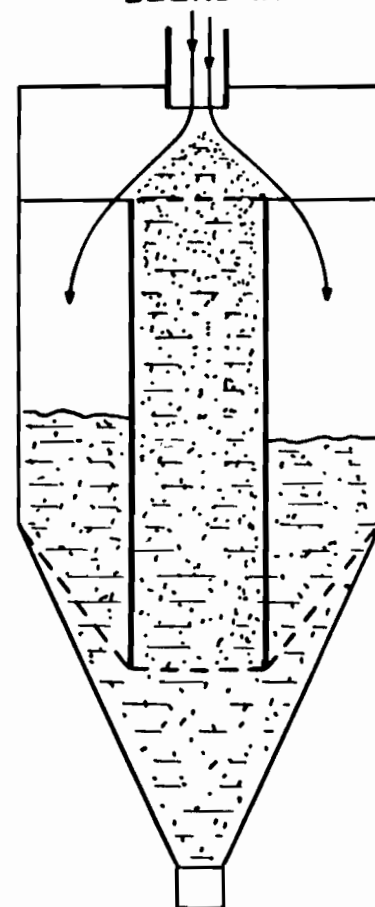


A

CONCENTRIC- CONE  
DISTRIBUTOR



BLEND IN



B

INTERNAL BAFFLES

**FIGURE 8**  
**METHODS FOR REDUCING SEGREGATION IN HOPPERS**

**MODERATOR ADAMS:** Thank you George. Our next speaker will discuss "The Status of Liquid Fertilizers" and I believe, as Frank Achorn mentioned yesterday, Liquid Fertilizers, bulk blending and granulation are our major sections of the Fertilizer Industry. Mr. Hovey Tinsman will discuss this subject. He is a Chemical Engineer. He manufactures 10-34-0 solutions, suspensions and nitrogen solutions. He is from Davenport, Iowa. Mr. Tinsman started in business with his brother in 1958. Mr. Tinsman also has a degree in "Business Administration".

### **STATUS OF LIQUID FERTILIZERS**

*Hovey Tinsman*

Since most of you represent various aspects of the dry industry, I probably should view most of this thirty minutes as discussion with competition. In this light, I would like to leave you with the impression that the liquid fertilizer outlook is definitely bleak and the concept of fluids has run its course. All liquid installations are running in the red, their equipment is obsolete, and all plants are for sale. We are, in short, succumbing to the bitter experience of small business being overrun by the corporate oil giants as well as the cooperative system. In brief, liquids are dead.

Since Joe Lewis and Frank Achorn have been very close to Twin-State and invited me to participate in these proceedings, I think you deserve a more realistic approach of "quo vadis" fluid fertilizers. Before getting into the status of liquids, or fluids, you should be aware that our own operation in Davenport, Iowa, services only northern Illinois and eastern Iowa. In this respect my prospective is quite limited in that it deals basically with corn-soybean rotation in this particular part of the Mississippi Valley. Furthermore, our company's participation is solely in fluid fertilizers, and in no way becomes involved with dry fertilizer or anhydrous ammonia. It may be significant, however, that our marketing practices encompass both retail and wholesale installations through approximately sixty outlets. Furthermore, we are a basic manufacturer of 10-34-0 and suspension products for all of these outlets.

In commenting on the status of fluids, they should be divided into four areas of concern:

1. Marketing.
2. Products.
3. Manufacturing.
4. Application and logistics.

#### *Marketing the Liquid Concept*

While much of the Round Table discussion the past three days has centered on technical information from a production standpoint, the most important concept of the fluid industry is that it is, or should be, marketing oriented. More than any other aspect of plant food industry, the liquid area has concentrated its personnel, training, its financial resources, and its time in the area of marketing. It is not surprising, then, that there have been more changes in marketing concepts than there have been in production and products. In my opinion, this also has been the strength of the liquid industry. Several years ago, our concern was

oriented around who was going to be on the farm in 1970 and the industry attempted to adapt. Today our concern is who will be on the farm in 1975 and 1980. The nature of today's farmer in our area is one of increased sophistication. Tomorrow's farmer is a production man and a purchasing agent. He will have his own concept and methods of research and will definitely be an applied cost accountant. Tomorrow's farmer had a concern over the economical use of his land, but more importantly he places a real value on his time. He centers most of his decisions around proper timing of *all* farming operations.

The liquid concept is dedicated toward keeping pace with the needs of this sophisticated farmer. He needs a high quality product with flexibility . . . a product that can incorporate herbicides, insecticides, micronutrients, as well as being flexible for any ratio of N. P. and K. The liquid concept dwells heavily on proper placement of plant food and the proper timing for maximum efficiency. The liquid concept depends heavily on custom application, so that this sophisticated farmer can do other necessary jobs during the rush spring season.

The concept of "weed and feed" has become a major program of all liquid installations. Application of a complete liquid program in conjunction with broadcast weed control has not only eliminated a costly trip for application, but more often than not it has given a more effective weed control program. The timeliness of the application in conjunction with fertilizer, either incorporated prior to planting or immediately following planting, has made the timing of the two operations ideal. Combining insecticides with starter fertilizers is another example of uniform distribution of product that has been an asset to the farm.

A further extension of the concept of combined operations is where the entire program, N, P, K, micronutrients, and herbicides have all been applied in one operation. The farmer has been saved the expense of numerous application trips, but more importantly, he has saved time — time that can be utilized toward field work and other necessary operations, in order to plant his hybrid at the optimum date.

In the area of micronutrients, a uniform application is necessary in order to give each plant its required proportion of product. Through the media of liquids, a uniform product uniformly applied has assured the farm that one pound of boron or three pounds of zinc are evenly applied per acre.

Most successful liquid fertilizer companies have placed above average emphasis on personnel connected with application and product sales at the firing line. The concept of liquid fertilizers is not necessarily marketable by every fertilizer installation, nor is it necessarily the most desirable program for every farm in our area. Those installations that are "order takers" and involved in a multitude of other rural programs may not have the desire nor the skill to act as a direct advisor for the farm. Those installations and

farmers that are highly oriented around original cost of plant food will never find themselves at home with a liquid concept. Many are the farms that place little value on their time, or they have adapted many of their operations such that fertilizer can be applied during the off-season. In these cases, the cost of the liquid concept may indeed be unacceptably higher. Those marketing personnel, however, that are oriented around developing a full program for the farm, and in fact give a valued service in assisting the farm toward higher yields, have carried well with liquids. They have developed a relationship with their retail clientele that has been based on performance rather than original cost per element of N, P and K.

The liquid industry will probably continue its promotion and penetration into the area micronutrients and combinations of herbicide application. If there are, indeed, yield increases from these particular programs, liquid personnel will undoubtedly be involved.

#### **PRODUCTS**

Not too many years ago, liquids were saddled with clear mixed grade products. They were of low analyses and with decided limitations in the application of potash. Because of the necessity of maintaining a stable, clear solution, raw material costs were high and the differential between dry and liquid programs was sizable. The development of 10-34-0 and high potash suspensions have had a remarkable effect on liquid participation in the total plant food market.

Suspensions were devised solely as a means of moving high analyses potash materials. The advantages were several. First and most importantly, freight costs between manufacturing plant and dealer were reduced by more than half. High analyses suspensions allowed liquid applications to cover 50 to 100 percent more acres per load, thereby increasing application efficiency. The same equipment and highly skilled applicator could cover considerably more acres. With clear liquids, most installations were geared to 4-10-10 as a basic analysis for potash. Not only was the analysis low, but the P/K ratio was most unacceptable for lighter soils and for most corn and alfalfa recommendations for our areas. Seed corn agronomists and extension personnel were increasing their attention on the value of potassium. Higher levels of potassium were mandatory while phosphate recommendations remained somewhat more level. Suspension analyses such as 5-15-25, 5-15-30, and 3-10-30 gave the liquid industry the flexibility to supply the necessary potash required for most crops in our area.

Suspensions, because of their nature of controlled salting out, are adapted to year-round use. No longer are temperature conditions a factor on the application of liquids. They can be applied in January as easily as April. Here again, liquids were able to participate on an equal basis with the dry programs.

10-34-0 production, while not new, has been greatly expanded because of higher quality raw materials available

on the market. Green Superphosphoric Acid, relatively low in impurities, can be developed into a stable product that is storable year-round. 10-34-0 can be used in conjunction with other lower cost forms of phosphate to produce long term stability suspensions. It is also used as the base for starter fertilizer. By the use of control equipment such as ratio controllers and magnetic flow meters, the production of 10-34-0 is easily automated and the most common plant limitation is the capacity of the cooling system.

In the development of both suspensions and 10-34-0, most liquid installations have oriented themselves around one of two program — (1) Purchasing on the open market of a high potash suspension for source of potash, or (2) Purchase of bulk potash. Either of these products are then combined in different ratios with 10-34-0 and 32% nitrogen solution to form the various grades. The simplicity of equipment at the dealer location has enabled key personnel to spend most of their time in the marketing area where their effectiveness is maximized.

#### **MANUFACTURING**

There have been several changes in the manufacture of liquids that have been of great interest to our company. The development of stable suspensions has been a most important factor to the liquid industry. Developing a product that will store for twelve months, one that will not stratify or settle to the bottom of a tank has enabled our marketing to be much more potash oriented. The production of suspension is not limited to just 10-34-0, but of course can utilize lower cost 54% acid and spent phosphoric acid as well. The development of an adequate air sparging system to prevent stratification has enabled centralized plants to make suspensions for a dealer network. No longer is it required that a suspension product be taken from the mixing tank to the field before potash settles.

The use of clay has posed several problems to the manufacturing of suspensions. Uniform clay "building" was almost non-existent. Some batches were most successful while others quickly separated, causing immense storage problems. Clay bags have been the norm for handling this necessary additive. At our own facilities, clay dust resulted in higher maintenance costs as well as being a health hazard.

The use of proper agitation with mixer and pump in conjunction with heat has given a far more stable and consistent product. Bulk clay handling has completely eliminated the obnoxious aspects of clay dust. In reference to your earlier discussions to responsibility for working conditions, bulk clay was mandatory.

On the horizon for liquids is the development of the T Reactor. This concept will enable low poly forms of phosphoric acid to be ammoniated at high temperatures to essentially produce polyphosphates at a liquid fertilizer plant such as ours in Davenport. This procedure has obvious economics for the superacid supplier because of higher production rates, as well as economics for the area liquid manufacturer. Some plants are currently producing 10-34-0



with a poly conversion of 70-75%. From an economic standpoint, this will allow a greater degree of blending of 54% ortho phosphate acid and other lower phosphate cost sources with high poly 10-34-0. I speak of the T Reactor with hope rather than with any history, inasmuch as we are in the process of installing the system now. But we have every expectation from data we have seen that the process is a necessary evolution within the liquid industry.

The liquid industry is obviously looking with some expectation to the utilization of a higher and higher percentage of 54% acid in their production of suspensions to make the eventual product more competitive with its dry competition. As the cost of liquid phosphates in the area of suspensions is reduced, the value of the plowdown suspension market will become an even greater percentage of the total liquid market. Lower cost phosphates that can be utilized in suspensions will enable the liquid industry to market on a low competitive price system, while at the same time maintaining the very desired advantages of handling fertilizer with pumps and applying a chemically combined product uniformly over the field.

#### *Application and Logistics*

Tremendous strides have been made in the liquid industry to capitalize on the liquid concept in the area of application. The tricycle flotation applicator, such as the Big A and Floater, make use of wide dimension Terra tires. This equipment has not only solved the farmer's problem of compaction, but allows the dealer to spread out his application work throughout the spring season. No longer does the farmer or dealer have to wait for fields to dry before pulling a standard type truck or buggy through the field. Flotation equipment has been the catalyst for market penetration in the area of "weed and feed". This is where the application of fertilizer and herbicide is applied to plowed ground prior to planting or as a post-planting pre-emergence application. Not only does flotation equipment convey application ability to the farmer, but it is designed with markers and other gadgetry that makes application uniform and accurate. At application rates up to an acre a minute, dealer installations have been able to put their key personnel in the flotation unit and lesser qualified personnel operating transfer units between dealer location and farm. The "weed and feed" program has brought to bear the importance of the qualified sprayer. The farmer may not have been aware of poor application or non-uniform application with fertilizer, but skips and overlaps of chemicals can prove disastrous to dealer/farmer relations.

The liquid fertilizer industry has also keyed in on optimum placement of fertilizer. We do not accept the premise that phosphates can be applied at any time or at any location for optimum results. The chisel plow and other minimum tillage equipment can easily be adapted with liquids to place the fertilizer at its desired depth in the soil. By use of liquids and pumps, it is a fact that liquids can be uniformly sprayed, dribbled, chiseled, or used as

pop-up, all utilizing the same product from the same storage tank with the same transfer equipment. It is indeed a very flexible media for moving plant food from basic supplier to the field.

The transportation of suspensions and other products is incomparably easier than with dry products. Suspensions are easily transported in used cement equipment making use of hopper bottom designed trailers. Through normal 3" pipe, it is easy to unload a suspension truck at a dealer installation in 15-10 minutes. The transfer is clean, complete, and short on time involved.

#### *Future*

Where are liquids headed in the next few years? There is little doubt that all farmers, dealers, and manufacturers are aware that the raw material costs for the liquid industry are higher than that for dry fertilizer and ammonia. But tomorrow's farmer that is successful today is well aware of his fertilizer costs and those of competing programs. If costs per raw material were the only thing that were considered for the entire industry, we would still be on rock phosphate and anhydrous ammonia. Many are the farms, however, that do place a value on proper timing, product performance, application, and cost of labor. Liquids have an ecology advantage in that no longer are manufacturing plants pressed to sell the concept of winter application to keep plants operating. The high capacity production nature of the liquid industry allows product to be manufactured and spread, not only at the optimum time for the crop grown and adapted to the farmer's time, but it is also adapted to the principals of ecology where field loss can be held to a minimum. I suspect the entire industry will see more emphasis on proper timing of plant food application based solely on the principle of ecology. Unless the fertilizer industry conforms to this necessary direction, people outside the fertilizer industry will legislatively set the standards.

During the past fifteen years, the liquid industry has gone through various phases experimenting with product and equipment. There was a substantial area to pioneer. During the last five years, liquids have indeed come of age. 1972. was a very successful year in liquid application and the enthusiasm on the part of the liquid industry may well be represented in the oversold condition for 1973.

MODERATOR ADAMS: Thank you Hovey. We now move to our last but not the least discussion by Mr. R. E. Ashcroft, Vice President, Wycon Chemical Co., Cheyenne, Wyoming. His company produces Ammonium Nitrate, Urea and Nitrogen Solutions. His paper covers Wycon's WyFlo-46 Urea additive process.

#### **WYFLO-46**

*Ronald E. Ashcroft*

Since we started urea production at Wycon in 1967, we have searched for an improved means of preventing caking in the prills during storage or transportation. We first used the conventional methods of clay coating, using 2 -



3% clay. The plant was originally equipped with excellent clay storage and handling facilities; however, this required almost constant attention by operating personnel in unloading, transferring, and monitoring clay addition equipment. Storage areas were also fairly dusty. Although the clay coating did a fairly good job in preventing caking, there were still periodic complaints of set-up.

In 1971 we investigated the use of an additive material which could be added before prilling and which was homogeneously mixed in the prill. We found that by using this additive we could eliminate entirely the use of clay coating and the prills exhibited less tendency to cake.

See attached graph showing caking index and moisture absorption versus additive concentration.

In addition, to improve caking resistance, the following improvements and advantages were realized.

1. Prills remain free flowing and resist moisture absorption.
2. Absence of coating agent eliminates dustiness and allows guarantee of 46% nitrogen content.
3. Feed urea prills can be guaranteed with 287 protein equivalent.
4. Prills are harder with less fracturing.
5. Bulk density of prills will increase by 2 - 4%.
6. Significant savings are realized in costs of conditioning agent versus coating agents. Labor savings will result by eliminating labor consuming clay handling system. Savings of \$0.45 - \$0.70 per ton of urea can be realized.

7. On new plant installations, very significant savings on investment can be realized by eliminating costly clay handling equipment.
8. Conditioned urea prills are completely soluble.
9. Facilities for storing and injecting the conditioning agent are relatively inexpensive and require minimum of operating or maintenance labor.

#### *Application and Control*

The additive can be obtained commercially, requires no mixing, and is metered into the urea process easily. The application can be easily monitored and controlled.

\* \* \*

We felt the improvements significant enough that we applied for a patent on its use. Patent application is currently pending at the U.S. Patent Office, and for this reason some of the data, know-how, and procedures are proprietary, but full disclosure can be made with an executed secrecy agreement.

During the recent lean years, we in fertilizer manufacturing have been forced to look very closely at ways of reducing production costs, and I can see no reason in the future to abandon that activity. The WYFLO-46 additive program has provided worthwhile cost savings in our urea production, and although these may vary in other plants, the possibility should be considered. The following information summarizes our projected cost savings in Wycon's Cheyenne urea plant.

COST COMPARISON

WYFLO-46 Conditioning Process vs. Coating Agent

A. Existing Plant with present clay handling equipment.

	<u>Coating Agent</u>	<u>WYFLO-46</u>
Pounds per ton Urea	60	18.92
Conditioner Cost/Pound	\$0.016	\$0.035
Conditioner Cost/Ton Urea	\$0.96	\$0.662
Additional Operating Labor @ 8 MH/Day	\$0.297	-
Additional Maintenance Costs	\$0.024	
Royalty	<u>-</u>	<u>\$0.15</u>
Net Cost/Ton Urea	\$1.281	\$0.812
Savings/Ton Urea	-	\$0.469

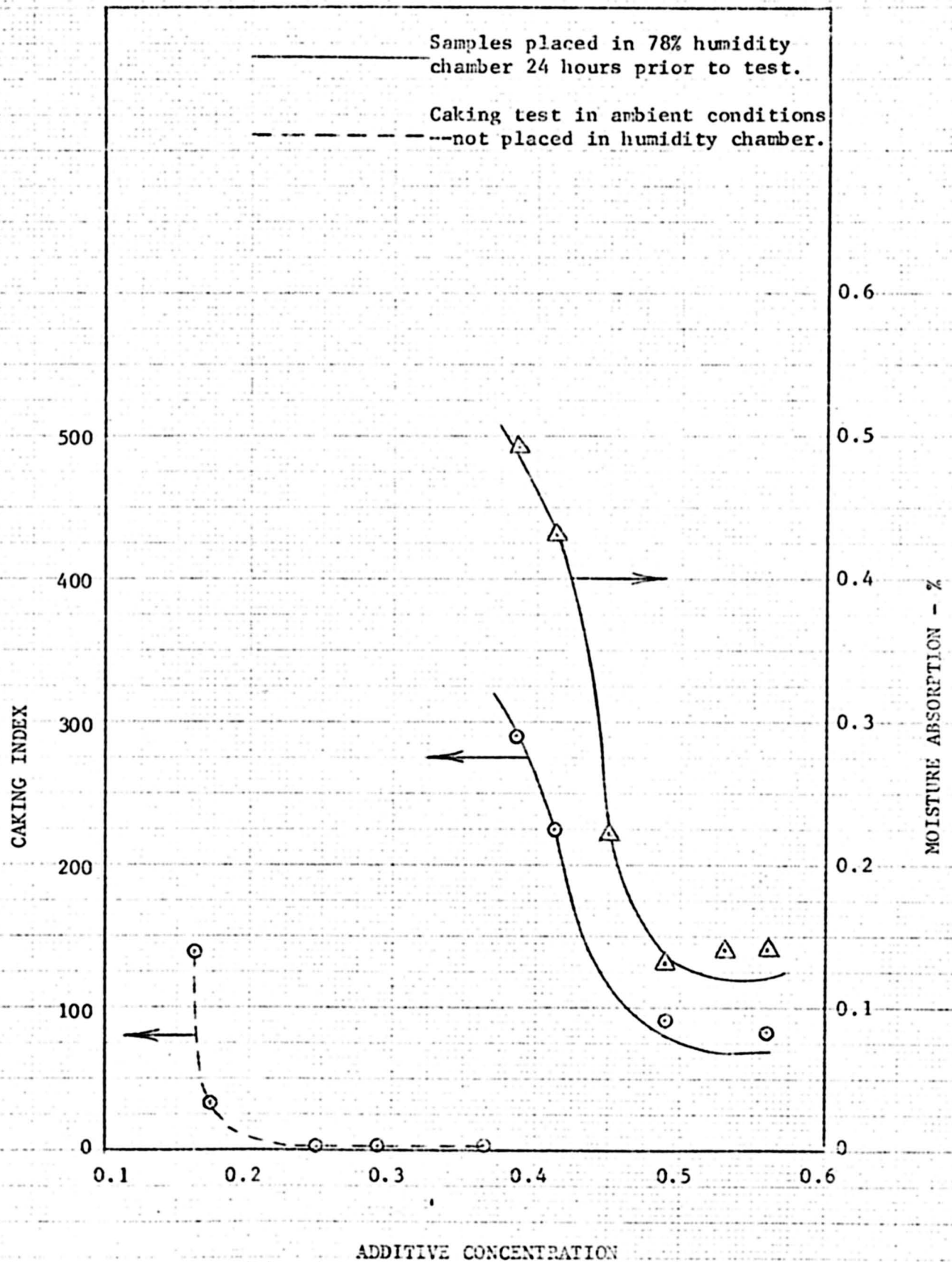
B. New Plant Installation (no clay handling facilities)

Depreciation on Equipment @ 10 Year Schedule	<u>\$0.277</u>	<u>\$0.036</u>
Total A & B	\$1.552	\$0.848
Savings/Ton Urea	-	\$0.704

NOTE: Above costs are based on Wycon's experience with 165 ton/day urea plant.

Effect of Additional Concentrations and Coating

# EFFECT OF ADDITIVE CONCENTRATIONS ON CAKING



MODERATOR ADAMS. Thank you Ronald. Your topic is most interesting and we appreciate your discussion. We have had a number of requests from time to time for information on improvement on Urea Storage.

This completes our 3 day program. Are there any statements or any reports anyone wishes to make at this time to the Round Table?

I am sure we have had another real good meeting this year and our Chairman has already given you his summary. If there is nothing more at this time we stand adjourned.

Get your diary out and write down the dates and

place for our 23rd Annual Meeting —

Shoreham Hotel

Washington, D.C.

Wednesday, November 6

Thursday, November 7

and

Friday, November 8, 1973.

Please make your reservations early.

See you in Washington.

EDITOR'S NOTE: The attendance for all 5 sessions was good. There was lots of applause.

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