PROCEEDINGS
OF THE
21st. ANNUAL MEETING
FERTILIZER INDUSTRY
ROUND TABLE
1971

November 10, 11, 12, 1971
Sheraton - Peabody Hotel
Memphis, Tennessee

Copies of these Proceedings and Back Copies – $10.00

Please make checks payable to
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Glen Arm, Maryland 21057

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Wednesday, November 10, 1971

Morning Session
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CHAIRMAN SPILLMAN: Good Morning Ladies and Gentlemen. Welcome to our 21st Annual Meeting. Our Theme "FROM THE GROUND BACK TO THE GROUND".

Our Executive Committee worked very hard to comeup with this 3 day, 5 session program. Two full one day Executive Committee Meetings were held in Baltimore during April and July. In addition we had many Baltimore Saturday Morning Sessions attended by Committee Members residing in and close to Baltimore. Most important, thanks to many of our Members for suggesting topics they wished to have discussed. The program is the result of the excellent cooperation from all of our group. Thanks very much.

The Highlight subjects to be thoroughly discussed are timely and of great importance to all of us, in all phases of our operations, – Nitrogen, Phosphates, Potash, Micronutrients, Environmental Regulations, Emission Control Considerations, Sampling, Water Quality Control, Pesticides in Mixed Fertilizers, Distribution of Fertilizers, 1970–1980 Future of Bulk Blending, Particle Size, Machinery, Engineering, Plant Layout and other pertinent topics.

I am sure you will all be interested (For the first time since starting our Round Table 21 years ago) we will have This Afternoon and Tomorrow Afternoon Informal Round Table Discussions (8 Tables) each accommodating about 30 seats. Several leaders will be assigned to each table on specific subjects. This will give you an opportunity to ask questions – a two way – take and give knowledge – from actual day to day experiences.

It is my pleasure and a real privelege to introduce to you Our Keynote Speaker, Joseph P. Sullivan, President of the Swift Agricultural Chemicals Corporation, a division of Swift and Company.

Mr. Sullivan is a resident of North Lake Shore Drive, Chicago, born April 10, 1933, Newton, Mass. He graduated "cum laude" from Harvard College in 1954 with a bachelor's degree in Government. Two years later he was awarded his "MBA" from Harvard's Graduate School of Business Administration.

Three years of service with the U.S. Army Finance Corps, as a Company Commander, followed his graduation from Harvard. Prior to joining Swift and Company, in 1959, Mr. Sullivan taught Personnel Management and Marketing at Butler University. He started with Swift in the Commercial Research Department and two years later moved to the Agricultural Chemicals Division from where he moved through several positions to become General Manager of the Division. In 1968 Mr. Sullivan was elected Vice President of Swift and Company with jurisdiction over the Agriculturals Chemicals and Phosphate Division. He became President, of the Swift Agricultural Chemicals Corporation, when it was formed in 1968 as part of an Organizational Restructuring.

Mr. Sullivan is married to the former Jeanne Baldi of Belmont, Mass. They have two daughters, Deirdre and Barbara, and a son Mark.

We are happy to have you with us, Mr. Sullivan, and are looking forward to listening to your Keynote Message "The Challenges of the Future."

The Challenges of the Future
Joseph P. Sullivan

The Fertilizer Industry has had more than its share of problems in the last five years. Ten years ago we were looking ahead to what we thought was to be a record decade for our business. And it was. Unfortunately, not all the records were the ones on which we had planned.

We have had to live with the problems of chronic overcapacity, weak prices and unrealistic competition. Many of these problems still are with us and probably will be for the near future at least.

But so are the lessons these problems have taught us, and how well we use what we have learned is the key to our success in the decade which we have just started.

As the dust settles from the storms of the last five years, we are beginning to get a clearer picture of the changing landscape of our industry. Immediately visible is the change in color – from deep red to pale green – a change which has to bring a smile to each of us.

Bullish signs are all around us signaling better times ahead for our industry. To quote from a recent major article in Barron's a major magazine for the investment community: "Out of a slump; the fertilizer industry has emerged in fine competitive trim." But let's not kid ourselves. We are greatly improved, but we still have a lot of work to do. When you compare the chemical fertilizer industry with the rest of American business, the picture is most clear.

Stripped of the colorful wording, the impressive mathematical projections for population and new markets, the references to new plants and technology, the chemical fertilizer industry by comparison is scrawny and undernourished.

As an industry we have a long way to go before we reach the levels we should occupy in what is the most important aspect of our – or any other – business, the return on the assets we have employed.

Let's take a brief look at our situation: In 1969, for example, while the chemical fertilizer industry was recording a loss of $70 million on assets of more than $3 billion or a rate of minus 4.3 per cent, the average return on assets for U.S. manufacturing industry in general was plus 12.3 per cent.

Closer to home, the basic chemical industry also showed a 12 per cent return on assets in the calendar year 1969. We have closed the gap appreciably in the past year. Figures for the fiscal year ended June 30, 1971 indicate that companies in our industry had total net profit of $65 million on assets exceeding $3 billion, or 2.1 per cent. It is an improvement to be proud of, but the hard facts are that on the average the companies in this industry did little better than break even while the average ROA for the rest of U.S. manufacturing industry was 9.9 per cent, and the basic chemical industry earned 9.4 per cent.

In a year of normal business conditions, we should expect industry to earn at least 10 per cent on assets. On this basis, the chemical fertilizer industry should have posted earnings of $300 million instead of $65 million before interest and income taxes.

The message is very clear. Our biggest challenge is to improve our rate of return; to take the management steps necessary to move our ROA up to where it should be in relation to the rest of U.S. industry.

To achieve this we are going to need commitment all up and down the line within our individual companies to perform two steps. Let's talk about the first step – heightening the awareness of the need to manage assets productively.

Each of us is going to have to create an appreciation and understanding in all of our employees – right down to the smallest farm service center – of the absolute necessity of strict management control of the assets for which they are responsible.

In some cases it is going to mean a complete reorientation of thinking for our people; a setting of new priorities that to many of them will be contrary to the way in which they have conducted their businesses in the past. It will be difficult, but it can be done. It must be done if we are going to effectively compete for the available dollars in the seventies and beyond.

We will have to take a lesson from other industries on how they manage their people, and then motivate ours to manage the assets they have entrusted to them in such a way that they will achieve this higher ROA.

Basically, we will have to do a better job of education, communication, and control.

All too long we as managers have kept elementary facts to ourselves. We have not explained to the people on the firing line how this business operates or should operate. We have failed to recognize that the knowledge level of the American people is going up all the time. We have not accepted the fact that they can understand the financial facts of life.

They must understand clearly that we are in competition not only among ourselves for customers dollars, but also in competition with all other industries for the dollars of bankers and investors.

Let's be honest with ourselves. Were we in the place of the major investor or banker would we be quick to put our dollars into this business with its ROA so far below the national average?

My own situation at Swift & Company is a good example. Swift, though best known as the world's largest meat packer, is a major factor in a wide variety of food businesses, the insurance industry, petroleum and chemicals, of which the swift agricultural chemicals corporation is only one part. I compete with all of these businesses within my own parent company for new capital.

If we as an industry are just going to refurbish, much less expand, we too are going to need dollars. We are going to need an improved ROA to compete for the banker's and the investor's dollars. And our people must have a fuller appreciation of this so that we can get this ROA back to where it should be.

One of the greatest helps we can give our people in achieving this goal is better internal financial control. And to be successful in this effort, we are going to have to provide the proper attitude and environment so that our own people can appreciate why these financial controls are necessary

We must put greater interest and emphasis on coordination and teamwork. We must spend more time on establishing better working relationships within our companies – working relationships, for example, between credit departments and sales staffs; distribution people and research and development teams.

The greater the sense of teamwork form top to bottom and from side to side, the better each of us is able to see the total business, not just the specific area in which we operate.

This will be the first step in getting the return on our assets up to where it should be. Now let's take a look at the seond critical step – the utilization of process, product and distribution improvement and innovation to achieve improved industry peformance.

Gathered at this 21st annual fertilizer Industrial Round Table is the finest talent in our industry; The people who will determine to a great degree the direction this industry takes in the years ahead. In the remainder of the week all of us will spend valuable time on such topics as new technology, new products, and new approaches to marketing, as well as the challenges we face in providing defenses against pollution of the environment by our industry.

We all recognize that this will require effort and substantial capital investment if we are to be successful. We are going to have to justify that investment. That is why I placed such great emphasis on return on assets in my remarks up to this point.

But now let's be more specific about the special purpose of this round table. Where are we looking in the areas of technology, new products, and changing markets?

In the next decade we are going to see substantial increases in the liquid fertilizer business because of the ease of application and labor-savings it affords the farmer. We also will be looking to higher analysis liquid grades, an area in which our colleagues at the T.V.A. have done considerable work.

We also will have to be ready to meet increasing demand for micronutrients throughout the country – both for isolated and general application.

Not only do we have to be concerned with technology, but also with distribution. (And here is another critical area for discussion at this round table.) We must identify and put into operation a better system of managing the distribution of our products during the last 20 to 30 miles to the farmer.

On the subject of marketing, I feel that we are going to see the need for more complete farm service stores in contrast to strictly fertilizer stores in the next decade. Two factors lead to this conclusion.

The family farm will survive in the next decade, but in a different and much larger form. It is estimated that by 1980, 98,000 farms in the United States will produce over 50 per cent of the crops. That is only 5 per cent of the farms we now have. Their size will mean their needs will be different, and they will foster an increase in the number of custom applicators, among other things.

But equally interesting is a growing trend toward country living. The new breed of rural resident, however, is not farming. He is the family man who has moved away from the congestion of the big cities for the open-air of country life.

His presence will promote the need for more "total service" operations similar to the country stores of previous days. And we as an industry are uniquely suited to respond to this marketing need.

Our recognition of the importance of the subject of environmental quality is evidenced by the time to be devoted to that topic during this round table.

Pressures from all sides are mounting in this area, and will continue to do so in the months and years ahead. We can expect more government regulation of pesticides and farm fertilizers both on the national and local level. It also is not illogical to assume that before long we may well see mandatory training and licensing of both salesmen and custom applicators.

We must be alert from a sales point of view to identify and anticipate the implications of new laws and regulations on our traditional businesses. And we must be ready from a management point to identify what each dollar of additional pollution control cost will have to mean in increased business if we are to achieve an adequate return on those assets we have invested in our businesses.

Now let me be blunt with you in pointing out the very special challenges that you and I have in achieving this second step of applying new products, new technology and services toward improving our industry.

We are operating in a climate which is based on the unfortunate experiences of the 1960's. Many people recall all too well the "pie in the sky" attitude which prevailed in the early 1960's when virtually any project which made any sense whatsoever was authorized. These people remember the shambles that occured as a result of this helter-skelter growth.

Unfortunately, the climate has now changed to a position where even outstanding projects find it difficult to see the light of day.

It would be terrible if we as an industry tried to draw too much from the last chapter of experience which has been written. Surely we made mistakes in the sixties, but we will make as great or greater mistake if we are over-cautious and develop a "stick in the mud" attitude in the 1970's.

Now, what can we do to overcome this attitude of overconservatism which very frankly exists in our industry today. I think our role must be to make certain that any project which we cast up for review and approval must be extremely well documented. It must honestly show not only the opportunites, but also the risks. It must show not only the potential profit, but also the total assets which will be employed.

Most importantly, it must be thoroughly researched and tested right through to the end user.

As an Industry we could have done better in innovation. We have had problems in applying new technology, such as the nre nitrogen production processes. Many of these problems could have been avoided thru better teamwork between engineering operations and R. and D. within companies. Many other problems could have been overcome more quickly thru better training and improved communication between Equipment Suppliers, Construction Engineers and the End User. We have also failed to understand the full implications of technological product or distribution innovation. Frankly we have not recognized the special problems facing a new product or technology in traversing the last 20 miles to our ultimate consumer – the farmer.

Our industry is replete with examples of products and techniques which have worked out well in the lab, at the bench-scale level, and even at a full plant operation, only to fail in the last 20 miles of the distribution chain.

We must recognize the incredibly difficult conditions that dealers or service center operators face in taking products to the farmer. I need not remind you of the special time dimensions, the storage problems, the personnel problems which make it necessary to develop goof-proof products and techniques for these last 20 miles.

I was remined of this the other night when I had the opportunity to hear Werner Von Braun outline a method to eradicate illiteracy and improve agricultural techniques in India.

The bulk of India's 500-million population is spread over 500-thousand villages. The plan, which hopes to eradicate illiteracy and improve agricultural techniquest in India, involves the placing of a communications satellite above India which would ultimately transmit educational television to each of these villages.

The villagers would gather at a central point and learn from television how to read, write and develop new agricultural techniques. One major challenge to be overcome is how the receiving transmitter will get power because most villages are not electrified. One solution is to supply the power through a generator run by pumping a bicycle-like contraption.

Having great faith in space age technology, I'm sure we will have no problem in getting the satellite up and in its proper orbit. Having seen the many failures in applying our technology to practical effective use, I'm very concerned about how well the bicycles will work and how greatly the bicycle pumpers will be motivated to do their job.

I hope people are worrying and working on these challenges as assiduously as on the problem of getting the satellite located properly.

Transferring this to our own situation, let's recognize, in short, that a new product or technique is only successful if a farmer or grower can use it effectively at his place of business at the right time and at the right price.

And this is why the Round Table plays, and must continue to play, an important role in bringing Suppliers, Producers and men with different functional responsibilities together to visualize the opportunities and challenges of new products and technology.

To summarize, we need to take two steps in order to move in the right direction at this crossroads of our industry:

First, we must become better financial managers no matter what particular job title we might happen to have. We must have confidence that our people will understand, if properly trained, the implications of good financial and business management.

The second step has particular pertinence here this morning. We must develop the zest to apply practical new products, new technology and new distribution techniques to create new opportunities for our industry. We must do this, recognizing we have an attitude problem to overcome because of our recent history, but with the confidence that we have the intelligence and dedication to change these attitudes.

Depending on how well we meet this challenge, it may be that our industry's worst economic problems are in the immediate past, and that we are truly on our way to fulfilling the great responsibility we have in providing food and fiber to an ever increasing population on this planet.

What Is New In Nitrogen

Garvin C. Matthieson

Editors Note: Sorry. This discussion is not available for inclusion in these proceedings.

Mr. Matthieson gave his discussion from notes. Other miscellaneous announcements were also made from the rostrum. Instructions were given the recorder at Memphis to carefully record this information and to transcribe promptly for mailing to us for final checking.

When we contacted the Recorder, asking for the final typed information he advised the work had not been started. We could wait no longer. We told him to cancel. Date March 1, 1972.

What Is New In Phosphate Production and Marketing

W. E. Jones

The newest thing in phosphate production and marketing is profit. The Fertilizer Institute has reported that in 1970, Integrated Fertilizer Producers, which includes the majority of the companies operating in the American phosphate industry, had a net income before taxes equal to .8 of 1% of sales. We will probably do a little better than that for 1971. When you compare this to 1969's record of an average loss of 4.3%, you can see why optimistic articles have begun appearing in the trade press. In fact, it has even been reported that I have occasionally been seen around the office with a smile on my face.

However, in spite of that literally fantastic improvement, I don't really understand, the optimism which I have seen expressed in the trade press in the last few months. The improvement in the industry's supply/demand position is only secondarily due to the growth of the fertilizer market. Among the primary reasons for improvement in the marketing and financial picture was the shut-down of a number of plants throughout the country and slightly more rational pricing practices on the part of the industry.

If we look at wet process acid capacity alone in the United States, we started 1970 with four fewer companies and four fewer plants than were in existance here five years earlier. Without taking into account the plants that were operating at reduced rates – and most of them were – 1/8 of the nation's total capacity was idle. That has to help the supply/demand ration, and thus profitability, unless of course it was your plant that was idle.

Again, according to the Fertilizer Institute, Integrated Producers had an average capital investment of $74,300 for each employee on their payroll. I am sure that figure is pulled down by the relatively much lower capital investment required for the producers' retail outlets. Current estimates for modern phosphoric acid plants show a capital requirement of nearly $20 million for a 1,000 ton-per-day plant. With that kind of capital requirement, I doubt if we will ever see a phosphate business produce better than a 5 to 6% return on investment. In case you are not aware of it, U.S. savings bonds are now paying 5½%.

The high capital required makes the industry vulnerable to another temptation. That is the temptation to keep the capital invested working at full capacity through incremental pricing of our products. Unfortunately for the concept of incremental pricing, the last price soon becomes the market price. As we have seen in the last two or three years, incremental pricing can kill us regardless of the demand for fertilizers.

Regardless of what all of us in the industry may say today, having just stepped out of the bath, the temptation of incremental pricing is always there. Sooner or later members of the industry will probably yield again.

Now let us look at just what our markets are.

First, within this decade, a market for American phosphate producers will be essentially domestic. The United States' share of the world export trade declined from 34% to 26% in just 3 years. This decline is just beginning.

Our export market in upgraded phosphate products has already almost completely disappeared. Mexico is exporting to Canada and has offered up-graded phosphates for sale in the United States. Nearly 3/4 of a million tons of new merchant phosphoric acid capacity came on stream outside the United States in 1970 and 1971. There are a couple of major reasons for these developments.

First is the declining importance of the United States' foreign aid program. From a high of over $200,000,000 just a few years ago, AID today is spending a negligible amount to send American fertilizers to the nations on our hand-out list. Thus these nations are now spending their own money according to their own priorities.

Fertilizer development overseas is not a matter of economic justification of capital investment as it is in the United States. It is, rater, a matter of government supported development to provide local employment as a basis for other economic development, and through exports to secure foreign trade, thus acquiring foreign exchange and a balance in the producers' own foreign trade.

Some of these same forces also apply to the phosphate rock industry. I know you have probably heard about Morocco and the Spanish Sahara until you are sick of them. If you reply on the export market, you are going to get sicker. Forget it.

Spanish Sahara has a low over-burden ratio and a high-grade matrix. With a minimum amount of washing and no flotation, they can put 75 to 80% PPL rock into ships. It has been a long time coming, but next year the Spanish Sahara will produce 1-1/2 million tons of rock. It will be up to 10 million tons a year by 1975 or 1976.

Sahara and Morocco have another great advantage. They don't have to put up with the limitations of the Port of Tampa. In spite of strong economic justification, the United States Government is dragging its feet in a project to deepen Tampa from 34 to 40 feet. In the meantime, every other major phosphate port in the world is either already at 40 feet or dredging is now underway to achieve that depth. Thus, today's ships which cannot take on a full load of American phosphate rock because of harbor depth can be fully loaded in competitive ports outside the United States. The difference of 7 or 8 thousand tons in a ship's cargo has an obvious effect on shipping costs.

Long term commitments ease the impact of these developments and cost factors upon American producers. However, there is a very good chance that by the end of the decade, American firms in the foreign phosphate markets will be supplying those markets from foreign production, not from United States' production.

Now let's turn to the domestic market. At its present growth rate of 3 to 4% a year, we should achieve a reasonable level of production in relationship to capacity within the next 4 to 5 years. We cannot realistically look at any substantial change in this rate of growth for a number of reasons.

In the corn states, more and more farmers are approaching optimum levels of fertilizer use. This year's fantastic corn crop with the resultant badly depressed prices will lead to the diversion of more corn acres to other crops, primarily soybeans, mext year and possible for the next few years. In addition, a number of the countries who have bought grain from the United States in the past have themselves become grain exporters, thus reducing the American farmers' market overseas. Such nations as Korea are not only no longer buying grain from the United States – they are actually selling grain to other nations in competition with the United States.

Increasing attention is being paid to the benefits of fertilizing soybeans, pastures and forests. Promotion of such uses can mean additional sales for the industry but an acre of soybeans will never use as much phosphate as the same acre planted to corn.

The conversion of arable fertile land to urbanization and suburbanization may be beneficial to the extent that they require the cultivation of less fertile lands to meet food and fiber needs.

In spite of these problems, the United States' market is still the largest fertilizer market in the world. In spite of the great strides being made in agriculture in other nations and in spite of the slow down in the relative rate of growth of the American fertilizer market, such growth will continue. The United States will be the major market for many years to come. It is logical to suppose we may find some foreign competition here at home. Although our major shipping port cannot send out ships loaded to 38 feet, the major port serving our major fertilizer market, that is, New Orleans, can accept ships which have been loaded to 38 feet in foreign ports. The fact that all major phosphate-importing nations, including the United States, have ports which accept modern day ships loaded to capacity, while only the United States has a major phosphate shipping port which cannot load to such capacity could lead to some interesting marketing situations over the years here at home.

Social and economic pressures on strip mining have already had their impact upon the phosphate industry. There is much more to come.

Compulsory land reclamation has hovered over our heads for many years. Now in Polk County, Florida, it is a reality with the county's new zoning ordinance. It will soon become a reality for every open pit phosphate producer in the United States. When one of the myriad reclamation bills now in the Congress or being considered by individual Congressmen becomes law – and I assure you that one of them will become law within the not too distant future – you will all be in the same position.

Strip mining, surface mining has become socially unacceptable. Efforts have been made in several mining states to completely outlaw surface mining. I don't think it will really happen. But the fact that such proposals gain substantial support should tell the wise man in the industry that he is going to be burdened down with restrictive legislation covering reclamation, waste disposal, and water use and conservation.

I hope that you know me and American Cyanamid Company well enough to know that we are not opposing such legislation. We are proud of our own record in these areas. We claim legitimately to be pioneers in land reclamation, solid waste disposal and water conservation. We feel such things are essential to the continued well-being of our country. Cyanamid and some other companies in the industry have made substantial strides on a voluntary basis. Other companies, for varying reasons, have not done as well. In today's political climate, everyone in the industry will soon be required by law to do at least as well, if not better.

In addition to these social pressures, growing urbanization of phosphate producing areas, particularly in Florida, imposes strong social pressures against surface mining and indeed against industrial operation. These pressures may today be greater in Florida than some other areas. Most of the people who are moving to Florida to live or are visiting there are looking for a tropical idyll. They want to find the Tin Pan Alley concept of the tropics within the borders of the United States. Surface mining and heavy industry have no place in this idyll.

At the same time, such urbanization pushes up land values to the point where surface mining simply does not make sense economically.

The early Sixties saw the boom toward bulk blending plants, many owned by basic producers. Basic producers such as Cyanamid integrated forward to the retail level. Retailers such as the co-ops integrated back to acquire more basic positions. In the past two or three years, we have seen some reversal of this trend. This reversal ranges from the complete withdrawal from the business such as that by Monsanto and the selling of Armour's agricultural business to other forms -- Mobil closed its Harding Plant and more recently disposed of its own fertilizer distribution center, but remains a major factor in rock production. Freeport Sulphur and Armour (now U.S.S. Agri-Chemical) went into a joint venture which gave Freeport a basic position in phosphate rock to supply its Uncle Sam Plant. More recently, Cyanamid and Kerr-McGee Corporation formed a partnership, Brewster Phosphates. Brewster Phosphates gives Kerr-McGee a basic position in phosphate production. Through the combining of reserves, it gives both partners access to the economies resulting from a high level of production in a capital intensive business. The partnership arrangement for the production of phosphoric acid and diammonium phosphate gives both partners access to modern production facilities at minimum capital cost, which not affecting either partner's retail operation.

All these arrangements – Brewster Phosphates and the others – reflect an effort to minimize capital investments in an industry where the economic size of production facilities have grown to the point that an individual marketing organization is hard-put to adequately handle the total output.

There are no General Motors in the Fertilizer industry. The closest thing to a General Motors of phosphate might appear to be the Co-ops. CF Chemicals and Farmland Industries have continued a steady expansion of phosphoric acid production facilities over the past few years when shareholder-owned corporations are "pulling in their horns". However, it should be kept in mind that these are organizations of Co-ops; i.e., they are composed of organizations of marketers who have combined to secure production facilities, which they do not wish to or cannot support as individual marketing organizations. Looked at in that light, the organization of Brewster Phosphates by Cyanamid and Kerr-McGee in not much different from what the Co-ops have done.

It appears that there will be very few important changes in products during the Seventies. The same fertilizer materials that we have today will continue supplying the lion's share of American plant foods over the next ten years or so.

The very compelling trend toward bulk distribution is still gaining ground for one reason – savings of labor and freight. Thousands of bulk blend plants built during the last few years will continue to be the major outlet for fertilizer materials. Indeed, during the Seventies bulk mixed fertilizers will take over nearly all the market.

This is not to say there will not be some changes in locations of individual plants and in the companies in the field. Some companies will continue to sell out their distribution systems as they decide to divert their capital to more rewarding investments. There will continue to be some shutdowns of individual plants which have been found to be unprofitable because of local market conditions, but most of these will probably be replaced by additional plants located in more favorable areas.

Cost per unit of plant food applied on the farmer's field will continue to be the dominant factor in product mix. Unless potential new phosphates show favorable economics against existing well accepted material, they are not likely to succeed in this highly competitive industry.

Potassium phosphates continue to receive attention. In limited areas they may offer certain agronomic advantages. However, until process development shows that the K phosphates can improve on existing PK combinations in supplying a unit of plant food, new production facilities are not likely to be built.

Looking some years ahead, urea ammonium phosphates may find a place in the plant nutrient mix. Perhaps the most interesting possibility will be a urea ammonium poly phosphate product adapted to both dry and liquid distribution. Favorable unit costs compared to our present approach with UA anhydrous and ortho phosphates will decide the future of urea ammonium phosphates.

Some of the best brains in the industry foresee the growth of mixed fluids reaching a plateau near the end of the 70's when they will represent about 20% of the total plant nutrient content of mixed goods. If the cost of ammonium polyphosphates can be reduced to a greater extent than now seems likely, the fluids would gain a boost from favorable economics which they do not now enjoy.

I am not sure that I have told you anything new about phosphate production and marketing. There are recurring cycles of interest in new approaches to fertilizer production. A few years ago furnace acid was all the rage. Then people gradually realized that except in limited areas with hydroelectric power the dream of furnace acid becoming competitive with wet process acid through miraculous reductions in power costs was not going to come about. Today, there arestates of interest about new technology. However, a commodity market in which capital can earn only 5 ot 6% and which is directly subject to the vagaries of the weather and the government is not going to attract investment for radically new products unless such products offer a substantial economic advantage over those existing today.

In the 1890's, when phosphate was first discovered in Florida, the phosphate industry became a glamour industry. In the 1930's when flotation came into widespread use, we had another spell of glamour. In the 1960's, we were setting out to feed the world and were developing high analysis phosphate products. We saw the greatest glamour of all. I honestly don't see any way that those glamour periods can return to the phosphate industry of the United States.

There is still a world to feed but the phosphate to feed it will not come from the United States. There is still the United States to feed, but there is a very real possibility that the phosphates to feed the United States may come from the outside world.

The key to success in the industry is in the hands of those who do the best job of rationalizing production, delivering bulk-blended products to the farmer at realistic prices while maintaining the most effective controls over their own cost – no glamour – just plain, hard work.

What Is New in Potassium

J. Fielding Reed

It is good that the title is not "What is New in Potassium *Problems*". So much of the news associated with all fertilizers in the past few years has revolved around the problems being encountered in the industry.

It is almost impossible to discuss what is new in any area of fertilizers without referring to some of the problems being encountered, since much of the news concerns activities that are the result of dealing with these problems. Still the long range view is good and most such problems are temporary.

Perhaps the industry devotes too much of its energy and attention to problems and too little to its responsibility in expanding the market.

PRODUCTION:

Production of potash materials continues to increase on a world-wide basis. U.S. production has not increased, but North American production has. In 1970 world production of marketable potash was the largest ever reported:

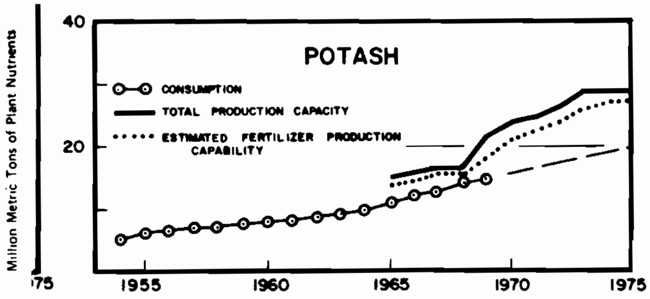
PRODUCTION OF POTASSIUM SALTS
(K20 equivalent, thousand short tons)

	1968	1969	1970
U.S.	2,722	2,804	2,729
Canada	---	3,509	3,514
World	17,869	18,810	20,443

World production exceeded world demand in 1970 and North American Production exceeded North American consumption. Data released by FAO indicate a 1969/70 world production of about 18,600,000 short tons K20 and a consumption for fertilizer purposes of 17,400,000 short tons. If the world industrial usage of about 800,000 short tons K20 is added to this consumption, these figures would indicate a reasonable balance between production and consumption on a world-wide basis.

However, it must be kept in mind that this balance was the result of the prorationing of production in the large Canadian potash production area. If these plants had not operated at less than 50% of capacity, there would have been a substantial excess of supply over demand.

TVA estimates that there will continue to be an excess of production capacity over demand for many years, as indicated on this graph:



Supply-Demand Relationship—World

Despite this information plans continue for expanding potash production. Cleveland Potash in Great Britain is expected to be in production within another year or so, with a substantial production capacity. The Congo mines are expected to increase production as the operations develop into full capacity. Shamrock Chemicals has received two Canadian Government loans to get their Port Stanley, Canada potassium sulphate plant in operation, with start up planned for late 1971.

Brazil is inviting investors to mine and refine potash deposits discovered in that country. Ethiopia continues to look for prospective developers of its potash deposits.

Expansion of potash production in the U.S.S.R. is reported to be continuing. Undoubtedly this increase in production will continue and many experts expect Russian production to substantially exceed domestic consumption. This will throw additional potash on the world market.

All of this adds up to prospects for a production capacity in the world that is much greater than recent consumption. When will consumption catch up with this production capacity? Will the gap between capacity and consumption widen or narrow in the immediate future?

CONSUMPTION:

The news in potash consumption is that the curve has not maintained its slope of the glorious mid 1960's. There are many reasons for this; among them:

(1) Economic conditions in U.S. and in world agriculture. Customers making less net profit will buy less. Too many big industries involved in the fertilizer business are indifferent to their customers' economic situation. Net farm income in the U.S. in 1971 is expected to be down about 3%. The impact of this cannot be ignored.

(2) Reduction of U.S. foreign aid funds for purchase of fertilizers in the developing countries. This is likely to dwindle even more.

(3) Over-estimation of the rate at which the demand would increase in developing nations. Yes, these countries need fertilizer – but they also need better roads, more schools, improved diets, and many more things. The question is the same as it has been for centuries. "Where will the money come from to pay for these?"

(4) Failure of the world fertilizer industry to properly support adequate market development programs. The industry expects fertilizer usage to just spring up. This just will not happen. Markets will have to be created and maintained by agressive and sustained market development programs.

Let's look at the consumption picture in potash over the past five years. Note the world trend and U.S. trend. How many fertilizer companies are asking themselves the reason for this change?

PER CENT INCREASE IN CONSUMPTION POTASH

	1966	1967	1968	1969	1970
World	10.5	7.4	7.3	6.0	5.9
U.S.	13.6	13.1	4.1	2.6	2.9

TRANSPORTATION:

Most of the potash production is a long way from the consumption areas. This has always posed a transportation problem. In recent years this has been accentuated as the total tonnage of potash to be moved has increased, and as the railroads have run into more and more financial problems.

Efforts have been made to spread consumption over the year. Agronomically there is every reason to encourage this. Potash can be applied just as effectively in fall or winter as in the spring.

About seven years ago the Potash Institute launched a campaign for "year-round fertilization". Research proved the feasibility of year round fertilization and so the support of official college and experiment station scientists was enlisted. Better farmers were ready for this – as a time and money saving practice. The toughest and last group to convince was the industry itself.

Such a program involved not just off season application of K, but also of N and P. The practice was just beginning to move when it ran into the snag of environmental objections. These objections concerned chiefy N, and to a lesser extent P applications. Even though K was not involved, the whole theme of fall-winter applications was set back.

There still is every reason why K could be applied in off season times. Potashing could become a practice just like liming. It will take perseverance and promotion to put this practice acress with the industry and the farmer. But it is sound agronomically, is time and money saving, and is a logical solution to the ever present transportation problem.

The railroads have been concerned about the seasonal transportation problems, car shortages, etc. We will see greater effort to solve this problem. Many practices are being explored such as rate incentives, off premise storage, etc. As Ed Wheeler so aptly put it, "There ought to be a requirement that a discussion on transportation be mandatory at every fertilizer conference – our payments to the railroads alone this past year have reached nearly a half billion dollars."

POLLUTION:

The fertilizer industry, along with many other industries, will have to wrestle with the problems of pollution. This concerns potash only indirectly. Potash is not a pollutant at all and has been cited as a non-pollutant by all experts. However, if rates of N and P are decreased as a result of the pollution scare, this is bound to affect K consumption. And year round application of all nutrients will be affected if the concept that off-season application contributes to pollution is spread around.

Actually the contribution of chemical fertilizers to pollution is extremely small and practically non existent. But the industry must take a positive approach on this and will have to devote energy and funds to research to prove this and education to tell it.

PRODUCTION REGULATION:

The big question in the potash industry is, "How long will regulation of production be continued by the Saskatchewan government?" "What's New in Potassium" will be vitally affected by decisions in Canada. These decisions rest with the government in power rather than with the industry.

When the Saskatchewan government imposed prorationing and at the same time price floors on Canadian potash, the effect was almost immediate upon the world-wide potash industry. The impact on the Carlsbad, U.S. industry was tremendous. European producers also were strongly affected.

In Canada limitation of production has its advocates and its opponents. As a temporary measure (2 or 3 years) few questioned its benefits. But now the question is how long must Canadian production be throttled down to 50% or less of production capacity while the rest of the world operates at almost full capacity.

TVA market analyses (as shown earlier) predict that production capability will exceed consumption for many more years. Other market analysists disagree, but none suggest that the gap between production capacity and consumption will close before 1975. How long then will Canada hold this umbrella over the world industry?

While there are differences in market predictions, one might well ask why any new ventures in potash production would be seriously considered. H. S. Ten Eyck stated at the TVA marketing conference, "There is far too much potash in the world and it doesn't look as though there is going to be any material change in this for several years."

NEW MATERIALS:

The development of new processes, new products, new properties, etc. has always been slow in the potash world. Perhaps this is because the salt that accounts for most of the market, potassium chloride, has been so satisfactory over the years.

However, in recent years, there has been greater recognition of the need for non-chloride sources in special soil areas and for special crops. As a result, interest has increased in potassium sulfate, potassium magnesium sulfate, and potassium nitrate. These products are produced today in excellent physical condition and are available to supply this market adequately. The products are beautiful, are high grade, and meet about any required specifications.

There is every reason to believe the demand for these products will increase because:

(1) Needs for sulfur are more widely recognized and are being better defined.
(2) Newer phosphorus sources do not supply sulfur to mixed fertilizers as did the old superphosphates.
(3) Sulfur in the atmosphere will be reduced as anti-pollution measures are required.
(4) Magnesium deficiencies are becoming more general and soil and plant analyses reveal these deficiencies.
(5) Sources of nitrate nitrogen are limited and there are proven advantages of a nitrate source as a partial source of N for many crop and soil conditions.
(6) With heavier applications of fertilizer on horticultural crops and non-farm use, a low salt index compound such as potassium nitrate finds a place.

Potassium phosphates have been considered for many years for fertilizer purposes. Field trials have proven their value. However, expense of production has prevented their use. Duval has announced its plans to produce potassium phosphate for agricultural use. This is not yet on the market but its appearance will be followed closely in the potassium field.

Interest has developed in potassium azide because it delays the conversion of ammonia into nitrate (which normally is converted into nitrate that may run off field into ground water and streams). By delaying the availability of the nitrate potassium azide is responsible for more N retention in the root zone. The azide itself has a short soil life and breaks down into potassium and nitrogen. In addition the chemical is a broad-spectrum herbicide.

PARTICLE SIZE:

Over the past decade demands for various particle sizes have resulted in production of potassium in grades of "standard", "coarse", and "granular". During the fertilizer year 1970-71, the breakdown showed that muriate deliveries were divided as follows:

	K20 – 1000 tons	
Standard	2,450	– 42%
Coarse	1,927	– 34%
Granular	970	– 17%
Soluble	405	– 7%

The grade situation has sort of grown randomly with little real systematic approach to exact requirements, and what we have is a somewhat confused picture. The grade "coarse" was offered in the mid 1950's as an assist to granulation but today most of the "coarse" is being used for blending or for direct application. The potash industry is exploring the question "what grades of muriate does the industry want and what exact specifications are desirable?"

THE FUTURE:

The long range outlook for potash continues to be good. It is evident however that the industry faces short term problems. Careful planning is to be expected.

Realistic market analysis is also essential – both in the domestic and in the foreign markets. The record of the entire fertilizer industry has been unenviable in the area of market analysis, especially in overseas estimates.

Aggressive, sustained market development programs are an absolute necessity not only in the potash field but in the fertilizer area as a whole. Assumptions that the fertilizer market will just spring up are unwarranted.

What Is New In Secondary and Micronutrients

1 — Engineering Aspects

Hubert L. Balay

The need for micro and secondary nutrients in the United States is growing rapidly for several reasons. Farming is becoming more intensive, and crops such as continuous corn or cotton sometimes exhaust the existing supplies of available micro and secondary nutrients. The trend to high-analysis N-P-K fertilizers is also eliminating many secondary and micronutrients which used to be carried along as accessory compounds in old low-analysis fertilizers. Too, because of the low price of phosphoric acid and triple superphosphate, granulators have switched even low-analysis grades from normal superphosphate and sulfuric acid to phosphoric acid and triple superphosphate.

Micronutrients are applied in many ways. Iron is frequently applied as a foliar spray to correct iron chlorosis. Molybdenum is required in such small quantities that it is usually dusted on the seed. Most micronutrients, however, are applied along with the primary nutrients. Mixing with primary nutrients is probably the best way to apply micronutrients, but they must be mixed well and applied uniformly.

Secondary and micronutrients can be incorporated with primary nutrients in several ways. Frequently they are incorporated with granular fertilizers. Sulfur is sometimes sprayed onto the rolling bed of fertilizer in the granulator.(1) (2) Micronutrients may be fed as slurry along with the liquids in the formulation, but most are fed as finely divided powders directly to the granulator along with the solids. Small amounts of micronutrients must be metered or weighed into the fertilizer accurately. Micronutrients are expensive, and excessive additions are uneconomical. Also, if too little is added, the expected agronomic response may not be realized. High application rates of some boron or copper micronutrient sources may be toxic to crops.

Micronutrients usually have no effect on granulation. However, they sometimes become ineffective when they react with the other ingredients. Conversely, reaction with other fertilizer ingredients occasionally makes insoluble micronutrients soluable. For example, zinc oxide can become water soluable when added to concentrated superphosphate or ammonium polyphosphate.(3) Zinc. sulfate can become water insoluble when added to diammonium phosphate formulations, but it remains soluble in monoammonium phosphate. Some of the synthetic chelates which are good carriers of iron and zinc can become ineffective if added to superphosphate formulations of fairly low pH.(4) This has been overcome in tests by adding the chelate to the ammoniating fluid; the high pH while the chelate is being added to the granules results in production of a stable, effective micronutrient source.

Incorporating micronutrients in granular fertilizer is usually not economical unless a large volume containing a single micronutrient or a mixture of micronutrients is required. To overcome poor economic of small lots and many grades, some operators have tried to add powdered micronutrients as the fertilizer is loaded out or bagged. Usually only a small amount of micronutrient, sometimes as low as 2 or 3 pounds per ton is required. The micronutrient must be finely divided to be uniformly mixed. Mixing a finely divided powder with granular fertilizer often results in segregation of components or an off-grade product.

Adding granules of micronutrients of the same size as the fertilizer granules usually solves the segregation problem. But when the fertilizer is applied, the micronutrient may be concentrated in the small areas where the micronutrient granules fall.

Another method is to blend a granular fertilizer which does not contain micronutrients with one that does. This is an effective way for bulk blenders and granulators to add micronutrients if a fairly large amount of the material containing the micronutrient is required. Many companies produce granular fertilizers containing secondary or micronutrients to be blended with other granular materials. Granular normal superphosphate and ammonium sulfate are examples of products often blended with other ingredients to supply sulfur.

TVA has experimented with binders to attach powdered micronutrients directly to the peller. Fuel oil, used motor oil, kerosene, water, and other fluid binders have been used effectively. Some fertilizers can be coated with some micronutrients without a binder although a binder is necessary in most cases to attach finely divided (−100-mesh) micronutrient to the pellets. As shown in Figure 1, the usual procedure is to mix the granular fertilizer and powdered micronutrient material for a minute, then add oil or another binder and mix for about one minute.(4) TVA has experimented with several kinds of mixers and has found that rotary drums and ribbon mixers are best for this technique. Tests show most micronutrients are firmly attached to the pellets by the binder and usually no segregation is encountered during transportation and application.

As an example 6.2 percent manganese oxide (−100-mesh) was mixed with a granular blend. A portion of this mixture was treated with an oil binder; the balance was used as a control. The products were bagged and four samples were checked for percent Mn. Figure 2 clearly shows the effectiveness of the binder.(5) Of the petroleum oil binders, fuel oil and kerosene sometimes penetrate and weaken bags. Heavier oils, like used automotive engine oil, do not penetrate single layer plastic bags nor paper bags with an inner layer of plastic. Oil should not be used with ammonium nitrate or mixtures containing large amounts of ammonium nitrate because the oil will sensitize the ammonium, forming an explosive mixture.

Water is an effective binder but in some cases a slight increase of water on the surface of the pellets causes caking. Fertilizer mixtures with water as the binder sometimes require anticaking agents. Chelate solutions are sometimes sprayed onto solid fertilizers. Care should be taken to avoid a batch too wet to apply.

Proper use of binders results in uniform mixtures of granular fertilizers and micronutrients. This has been demonstrated in a TVA field program.

Probably the most uniform way to apply micronutrients is to dissolve the materials in a liquid fertilizer solution. A drawback is the limited solubility of most micronutrients in liquid fertilizers. Boron as sodium borate or molybdenum as sodium molybdate are sufficiently soluble in both ortho- and polyphosphate solutions for quick dissolution. However, zinc, iron, copper, and manganese react with orthophosphate solutions to form metal ammonium phosphates that precipitate out of solution. Most of the materials are more soluble in polyphosphate than in orthophosphate solutions – probably because of the sequestering effect of the polyphosphate. Much more zinc (as zinc oxide) can be dissolved in ammonium polyphosphate solution (11-37-0) than in ammonium orthophosphate solution (8-24-0).

Solubilities of micronutrient materials should be determined from the literature before a batch is mixed. Commercially available organic chelating compounds do a good job of dissolving micronutrients and making them available to plants. They are widely reported by agronomists to be up to five times as effective as inorganic sequestrants. Their higher level of effectiveness may, in some situations, offset the generally higher cost of the organic materials.

Micronutrients may not be sufficiently soluble in a liquid fertilizer to correct a deficiency, particularly where more than one micronutrient is required and where application rates are low. Suspension fertilizers offer a way around this problem, as relatively large proportions of micronutrient materials may be suspended in most of these fluids. Frequently the micronutrient can be incorporated merely by adding the appropriate amount to the suspnesion mixture while it is being made. Necessary requirements are that the micronutrient particles be fine enough to suspend properly and that no adverse chemical reactions occur between the materials.

Secondary or micronutrient materials may be suspended individually. A successful 0-0-0-40S suspension was made from flowers of sulfur, water, and 2 percent clay. It was dually applied with anhydrous ammonia.

Large amounts of micronutrients are being added to mixed fertilizers. It is expected that micronutrient deficiencies will become more common in the future and that the techniques described above will be widely used.

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What Is New In Secondary And Micronutrients

2 — Agronomic Aspects

John J. Mortuedt

I. Introduction

The secondary nutrients in plant nutrition are calcium, magnesium, and sulphur. Deficiencies of the latter two nutrients are probably more widespread now than in the past. The micronutrients required in plant nutrition are boron, copper, iron, manganese, molybdenum, and zinc. These elements are required in relatively small amounts for optimum plant growth. Deficiencies of these nutrients are also becoming more numerous as a result of more intensive cropping, leveling of land for irrigation, and cultivation of new lands. The use of higher analysis fertilizers has reduced the amounts of secondary and micronutrients added as impurities. In addition, better means of detection of the micronutrients in plant tissues and soils are now available, so that more research is being conducted on micronutrients now than was done a decade ago.

II. Application alone or with macronutrient fertilizers.

Application of secondary or micromutrients alone to soils results in increased costs over application together with primary nutrients. The most serious disadvantage of applying micronutrients alone may be the difficulty in obtaining uniform distribution of the small amounts generally applied. Therefore, most of the micronutrients are applied with mixed fertilizers. Except for iron, applications of secondary and micronutrients are usually made directly to the soil.

As stated in the companion paper, the plant availability of some nutrient sources may be changed when they are incorporated with mixed fertilizers. Chemical reactions which occur during these production processes may increase or decrease the solubility of the micronutrient source and its plant availability. Therefore, care should be taken to select the combinations of micronutrient source and macronutrient fertilizer which will be economical, practical, and effective for crops.

A. Application of secondary nutrients.

The amounts of magnesium and sulphur required by most plants are almost equal to that of phosphorus, as shown in Table 1. Their importance in plant nutrition has prompted some people to suggest that calcium magnesium and sulphur be called primary nutrients along with nitrogen, phosphorus, and potassium. Calcium will not be discussed in this paper, since this nutrient is adequate in neutral and calcareous soils or in adequately limed acid soils.

1. Magnesium

Magnesium deficiencies occur on acid sandy soils, and on other soils with low levels of exchangeable magnesium or high levels of exchangeable potassium. The most common source is magnesium sulphate, although a double salt of magnesium and potassium sulphate is also used. The latter is an effective source of potassium, magnesium, and sulphur. Another fertilizer magnesium source is magnesium oxide. The application rate usually ranges from 10 to 40

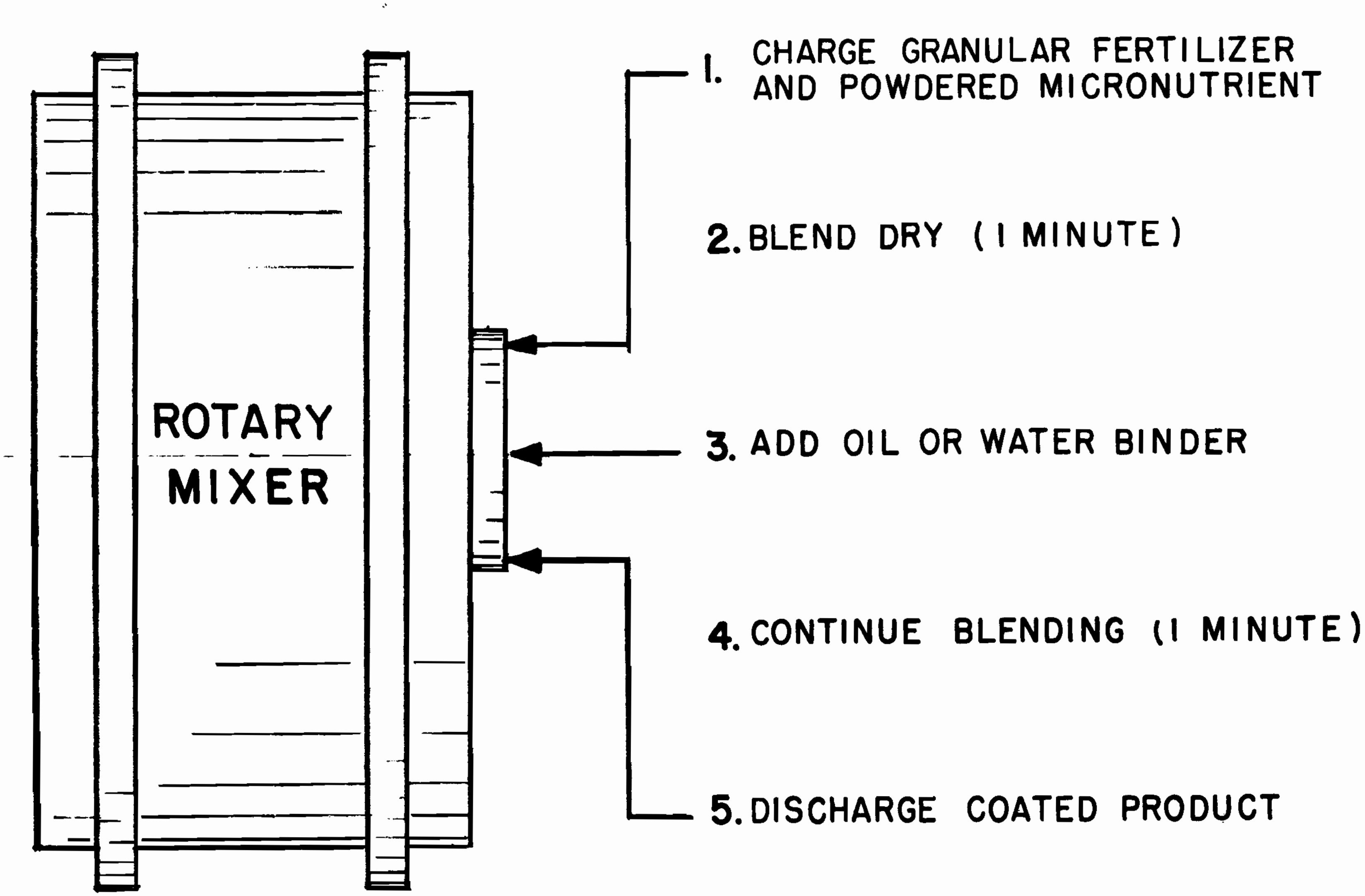
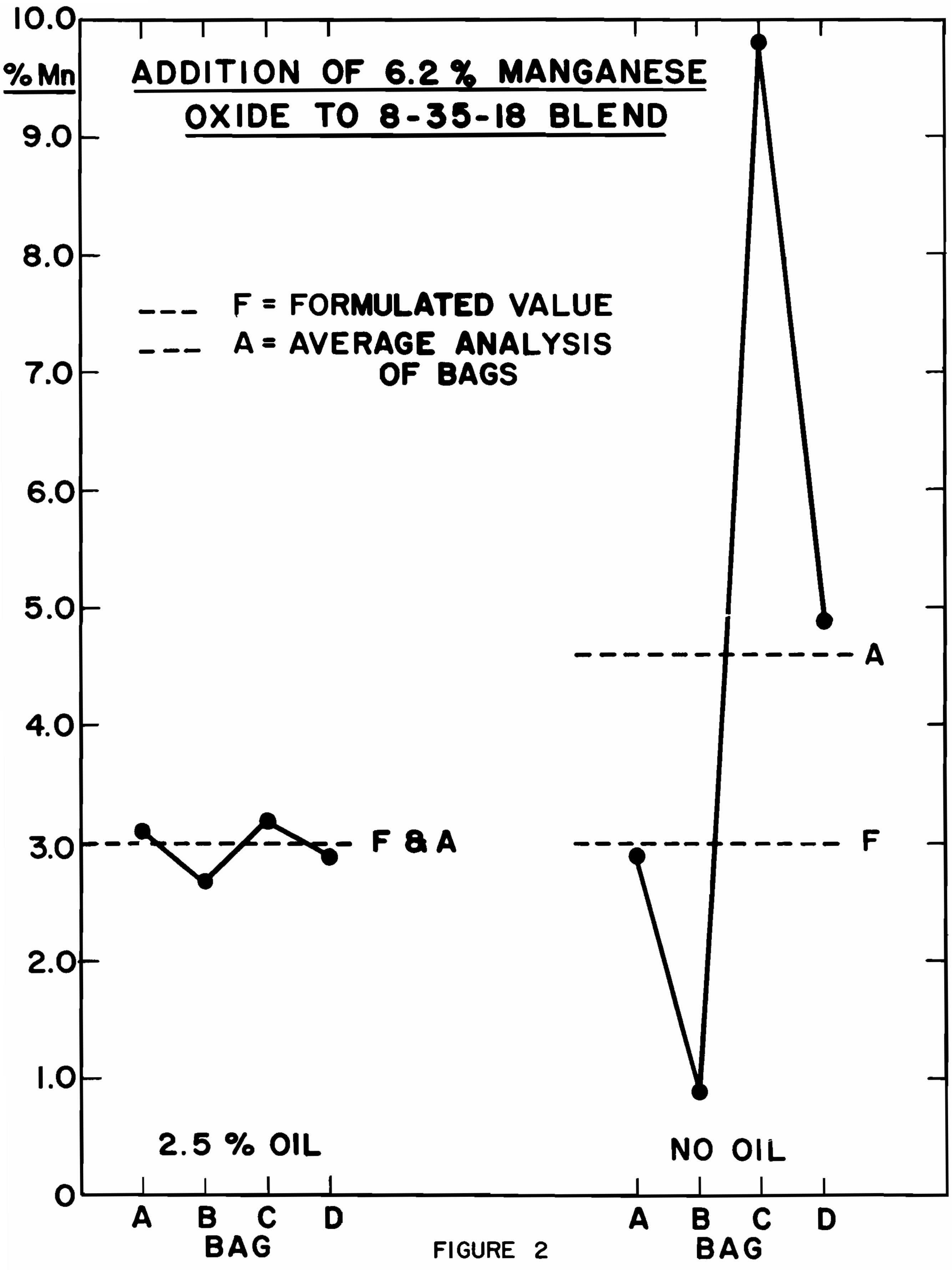


FIGURE 1

BATCHING PROCEDURE FOR ADDING MICRONUTRIENTS TO GRANULAR FERTILIZER



ADDITION OF 6.2 % MANGANESE OXIDE TO 8-35-18 BLEND
% Mn
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
--- F = FORMULATED VALUE
--- A = AVERAGE ANALYSIS OF BAGS
F & A
A
F
2.5 % OIL
NO OIL
A
B
C
D
BAG
A
B
C
D
BAG

FIGURE 2

pounds of magnesium per acre. Dolomitic limestone is recommended for liming acid soils that may be low in available magnesium.

2. Sulphur

Deficiencies of sulphur are found mainly in the Southeast, and the Northwest, but crop responses to sulphur fertilization have been reported in 29 states. These soils are usually low in organic matter, sandy and well drained. Appreciable residual effects from some sulphur sources have been noted.

The common sulphur sources are ammonium sulphate, ammonium nitrate sulphate, ammonium thiosulphate, potassium sulphate, potassium-magnesium sulphate, ordinary superphosphate (containing about 20% sulphur as gypsum) and elemental sulphur. The sulphate sources (except gypsum) are watersoluble and are immediately available to plants. In contrast, elemental sulphur must be oxidized to the sulphate in the soil before it becomes available. The oxidation rate is usually directly related to the fineness of the sulphur and its distribution in the soil.

Other sulphur-containing products which are relatively recent or are now being developed are concentrated superphosphate-sulphur, ammonium phosphate-sulphur, sulphur-coated urea, urea-ammonium-sulphate, and high-analysis granular sulphur assemblages. Ammonium polysulphide, amminium bisulphate solution, ammonia-sulphur solution and sulphur slurries are also available. Some of these products are commercially available at this time. They are fully described in the chapter by Beaton and Fox (1) and in Technical Bulletin by Bixby and Beaton (2). Production, marketing and use of sulphur materials were recently discussed in a symposium cosponsored by TVA and The Sulphur Institute; the proceedings are available from The Sulphur Institute(4).

Some of the primary nutrient sources also contain sulphur. These sources, such as amonium sulphate, normal superphosphate and potassium sulphate, are priced mainly on their primary nutrient content, with little or no credit given for their content of sulphur. Where applied sulphur is needed for optimum crop production, these materials should also be credited for their sulphur values. This would place such materials in a better competitive position with those fertilizers not containing sulphur.

B. Application of micronutrients.

Some of the agronomic problems encountered when micronutrients are applied alone or with macronutrient fertilizers are as follows:

1. Boron

Most boron deficiencies occur on sandy soils, especially during dry weather. It is essential that the proper amount of boron be uniformly applied to soils because the range between deficiency and toxicity is narrow. Incorporation of borax with various fertilizers does not reduce the agronomic effectiveness of this common boron source(5) Apparently, borax does not react chemically with fertilizers to form unavailable reaction products. It is preferable to keep the boron concentration in the fertilizer rather low so that a given rate of boron is supplied by a relatively large number of fertilizer granules.

Borax is effective as a soil or foliar application. Application rates generally range from 0.25 to 3 pounds of boron per acre. Since crops like corn and soybeans are quite sensitive to boron, care must be taken in applying boronated fertilizers. Most states require that red caution tags be placed on bags of boronated fertilizer because of this toxicity to sensitive crops.

2. Copper

Copper deficiencies are generally confined to soils high in organic matter although a few mineral soils have also been reported as being deficient. Mobility of copper in soils is rather limited. Some plant species are very sensitive to copper, so care must be taken in application of this micronutrient. Soil applications of copper sulfate, basic copper sulfate and copper oxide are effective if broadcast alone or with fertilizers. Mixing these copper sources with macronutrient fertilizers apparently presents no agronomic problems, but toxic effects could result from band applications if these fertilizers contain appreciable copper concentrations.

Application rates are usually in the range 5 to 15 pounds of copper per acre. Appreciable residual response to applied copper has been obtained in some soils; therefore, it may not be necessary to reapply copper annually.

3. Iron

Iron deficiencies are often prevalent in calcareous soils, especially during cool, wet weather. Iron is usually applied to crops as a foliar spray, either as a solution of ferrous sulfate or as a chelate. In severely iron-deficient crops, more than one spray application is essential for complete recovery. Soil-applied ferrous sulfate is easily oxidized to unavailable forms in neutral to calcareous soils. Incorporation of iron with granular phosphate fertilizers is not a recommended method of application. Soil application of some iron chelates is effective but the cost of these chelates is rather high, so use is restricted to horticultural crops.

Recent results from greenhouse tests have shown that fluid polyphosphate fertilizers containing ferrous sulfate and ferric sulfate are effective in supplying iron for grain sorghum(9). Ferric oxide was ineffective when applied alone or with the same fertilizers in these tests. The low amount of iron (about 0.8%) that can be dissolved in polyphosphate solutions may limit their usefulness as a carrier of iron sulfate. Suspension fertilizers may prove better because they can carry higher levels of iron. Results of several field tests show that polyphosphate suspensions containing ferrous sulfate are effective for corn and grain sorghum, but they must be banded close to the seed row. Technical problems in mixing and applying this fertilizer must be solved before its field use can be recommended.

4. Manganese

Deficiencies of manganese are more prevalent on alkaline soils, highly organic soils and acid, sandy soils which have been limed. In extremely acid soils the amount of manganese in soil solution may be high enough to be toxic to some crops. Applied divalent manganese is easily oxidized to unavailable forms in neutral to calcareous soils. Therefore, it is advisable to apply manganese with an acid-forming fertilizer such as superphosphate(14). Results of limited research have shown that the availability of manganese is not greatly affected by cincorporation with most fertilizers(12).

Manganese sulfate and manganous oxide are the usual sources and apparently are equally effective for plants, if the latter source is finely ground and mixed with the soil. Manganese chelate is not very effective because it is rather unstable in soils(3). Both manganese sulfate and manganese chelates are used for foliar applications. Soil application rates range from 5 to 40 pounds of manganese per acre.

5. Molybdenum

Unlike the other micronutrients, the availability of native soil molybdenum increases with soil pH. Therefore, sufficient soil molybdenum usually becomes available when acid soils are limed. This micronutrient is required in very small amounts by crops. The most prpractical application method is seed treatment. Amounts as low as 1/2 ounce of sodium molybdate per bushel of soybean seed have provided enough molybdenum to correct deficiency symptoms of this element. Foliar sprays of molybdenum salts are also quite effective.

There is no evidence that the availability of molybdenum to plants is affected by incorporating molybdenum sources with macronutrient fertilizers. The main problem is to insure homogeneity of the small amounts of molybdenum in the fertilizer. This is usually done by spraying molybdenum solutions on the fertilizer in the granulation process. Soil application rates are generally less than one pound of molybdenum per acre.

6. Zinc

The mobility of zinc in fine-textured soils is quite limited. It is therefore important that applied zinc be adequately distributed in soil. The availability of native soil zinc to plants is generally higher in acid soils, with zinc deficiencies being most prevalent in neutral to calcareous soils. Both soil and foliar applications of several zinc sources are effective for crops.

Incorporation of zinc with various nitrogen fertilizers is generally an acceptable method of application. The agronomic effectiveness of a particular nitrogen source as a sinc carrier is related to its effect on soil pH(15). For example, ammonium sulfate is superior to sodium nitrate as a sinc carrier because the former nitrogen source is acid-forming, as shown in Figure 1.

The type of phosphate fertilizer affects the availability of applied zinc to plants. Concentrated superphosphate and ammonium polyphosphate are effective carriers of both zinc oxide and zinc sulfate, while monoammonium phosphate is an effective carrier of zinc sulfate only(8). Thos phosphate fertilizers which give an alkaline reaction, such as diammonium phosphate, urea-ammonium phosphate, and ammoniated superphosphates are much less effective as carriers of both inorganic sinc salts, because unavailable reaction products are easily formed(6). Although immediate availability of zinc applied with the latter phosphate fertilizers is quite low, a residual effect may be expected. The magnitude of this residual effect has not been determined.

There is no apparent adverse chemical reaction when zinc sources are combined with potassium sources. Chelated zinc sources apparently are compatible with most fertilizers, but their cost is generally higher. Coating zinc sources on granules of various fertilizers is also an acceptable method, but there are problems in obtaining adherence to the fertilizer.

Application of zinc oxide with fluid fertilizers may be a more effective method than application with granular fertilizers. This is because of the better distribution of this water-insoluble zinc source in soil when applied with fluid fertilizers(7). However, the solubility of zinc in some liquid fertilizers might limit the zinc application rate at the normal nitrogen and phosphorus application rates. Use of suspensions instead of liquid fertilizers allows higher zinc rates relative to those of nitrogen and phosphorus.

Increasing the concentration of zinc in granular macronutrient fertilizers reduces the number of granules required to supply a given zinc application rate. Since zinc does not move very far from its application site in the soil, the volume of soil affected by applied zinc is inversely related to the zinc concentration in most fertilizers. Crop response also may be reduced when granular materials with high zinc concentrations are applied. Under most conditions, broadcast applications of zinc are more effective than band applications. The usual zinc application rates range from 3 to 10 pounds per acre.

III. Consumption of micronutrient fertilizers

Until recently it has been difficult to estimate the amount of micronutrients sold for fertilizer in the U.S. beacuse no data were available. In 1967 the Statistical Reporting Service of the USDA began to obtain data from the primary manufacturers of all micronutrients except boron. Since then, three annual summaries by geographic regions have been published along with the data for consumption of the primary nutrients. The results are summarized in Table 2 on an elemental basis, because the nutrient content of micronutrient sources varies widely. The actual tonnage of micronutrient sources therefor is much higher.

The consumption of copper as fertilizer decreased from fiscal year 1968 to 1970, while the consumption of iron, manganese, molybdenum, and zinc varied during this period. More zinc sources were sold than of any other micronutrient. This reflects the widespread reports of zinc deficiencies in this country, especially on corn. The second highest usage is of manganese materials; large acreages of soybeans are fertilized with this nutrient.

Since there are only two major producers of boron sources, this element is not now reported. It has been estimated that the amount of boron sold for fertilizer in fiscal year 1969 was about 2500 tons, as expressed on an elemental basis. The tonnage of micronutrient materials sold in fiscal year 1969 was about one percent of the tonnage of all mixed fertilizers sold during the same year in this country.

Since there are only three years' data on micronutrient consumption, it is difficult to determine trends, or reasons for yearly fluctuations. More accurate assessments of trends will be possible as more data is accumulated in the coming years.

IV. Recent publications on microbutrients

Recently a symposium, Micronutrients in Agriculture, was held at TVA. The proceedings of this symposium, cosponsored by TVA and the Soil Science Society of America, will be published by the latter cosponsor(10). The book covers the following topics: Chemistry of micronutrients in soils; Concepts of micronutrient uptake and function in plants; Diagnosis and correction of micronutrient deficiencies; Micronutrient fertilizer technology; and Trace elements in animal nutrition and the environment. The four chapters on Micronutrient fertilizer technology should be of special interest to those in the fertilizer industry.

Another new publication which includes discussions on the production, marketing and use of secondary and micronutrients is the second edition of Fertilizer Technology and Usage(11). This book is also published by the Soil Science Society of America.

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Table 1. Plant nutrient contents at a specified yield level of various crops*

	Yield,	Content, Pounds per acre				
Crop	per acre	Nitrogen	Phosphorus**	Potassium**	Magnesium	Sulphur
Corn	200 bu	320	46	205	66	44
Cotton	2.5 bales	125	33	75	16	23
Grasses	4 tons	120	18	100	15	16
Peanuts	3,000 lbs	220	20	100	28	25
Rice	6,500 lbs	135	22	135	15	18
Soybeans	50 bu	185	22	100	12	10
Wheat	80 bu	150	30	100	24	22

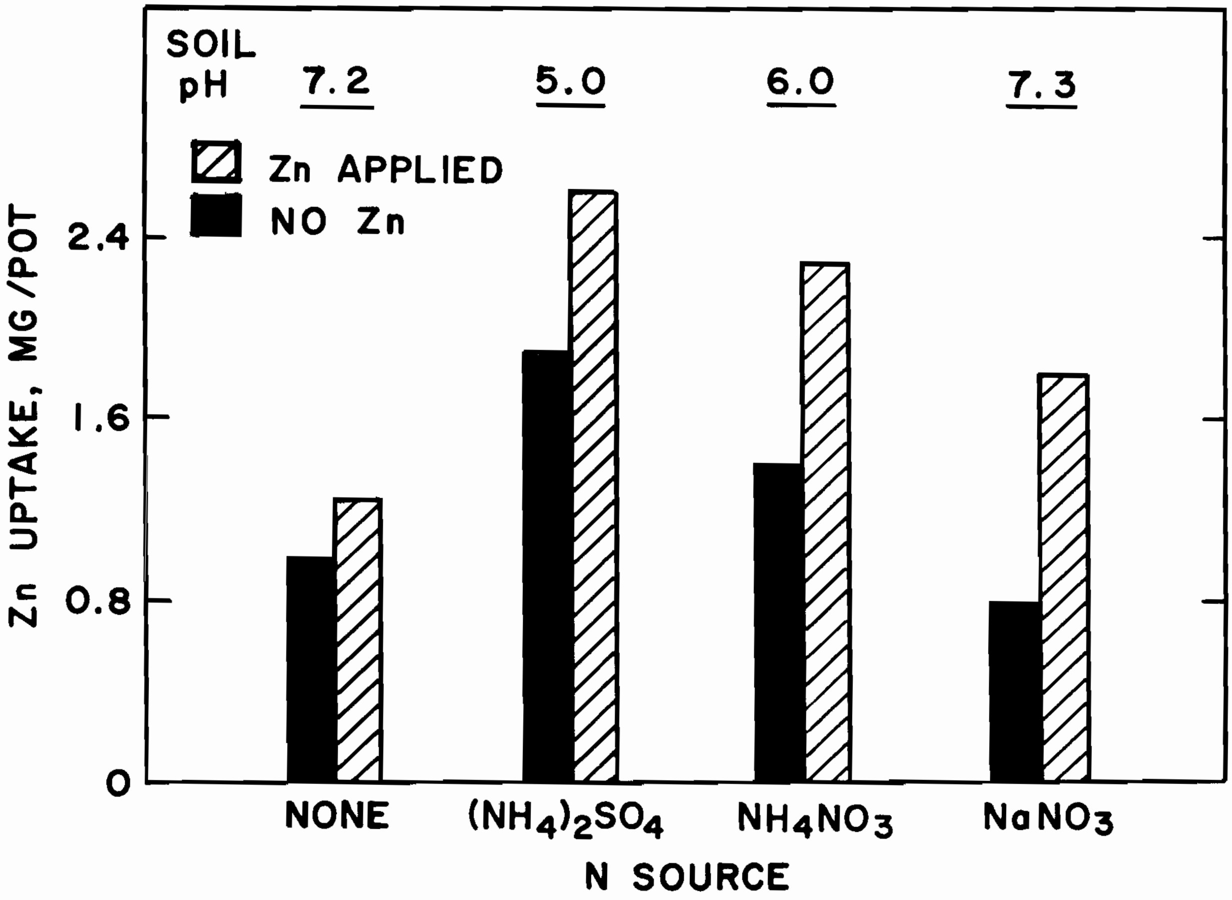
* Bixby and Beaton (1970)

** To convert P to P_2O_5 and K to K_2O, multiply by 2.3 and 1.2, respectively.

Table 2. Amounts of micronutrients sold for fertilizer in the United States*

	Tons (expressed on elemental basis)		
Micronutrient	1967-68	1968-69	1969-70
Copper	2,410.4	1,387.2	868.1
Iron	3,459.5	2,878.8	3,620.9
Manganese	11,582.4	9,593.4	13,505.1
Molybdenum	79.6	64.5	68.5
Zinc	14,495.0	20,197.7	18,271.3

* Statistical Reporting Service (1970, 1971).


SOIL
pH
7.2
5.0
6.0
7.3
Zn APPLIED
NO Zn
Zn UPTAKE, MG/POT
2.4
1.6
0.8
0
NONE
(NH4)2SO4
NH4NO3
NaNO3
N SOURCE

Wednesday, November 10, 1971

Afternoon Session
Moderators: Joe Whittington and Wayne King
Informal Round Table Discussions

You Are On The Program

Joe Whittington

From the close attention paid to all the speakers this morning it is evident that our 21st Annual Meeting has taken off with a bang.

The bulletin which announced our meeting stated "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 originated the Fertilizer Industry Round Table.

In sports, education, government, industry, and other fields, there is growing recognition of the need to swing back from impersonal spectatorship to participating personal involvement – back to the town-meeting type of small forums where all were encouraged to contribute their 2c worth.

Our industry's experience in recent years has demonstrated the vast difference between "sound good reasons and reasons that sound good." Where could one find a fitter place "to seperate the wheat from the chaff" than "Around Tables" with friendly, forehanded fertilizer folk from all over the world?

Numerous comments by those here are reminiscent of the argument whether Satisfied and Contented are synonymous. One said yes, the other insisted, "not al all," citing as an example, "I'm satisfied somebody is running around with my wife, but I'm not contented." Doesn't that sound like us? From the standpoint of liking our field of endeavor we're well satisfied, but with recent years' results we're far from contented. So let's kick our problems around the tables to come up with solutions to replace that futuristic "one-of-these-day's" resigned smile of unprosperous satisfaction, with an "up-and-at-'em NOW" smile of prosperous contentment.

According to Abe Martin, "When they say it aint't the money it's the principle, it's always the money." You were wrong in our case, Abe, for we've been pretty good on the principles, but downright poor on the money. In fact our keynote speaker cautioned us this morning to improve on our practices or there won't be enough money left to maintain our principles, nor our principals.

Now let's gather around a table, moving in turn to another table when the bell rings, so that all of us will get a broader and better background on our overall problems and potentials. At each table our speakers and other leaders will monitor the discussions, which will be summarized for publication in the annual Proceedings.

Machinery Table No. 1

Leaders: W. J. Sackett, Sr. and W. J. Sackett, Jr.

We were quite gratified by the high amount of interest and participation at this table. A synopsis of the discussion boiled down to four basic questions.

Question No. 1 . . .
What is the first thing that a manufacturer should do in analyzing the equipment that he will need for a bad granulation plant stack?
Question No. 2 . . .
Which is the better solution to cleaning up dryer and/or cooler stack? A wet scrubber or a bag filter house?
Question No. 3 . . .
What's new in the equipment line?
Question No. 4 . . .
What are the best methods to control in-plant dust?
A summary of the discussion and conslusions reached for these questions were as follows:
QUESTION NO. 1
What is the first thing that a manufacturer should do in analyzing the equipment that he will need for a bad granulation plant stack?
ANSWER NO. 1

First, before anything is done, remember that your granulation system may have been designed and installed in the 1950's or early 1960's when the only real consideration was production. At that time, dust and fume control were not of primary interest as they are today. Consequently, many systems were not designed for optimum efficiency, as they would be today. In our studies of many plants, which are of an early vintage, we find that the ducts, cyclones and fans are not properly designed for the size production equipment. One plant in the Norfolk area, for instance, we found with 42" exhaust ducts, when 27" or 28" was indicated. Naturally, this type of an installation causes excessive build-up and a bad stack.

In some cases, we found that by merely redesigning and installing new ducts, cyclones and fans, that we are able to meet the codes of certain municipalities, temporarily at least, without going the installation of a scrubber or bag house. Naturally, when we do the design work, we size the fan with adequate capacity for the future installation of a scrubber or bag house and leave adequate room for easy future installation of same.

Messrs. Clarence and Neil Reichard of the Robert A. Reichard Company in Allentown, Pennsylvania stated that we had done such a study for them and that it had improved their situation tremendously. They have the facilities for easy installation of a future scrubber when it becomes necessary.

QUESTION NO. 2

Which is the better solution to cleaning up dryer and/or cooler stack? A wet scrubber or a bag filer house?

ANSWER NO. 2

A scrubber of low pressure drop type is, of course, a less expensive original installation than the bag house. Effluent can be a major problem however.

The best solution for this is to reuse cooler air thru the combustion chamber for secondary dryer air and therefore, cut the amount of CFM required for drying and cooling roughly in half, thereby cutting the number of GPM required to do a scrubbing job in half.

Bag filters have been successfully operated on dryer and cooler stacks, but are expensive installations and care must be taken to see that they are properly maintained and that temperatures are carefully controlled at all times to prevent condensation and the resultant corrosion. These conditions must be controlled during shutdown periods, as well as when running. A combination of insulation, electric strip heaters and booster heaters are normally required to do this job.

We like the scrubber concept best because of ease of maintenance and lower cost originally for installation, but either will work satisfactorily.

QUESTION NO. 3

What's new in the equipment line?

ANSWER NO. 3

a. For one thing, a bulk Conditioner. This unit, powered by a 7-1/2 or 10 HP Drive, can eliminate the problems and expneses of a shipping tower. The Conditioner is a machine with a slow moving (approximately 70 RPM) rotor and a stainless steel perforated grate, which can be placed directly over the boot hopper of a shipping elevator. It does the job of a scalping screen and the pulverizer usually found in such a shipping unit, and therefore reduces the height needed for these operations. In other words, this machine eliminates the expense of a scalping screen, pulverizer, anywhere from twenty to forty feet of elevator and the structure needed to cover this equipment.

b. A Twin Rotor HI-EFFICIENCY Mill has been developed which does an outstanding job of cracking the oversize material from the double deck screens in a granulation unit. Efficiencies of up to 85% thru a 6 mesh on the first pass have been noted. The main contribution that this mill has made to a granulation plant, is that the ammoniator operator can now granulate properly without worrying about an excessive build-up in his screening circuit because of increased oversize. Mr. Dale Kieffer, of Smith-Douglass, who was at the table at the time, concurred that the mill did a good job.

c. An undertrack unloader has been designed which is completely dust and water tight and makes for a very simple installation. This unit (which we call the BULK-TOTER) merely bolts to the web of the railroad track and carries the material from hopper bottom or box cars, directly to a shuttle conveyor or bins, whichever is indicated. The advantages of this machine are that it is totally enclosed with absolutely no dust problems and takes the place of the old auger or undertrack belt with pit and elevator with pit, which are expensive maintenance items and usually very dusty installations.

QUESTION NO. 4

What are the best methods to control in-plant dust?

ANSWER NO. 4

First of all, we would advise that you purchase equipment that causes the least amount of dust problems. Totally enclosed types of conveyors are available, for instance, in lieu of belts, continuous elevators are available in lieu of centrifugal types, etc. In the case of an existing plant which has problems, we would advise a properly designed dust system to a bag filter house of either the shaker or reverse jet type. A bag filter for this type of installation will be considered cheaper than the filter house discussed earlier for a granulation system, because when handling ambient air, we can use an air to cloth ratio anywhere from 6:1 to 8:1, whereas the granulation unit requires 2:1 to 3:1. There are some very difficult dust control problems in plants, one of the toughest of which, is the discharge point of a shuttle conveyor to a bin, especially an empty bin. The only possible solutions that we envision at this time, are internal spouting to the floor of the bin, open on top only, to try to help some of the dust hazard and the enclosing of such a bin with an exhaust port to a header which would lead to a bag filter house. The latter suggestion is, of course, a very expensive one. Most of the in-plant dust problems can be controlled with a much less elaborate type of design.

Machinery Table No. 2

Leaders: Elmer J. Leister, E. B. Doelp, R. E. Robinson, Jr. J. N. Moore III, E. K. Thompson, Al Johnson, Gary Littrell

The purpose of the individual round table is to offer an opportunity to a smaller group to enter into an intimate discussion concerning their problems pertaining to Equipment and Production.

The presence of highly qualified Production Executives aided in the interchange of ideas. Small, medium and larger Companies participated. The total discussion period lasted 2 hours. There were 4 group changes.

It was noted that a number of people elected to remain at our table for more than one period. This was an indication to us of interest in the Group discussion.

Each discussion leader was given an opportunity to focus attention on Products and Processes which they felt to be of particular interest. This type of forum initiated good discussions. Atlanta Utility Co. and Edward Renneburg & Sons Company had been particular active in Air Quality Improvement and related Production Technology. Stedman Machinery Company offered comments on performance and testing of size reduction equipment.

Information was given illustrating broad principles effecting Granulation Efficiency, Emission Reduction and Effective Production Rates.

During the discussion and answer periods considerable interest was shown in the following typical problems.

1– Loss of raw material values through shrinkage.
2– Control of chemical analysis.
3– Specifications of particle sizes for maximum production efficiency.
4– Best procedure for making grade changes.
5– Results from the use of Phosphoric Acid and Superphosphoric Acid.
6– Best procedures for compliance and satisfying Air Quality Regulations.

Several Production People expressed concern over best means of controlling shrinkage. A Representative of a large Company stated that they operated with a goal of around 2% loss and were working on the shrinkage problem to cut this down if al all possible. Some of our group acknowledged loss values in the range of from 2% to 6% under extremely adverse conditions. The thorough discussions on shrinkage brought out some real factors for study to keep the problem down to a minimum. Causes: Incorrect formulation, failure to adjust formulas precisely for actual analysis on a dry basis and allowing for moisture content of the raw materials which must be evaporated. Also physical losses due to spillage, emissions, over formulation, incorrect railroad weights on incoming materials and overweight shipping in bags and bulk.

Questions were raised on accepted procedures for making grade changes without shutting down the equipment or losing too much time between each change. The group had various procedures, Viz: Partially runout the present grade, empty the system completely and runout the recycle with steam.

Various experiences were reported in connection with the use of Phosphoric Acid and Superphosphoric Acid. Results were somewhat inconclusive.

Machinery Table No. 3

Leaders: Joseph L. Prosser, John Shaughnessy
Frank Handwork, Albert Shirer, John Johnston

This table was quite well attended and enjoyed a large amount of participation.

The subject of discussion was the use of bag filters in fertilizer plants in general and as applied to the dryer, cooler and ammoniator in particular.

A general discussion included the basic design features of bag filters having to do with methods of cleaning. The general consensus was that shaking the bags provide a very positive method of cleaning (perhaps the best) but also comprised the greatest amount of stress thereby reducing the life of the bags. Reverse air techniques for cleaning were considered to be excellent if this method provided adequate cleaning force. The idea of combining reverse air with moderate shaking was discussed as was the idea of compressed air pulsing of reverse air to increase cleaning ability.

The second major point for dicussion was the problems of condensation within the bag house. This has caused serious problems in the past and has actually made some fertilizer manufacturers abandon installed bag filters and avoid installation of new units. Mr. Herman Powers of Borden Chemical pointed out that his company has successfully used bag filters on dryers for the past 6 or 8 years. They have only accomplished this, he went on to say, by carefully controlling the air temperature both during operation and when shut down. This control includes some or all of the techniques of insulation, introduction of additional heat into the air stream, installation of strip heaters for down-time periods, and by-passes around the collectors when dew point problems are anticipated.

There was then some discussion concerning the use of a bag filter for controlling the emission from a rotary TVA type ammoniator. It was thought generally that the moisture from the ammoniator is generally very great and would cause problems to a bag filter. However, Mr. W. Biederman of Swift and Company pointed out that such an installation has been operating satisfactorily in their Los Angeles area plant.

Another area of general discussion was the designed air to cloth ratio as applied to bag filters used on fertilizer dryers. It was concluded that the present recommendations of the larger manufacturers of an air to cloth ratio in the range of 2 to 1 to as high as 3 to 1 for a shaker type collector should not be changed. This has all been based on experience and really it was the feeling that perhaps a higher air to cloth ratio might work but no one really wants to be first to experiment with these higher ratios.

Machinery Table No. 4

Leaders: Stephen J. Jamvac, Wayne W. King, L. E. Hubach

A synopis of the Round Table Meeting under the title of "Screens and Screening" started each session with the Purposes of Screening.

1) To remove fines from material before reduction equipment such as a crusher, ball mill, rod mill, etc.
2) To produce a commercial or process grade product to meet specific particle size limits.
3) To scalp out tramp or oversize material.
4) To remove fines or degradation from a finished product before shipping.

Having this as background, questions arose as to the more popular sizes of complex granular fertilizers and the tonage of either feed and/or product from a 4′ wide x 15′

long two surface Tyler Hum-mer electric screen. Taking first the product size, the trend is toward a 7 mesh x 14 mesh product as related to Tyler standard screen scale. This deviates from the more popular 6 mesh x 16 mesh product of a few years ago when judged by the same sieve series. The tonage rate or rather the product rate with a 6 x 16 mesh product would be 20 ot 25 tons per hour assuming a 2:1 recycle or 40 to 50 tons per hour of feed. The closer the size range, or for a 7 x 14 mesh product, the rate of recovery obviously drops to approximately 15 tons per hour and where manufacturers have elected to size closer, they have installed a second 15′ long classifier screen for a product recovery rate of 30 tons per hour.

With DAP, MAP and other high recycle rates, the tonage rate of feed to the screen is abnormally high and can be accepted simply because a high recycle is required and otherwise good product is recycled and sacrificed as product to benefit recycle.

Of particular interest and common to all groups is the question of noise or abatement thereof. The first serious objection to the noise of a classifier screen was raised at TVA in 1968. To alleviate this problem the Tyler Company installed in each V-50 vibrator a composition wear plate (part No. V 276-3) which aided in reducing the noise with an interesting side advantage of longer wear than the previously used steel wearing plates thus reducing the frequency of shimming to maintain the clearance between the armature assembly and magnet assembly. In an effort to further reduce the noise, the Tyler Company installed Korfund isolation mounts with the purpose of mechanically and physically isolating the screen body from the supporting structure. Even though the Hum-mer screen body is non-vibrating, it was known that a goodly percentage of the noise was a mechanical transmission and by physically isolating the screen, the mechanical transmission of noise would likewise be reduced. A combination of the composition wear plate and the Korfund isolation mount proved to be satisfactory and acceptable.

In the interim period, several other installations have been made with a combination of the features described above and likewise have been satisfactory.

The composition wear plate, while soft and resilient, relative to the steel wear plate, does not detract from the efficiency of screening within the size range of importance to the Fertilizer Industry, and the Tyler Company now uses as standard on all new equipment, the compostion wear plate.

Screen blinding is almost always a problem, either due to wedge or coating blinding and where this is a problem of severe proportions, Tyler has suggested the use of a half sandwich screen application where there is a coarse mesh cloth in the same set of reinforced hook edges as the Ty-Rod section used on the second surface, since blinding is more critical when removing fines. The screen section vibrates in sine waves from the center vibrating strip outwards and returns and with the use of the backing screen there is a different resonance of vibration between the two, resulting in the backing cloth actually slapping the Ty-Rod facing cloth, freeing it from residual blinding.

Information on the composition wearing plates, Korfund isolation mounts and half sandwich applications is available from the W. S. Tyler, Incorporated, 8200 Tyler Boulevard, Mentor, Ohio 44060. With the request, however, we do ask that the serial number(s) be given so that we can positively identify the installation.

Potassium Table

Leaders: J. Fieding Reed, Rodger C. Smith

The Potassium Table was well attended and active, useful discussion was led by Dr. J. Fielding Reed, President, North American Potash Institute. Discussion encompassed the agronomic-economic response to potash use, product characteristics of the grades of muriate of potash and the status of new potash materials and production.

At the United Nations World Conference at Kiev, U.S.S.R. in 1971, papers were presented indicating that in the developing countires potassium often produces the greatest return per dollar invested. In the U.S. it is a question whether or not soybeans, as their acreage increases in relation to corn, will sustain the potash market expansion.

Particle size of particularly the Coarse and Granular grades of muriate of potash were discussed with some expression that the ideal grade for blending with D.A.P. and other granular or prilled materials would be a grade mid-way between the present Coarse and Granular grades produced. The present grades of fertilizer materials and their particle size specifications originated with a symposium at an earlier Fertilizer Industry Round Table meeting. The term "soluble" as applied to grade of muriate was discussed, with evidence of some confusion.

There was discussion of new potash materials, i.e., potassium polyphosphate which is being investigated by a potash producer. There was also discussion of potassium sulphate production and probable changes in supply.

World supply – demand as presented by Dr. J. F. Reed were discussed. The question was raised as to whether or not potassium is a pollutant to which all the evidence is that it is not harmful in any way.

Nitrogen Table

Leader: B. E. Adams

We had excellent attendance. The group were extremely interested in the various discussions on Nitrogen and contributed enormously asking questions and giving many of the answers.

Highlights of our question and answer periods were as follows:

What systems are available for reducing corrosion with non-pressure solutions? Surfactant System – Dichromate – Phosphate.

Comments on Ammonium Sulphate supply and demand? Under priced last year and price freeze will affect short term pricing.

Has low pressure solutions dropped off significantly over the last several years? Yes, but some economics still benefit dealers with equipment.

What will future hold for Nitrogen Products – Uran and Non Pressure versus Anhydrous Ammonia? Uran is most flexible in operation with addition of pesticides-micronutrients in non pressure equipment.

Has Gas curtailment affected Anhydrous Ammonia production? Yes, Spring availability will be affected by curtailment.

Will prescription fertilizers tend toward liquids or Blend? Lean toward liquid due to sequestering properties of Ammonium Poly Phosphate. Has been underestimated.

Is Urea making inroads in bulk blending? Yes, basically due to urea pricing.

Has any improvement been made in urea conditioning to make better for blending? Much discussion. No Basic changes.

How does Urea compare Vs. Ammonium Nitrate as direct application material? Urea preferred due to price. Ammonium Nitrate stores better than urea in bulk. Ammonium Nitrate can pose insurance problems.

Any difficulty in getting Micros in clear liquids? Yes, go to suspension.

Has any credit been given for Sulphur in Ammonium Sulphate? In spots, principally Nebraska.

In most of Ammonium Sulphate made now of large crystal size? Crystal size is basis tonnage through the crystalizers. Some Companies sell various screen fractions.

Review Nitric Acid production. Any Improvements? Catalysts, a couple of new ones, that permit exclusion of platium but under secrecy.

Discussions of Coated Urea, Fertilizers

Urea vs. Ammonium Nitrate in bulk blend without consideration to price? Physical Condition? Not much difference in hygroscopicity. Urea reacts with Triple Superphosphate to release water.

What is likelyhood of Urea size change? There are several sizes of Urea now. The prilling tends to be small.

DSM Urea coating – 1-1½% special oil, 3 oils including vegetable oil – cost about $1.50 NTP Urea.

10% Soybean or Linseed
80% Petrolatum medium weight oil
10% Paraffin.

Anyway to ship, 75% – 80% Urea Solution and keep it from breaking down? Keep transit time down, cut concentration.

Anything to cut down dust with coated Urea. Try spraying with a light-weight oil.

Thursday, November 11, 1971

Morning Session
Moderators: Herman G. Powers, Allen S. Jackson, Gene A. LeBoeuf

Environmental Regulations In the Fertilizer Industry

William C. White

There is hardly any step or process for fertilizers in their journey "from ground to ground" exempt from some sort of potential regulation. Prominence among regulations prior to the seventies was in the quality control category, i.e. criteria for nutrient availability, product registration, label details, and the like. However, for the foreseeable future, environmental regulations for the fertilizer industry will occupy the seat of prominence.

The reason for this shift in prominence is obvious. The older type of regulations, which focused on product quality and uniformity, seldom if ever closed plants or determined plant location. Environmental regulations, presently on the books or in proposed drafts, have the potential for doing each. They combine elements of both urgency and importance and present the greatest challenge for survival and adaptation the fertilizer industry probably has ever faced.

The array of environmental regulations extends from the Potomac to the local ordnance. Discussing these in detail would extend this program far beyond the deadline for tomorroe, and even would be of questionable value in view of their state of flux. Therefore, the following discussion centers more closely on some responsibilities the industry bears as it faces an *environment of regulations.* For purposes of organization, I will discuss them under 10 headings.

1. *Resource Use*

The fertilizer industry, like all others that provide goods for man's welfare, be it housing, transportation, or whatever, is a user of natural resources. Each of these natural resources we use in fertilizers is exhaustible. Thus, one of our priority responsibilities or roles in environmental protection is to assure the most efficient use possible of natural resources serving as raw materials. There simply is no "double cropping" of an empty mine.

A sensitive conscience regarding our natural resources also will cause us to pause when we examine some figures for ammonia production. For each ton of ammonia produced, we comsume about 33,500 cubic feet of natural gas. An annual production of about 13 million tons of ammonia, our current rate, represents a consumption of 435.5 billion cubic feet of natural gas.

This figure of 435.5 billion cubic feet may be more meaningful if translated. Based on 1969 consumption rates, it is enough gas, according to figures from the Washington Gas Light Company, to supply the Washington, D.C., metropolitan area for 4.6 years.

Assuming that eventually we may obtain sources of hydrogen for ammonia production other than from natural gas, we may say that our supply of nitrogen is inexhaustible in view of the 35,000 tons of nitrogen in the air over each acre. However, hydrogen, nitrogen's partner in the ammonia molecule, is the expensive item and may be the limiting item for nitrogen fertilizer in the future.

Figures from the Bureau of Mines will show that our phosphate reserves are adequate for at least another 200 years, and potash for another 120, at the present production rates. Whatever figures we use, the fact remains that these valuable resources are exhaustible, and that for the sake of our future environment we should use them as efficiently as possible and with the maximum benefit to man.

2. *Clean Production Processes*

Hardly without exception, every production process has one or more by-products. For environmental purposes, these fall in one or more of three categories – air emissions, fluid discharges, and solid wastes. The Clean Air Act, the Federal Water Pollution Control Act, and Senator Muskie's SB 2770, are examples.

Dust, oxides of nitrogen and sulphur, fluorine, and visible plumes, are the principal air emissions from fertilizer manufacturing. Each is coming under governmental scrutiny and will be controlled by emission rates, reasonable or unreasonable.

For example, in the FEDERAL REGISTER August 14, 1971, EPA authorized states to limit emissions from sulfuric acid plants to 6.5 pounds of SO^2 per ton of 100 per cent acid produced. Then, on August 17, it published a proposed emission limit of *four* pounds of SO^2 per ton of 100 per cent acid in new plants. Industry had an opportunity to respond to the proposed standards for new plants and the Institute, working through engineers of its Manufacturing Environmental Committee, has reported to

EPA its recommendations on the proposed standards for new plants. Nowhere could we find evidence the four-pound limit would be feasible. Our most recent report from EPA, however, indicates that hte "die is cast" for four pounds. Obviously, brimestone burners will have difficulties in the future!

Allowable levels of substances in fluid discharges from fertilizer processes are somewhat like SO_2 and NO_2 from the stack – up in the air. However, studies have been conducted for EPA, and we know that liquid discharge standards are in the mill. Approved direct discharge of untreated waste, such as gypsum, simply will not be in the books. The Refuse Permit Program, co-administered by EPA and the Corps of Engineers, will cause many a valve to be tightened. Their standard effluent levels, reference guidelines, or whatever they may be called, eventually will give government agents rules to follow for every liquid discharge, whether from production process or from site runoff.

3. *Product Movement/Storage*

Production is only the first step down a long path of environmental regulations affecting the industry. It bears responsibility against release, by accident or otherwise, of its products to the environment during shipment and storage.

Procedures for transporting anhydrous ammonia and ammonium nitrate already have been spelled out by the Department of Transportation. Most aspects of these pertain to safety, but accidental discharges, as they may affect the environment, also are receiving increasing attention.

Two recent bills in state legislatures are good examples of activity in this field. New Jersey Assembly Bill No. 2037, introduced in January, 1971, proposed protection by dikes, shields, or impervious membranes for storage of certain chemicals unless a permit is obtained annually from the Department of Environmental Protection to do otherwise. And a year earlier, there was Senate Bill 6846 in New York that would have prevented storing more than 1000 gallons above ground of any liquid which might have an impact on waters of the state, unless certain dikying, fencing, and specifications were met. It would have been a death blow to many a liquid fertilizer tank. Although each of the two bills failed, they are indications of what may happen in the legislative halls in the future.

4. *Product Use*

Responsibilities for our product do not stop when the sale is made to the farmer. There are some who would have the industry bear the responsibility for all possibilities of surface runoff or degradation of ground and stream waters whenever there is the slightest bit of information associating farm fertilizer use with nutrient levels in natural waters.

In Massachusetts in 1970, there was House Bill No. 993. It was short: "Whoever offers for sale, sells or uses any inorganic fertilizer shall be punished by a fine of not more than $50." After one hearing, the bill was rewritten to propose a study by the University of Massachusetts as to what fertilizers do in the state. And, after the legislators learned that studies cost money, the substitute bill made no progress.

A more recent development regarding responsibilities of industry, as well as the user, for fertilizers is the proposed regulation in Illinois for plant nutrient applications. Although these proposals conform very closely to current agronomic recommendations of the university, a system of regimentation would supplant that of individual choice by the farmer depending upon his own farm conditions and what he has learned most recently from research and extension programs. Seven of the 10 hearings for these regulations are now behind us, and there still has been no significant testimony showing why such proposals would be justified. In the meantime, however, it is industry's responsibility to see that the facts be presented in the best possible manner in the hope that the Illinois Pollution Control Board members will cast their votes accordingly.

5. *Be Informed*

Speed reading courses may be a necessity for all of those wanting to remain in the industry in the future. State and federal regulations are being generated at an increasing pace and "ignorance" still remains a useless alibi for violating any law or regulation.

Environmental responsibilities will cause many of us to learn almost completely new vocabularies. Noise levels in decibels, plume densities in degrees of opacity, ppm in standard effluent levels, and other expressions may be as commonplace in the future as pounds per acre. The responsibility still lies with those of us in industry to learn this language and to be able to handle it as well as any environmental specialist or government agent.

6. *Cooperate With Regulatory Agencies*

The uniform fertilizer bill, the uniform specialty fertilizer label, uniform methods of expressing fertilizer grades, and other examples, can be cited to show the results of cooperative efforts between industry and regulatory agencies.

The farmer and industry have received tremendous benefits from close working relationships with state fertilizer control officials, as their influence on what business may be permitted and how it may be conducted seems certain to increase in the near future. There is good reason to believe that this group of officials will welcome contributions and counsel from industry just as have state fertilizer control officials. You will find no fertilizer experts in the ranks of environmental administrators. Obviously, they should rely on substantial input from well-informed industry sources. This should not only be considered a responsibility but an opportunity for the fertilizer industry.

7. *Personnel Training*

Unfortunate experiences in environmental regulations will be avoided only with personnel training. Washing of tanks and application equipment in the wrong corner of your lot, hauling uncovered goods in bulk, dumping of odds and ends in the discharge pipe, and the like, only will be avoided with trained personnel.

If we bear this responsibility for our personnel with environmental regulations we very likely will be scheduling workshops for all employees, from payloader operator to plant manager. How we shoulder this responsibility may well determine citations for environmental violations.

8. *Research and Development*

For some environmental problems there are only two alternatives – lock the doors or unlock new discoveries. Each of these can cost money, but only the latter may keep us in business.

There are examples not too distant from where we are today – fertilizer plants closing simply because of obsolescence. More will follow if we do not bear our responsibility for research and development, including support of groups such as TVA, which has outstanding capabilities for fertilizer technology.

Figures from the most recent issue of Fertilizer Financial Facts, fiscal year ending June 30, 1971, show where some of our priorities lie. This report, a service of The Fertilizer Institute, shows that expenses for research and development were equivalent to only 0.2 per cent of net sales. Expressed differently, this amounted to four-to-eight cents per ton of fertilizer, depending upon which group in industry you compare. For two of the principal groups, total R&D funds for 41 major producers were $5.2 million. This amount, incidentially, is considerable less than inspection fees paid to states last year.

One of the penalties industry will face in getting adequate research in environmental field is the lack of coordination among public funding groups. Industry should work at every opportunity to assist public agencies in coordinating their research efforts so that duplication will be minimized, and that appropriations are placed with proper priorities.

9. *Investments Will Be Required*

Pollution control costs money, and it will cost more in the future. It will be the responsibility of industry to bear this cost as the control practices apply to its production, shipping, and storage operations.

The magnitude of such investments can be represented by figures reported by John A. Layton at the Institute's Fall Fertilizer Conference. Mr. Layton, vice president of Agrico, reported that since 1966 the Florida phosphate industry has spent capital money amounting to the following for compliance with present regulations:

Air	$25.2 million
Water	$14.6 million
Conservation	$10.0 million

The total for these three group expenditures is $49.8 million. However, this was only the beginning. This equipment does not maintain itself automatically, nor does it operate without expense. Mr. Layton reported that expenditures to operate these systems, and to maintain them since installation, have exceeded $50 million.

Before spending money for pollution control equipment, it is imperative that the equipment give a performance that will meet the current and anticipated requirements. A recent case has been reported in Illinois where installation permits have been denied for the installation of certain pollution abatement equipment in fertilizer plants. Apparently, the environmental officials consider the equipment short in performance even before it is installed.

10. *Account For Your Costs*

Each of the above nine areas of responsibilities has either a direct or indirect cost. Hardly without exception, these increased costs are non-productive costs; they do not increase production efficiency or output. The effect may be the opposite.

As with all other phases of our business, we will be responsible only if we know what our total, true costs are and include them with our product prices.

Summary

The fertilizer industry has, indeed, a broad role in environmental protection. From efficient resource use to responsible cost accounting. Neglecting any one may be critical to continuation of a profitable business.

Those we have tried to emphasize are:

1. Use natural resources efficiently that serve as our raw materials.
2. Assure that air, water and waste discharges from production processes have minimum impact on the environment.
3. Assure against accidential discharge while moving and storing products.
4. Encourage farmers to use fertilizers at the proper time, applied in the proper manner, and in the proper form to minimize risk of agricultural pollution.
5. Stay informed of environmental regulations.
6. Assist environmental officials in writing and administering environmental regulations.
7. Participate in training programs to stay abreast with the latest developments and to comply with current regulations.
8. Discover better ways of manufacturing, delivering and applying fertilizers.
9. Invest in pollution abatement equipment.
10. Use complete cost accounting to cover additional costs for environmental protection.

The fertilizer industry has an enviable record in its contributions to man's welfare. A sensitive industry conscience will assure that man's environment, as well as man himself, will be the beneficiary of our industry fulfilling all of its responsibilities for improving environmental quality in producing and delivering plant nutrient products to farmers at home and abroad.

The Wellman Lord SO^2 Recovery Process

Brian H. Potter

The Wellman Lord SO^2 Recovery Process was originally conceived in the mid 1960's when the price of elemental sulfur in the United States was rising rapidly. Much of the company's business at that time lay in the design and construction of fertilizer plants, and we were highly conscious of the need for alternate and less expensive sources of sulfuric acid as a necessary raw material for the fertilizer industry.

The process as developed is capable of usefully recovering SO^2 from stack gases, although with today's low sulfur prices it is not able to do so and compete with conventional sulfur sources. We now see the process as one which will enable industry to operate plants which emit SO^2, and to control the SO^2 emission below current and anticipated regulatory levels.

It is interesting to note that the process is flexible, in that it can be applied to many different types of plants, and we have in commercial operation, applications on three excellent examples.

OPERATING PLANTS

1. Olin – Paulsboro, New Jersey
   This plant handles exit gases from a spent acid regen sulfuric acid plant 700 TPD capacity. Gas treated is 45,000 scfm containing up to 6,000 ppm SO^2. Exit gas is easily controlled to well below the original design basis of 500 ppm. The plant has operated since Mid July 1970; it is fully accepted by Olin, and is now an integral part of their operation. The product SO^2 is returned to the sulfuric acid plant.
2. Japanese Synthetic Rubber – Chiba, Japan
   This plant handles exit gases from two oil fired boilers burning 4.2% sulfur oil. Gas treated is 124,000 scfm. This plant started up in August 1971, and is achieving extremely low SO2 emissions. The design, as reported by our licensee, Mitsubishi Kakohi Kaisha Ltd., in Oil and Gas International, August 1971 issue, was to reduce SO2 by 90-95% from 2090 ppm. In this plant, the product SO2 is taken to a new sulfuric acid plant, and the final end product is 98% sulfuric acid.

3. Toa Nenryo – Tokyo
   This plant, built by our licensee Sumitomo Chemical Engineering Co., Ltd., handles exit gases from a refinery claus plant. Gas treated is 41,000 scfm containing 13,000 ppm SO^2. The plant has been operating since mid August 1971 achieving the design emission which was for 200 ppm. Refinery operation has been such that the plant thus far has not needed to operate beyond 75% of design, but no problems are anticipated in easily meeting full design requirements. The product SO^2 is pumped back to the claus plant for recovery as elemental sulfur.

PLANTS UNDER CONTRACT

We are actively working on firm projects for a number of clients, and here again it is interesting to note the variety of plants.

1. Standard Oil – California – El Segundo, California
   We will treat gases from three claus plants. Gas to be treated is 25,000 scfm containing 9,600 ppm SO^2. Design exit will be less than 500 ppm SO^2. The plant is expected to start up in July 1972.
2. Allied Chemical Corporation – Chicago
   We will treat gases from three sulfuric acid plants. Total gas stream 31,000 scfm. containing 2,600 ppm SO^2. Design exit will be below anticipated regulations. The plant will start up in October 1972.
3. Olin Corporation – Curtis Bay, Maryland
   We will treat gases from three sulfuric acid plants. Total gas stream 64,000 scfm containing 4,000 ppm SO^2. Design exit will be below anticipated regulations. The plant will start up in October 1972.
4. Pulp Manufacturer (Confidential)
   We will treat gases from black liquor boilers, totalling 100,000 scfm. containing 4,700 ppm SO^2. Design exit gas will be below anticipated regulations. The plant will start up in early 1973.

PROCESS DESCRIPTION

The process comprises two main sections:

a) Absorber area
b) Chemical regeneration area

and this is true for all applications. We could perhaps consider a third section, gas pretreatment, although we do not class this as a part of the WL SO^2 Recovery Process itself.

GAS PRETREATMENT

We design so that the absorber, in all cases, receives the gases at 130° F to 150° F, saturated, and essentially free of particulates. Thus for a sulfuric plant application it may be necessary to add water or steam to raise the gas temperature and saturate the gas. For a claus plant application we must cool the gas exit the incinerator. For a boiler application we may need to install fly ash collectors, and we would certainly need to install a quench scrubber to cool and saturate the gas.

ABSORBER AREA

In the absorber the tail gas is contacted counter currently with a sodium sulfite (Na_2SO_3) – sodium bisulfite ($NaHSO_3$) solution which chemically abosrbs the SO^2 to form additional bisulfite. The tail gas, stripped of SO^2, is discharged to atmosphere.

CHEMICAL REGENERATION AREA

The SO^2 rich solution flows to the chemical regeneration area. There it is boiled by indirect heating with steam in an evaporator cystallizer. The solution decomposes into a wet SO^2–H_2O gas and a precipitate of sodium sulfite srystals. Part of the circulating load in the evaporator is drawn off and sent to a dissolving tank where the sulfite crystals are redissolved in water. This new solution becomes the lean feed stream to the absorber.

The wet SO^2 gas flows to a condenser train where most of the water is condensed and reused to dissolve the sulfite crystals.

The final product SO^2 gas is then discharges to battery limits. It can be returned to the parent plant in the case of H_2SO_4 plants and claus plants. It can be used as feed to a sulfuric acid plant in the case of a boiler application.

Back in the absorber two further reactions may occur:

a) If SO_3 is present, some sodium sulfite will react with SO_3 to form sodium sulfate.

b) If oxygen is present, some sodium sulfite will react, again to form sodium sulfate.

These sulfates will not regenerate in the chemical plants and the system must be purged to control the level of this salt. As the purge contains sodium sulfite and bisulfite as well as sodium sulfate, there is a loss of sodium ions which must be replace and a make up of fresh caustic is therefore required. This results in a twofold problem.

1. The purge stream must be disposed of.
2. The fresh caustic represents an operating cost,

and this problem is being worked on at the present time. We have found that an antioxident will help reduce the sulfate formation to about half. We have also pilot tested a purge treatment system which will selectively separate undesirable sulfate from the useful sulfite and bisulfite. In total, therefore, we can minimize the purge to about 25% of its present quantity, and further, can attain a purge which is innocuous and has no appreciable COD.

MATERIALS OF CONSTRUCTION

In general, the materials of construction which we selected for the Olin Paulsboro plant have proven satisfactory. We found a problem in the vapor space of the evaporator, where we detected some pitting. This item was made 304ss, and we no longer specify this material for vapor-liquor service but instead use 316ss or Incalloy 825. We have found 316 to be an excellent material after 18 months of service. FRP appears to work well for piping service, but in a colder climate we must steam trace many process lines, and therefore, specify stainless steel.

OPERATING RELIABILITY

The process is being installed, and considered for installation, for some applications where it is imperative that the gas clean up operation is in action 365 days per year. This is particularly so, for example, in refinery operation, where a complete refinery is liable to be closed down any time air pollution regulations are violated. The absorber section is extremely simple in design, and with a minimum of installed spare equipment, can be made almost fool proof.

The chemical plant is subject to the same operational breakdowns as any other chemical operation, more so than the abosrber area because it contains more equipment. However, by installing surge tanks ahead of and behind the absorber, the chemical plant can be shut down for routine maintenance whilst the absorber stays on line.

These surge tanks serve other important uses in some cases, because they will permit steady operation of the chemical plant even though the parent plant off gases fluctuate in volume or SO^2 content. They will also, to a degree, help overcome problems often encountered during start up and upset conditions, depending, of course, on the severity and length of time of the upset.

ECONOMICS

The following is a hypothetical example of an application treating gases from an existing claus plant incinerator.

CLAUS PLANT

Capacity	200 STPD sulfur
Efficiency	96%
Gas exit incinerator	Volume 24,000 scfm Temp. 1100-1200° F SO2 content 1320 lbs/hr.
Gas to SO2 absorber	Volume 22,000 scfm Temp. 140° F. SO2 content 1320 lbs/hr.
Gas to stack	Volume 22,000 scfm SO2 content 250 ppm (54.5 lb/hr.)
SO2 product	1146 lbs/hr.

Total Utilities:

Steam	Produced in waste heat boiler 20,000 lbs/hr Required in chemical plant 13,000 lbs/hr Net export 7,000 lbs/hr
Connected H.P.	300
Cooling water (30°F rise)	1000 gpm
Process water	Intermittent
Instrument Air	50 scfm
Caustic (100% NaOH)	1.0 TPD

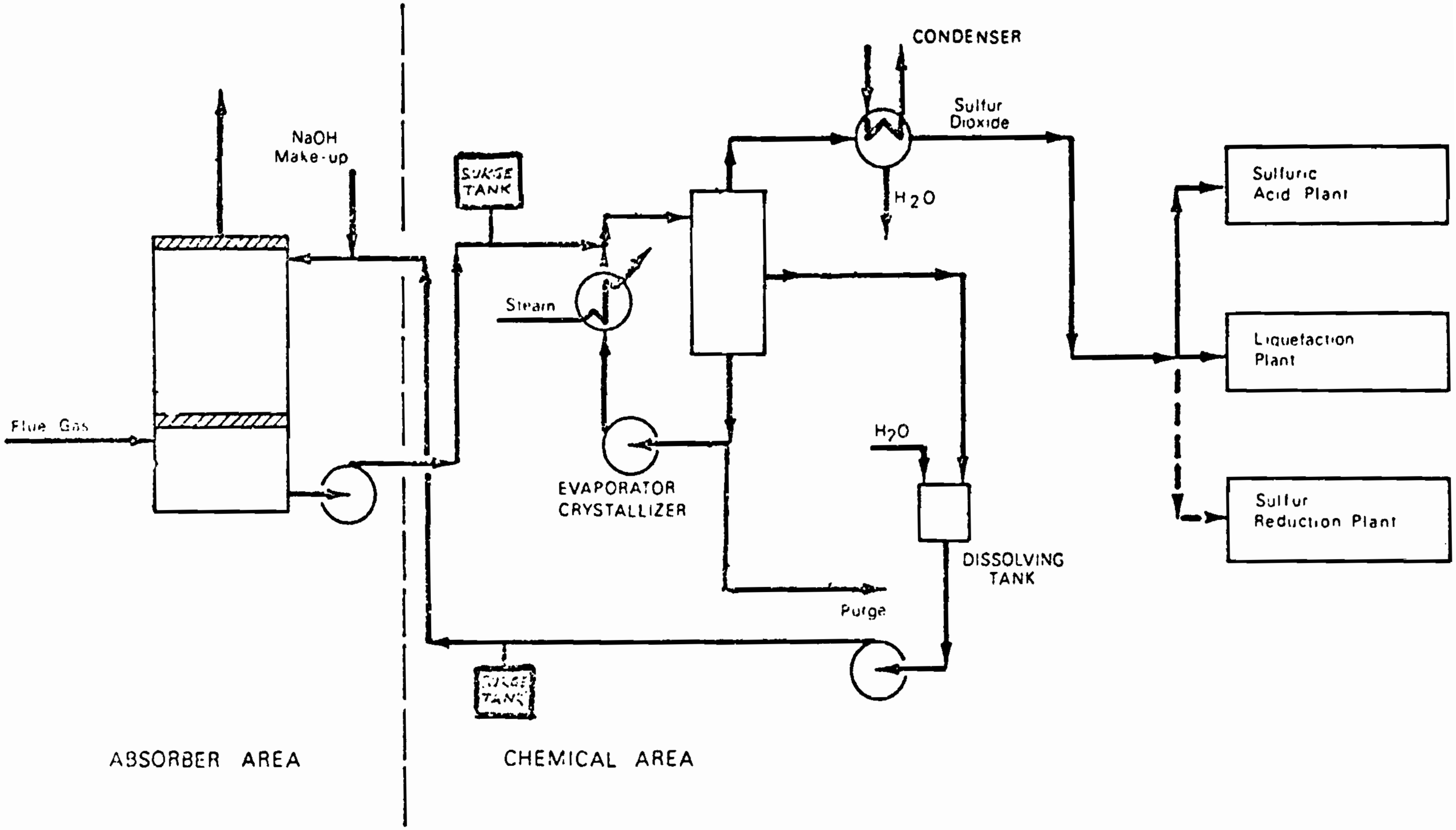
Capital Investment

Gas cooling Allow		300,000
SO2 Recovery Process		1,250,000
	Total –	1,550,000

Operating Costs:

	$/Year
Capital charges @ 15% of investment	232,000
Labor–8000 hrs @ $3.75 hr.	30,000
Supervision–2000 hrs @ $4.75 hr.	9,400
Payroll benefits–25% labor and supervision	9,850
Maintenance 3% of investment	46,500
Electricity	20,000
Steam	––
Cooling water 2c/1000 gal.	10,400
Caustic @ $75/ton	27,000
Overhead–50% labor + supervision + maintenance	42,950
	$428,100

In effect, we have improved the efficiency of the claus plant, in terms of useful sulfur recovery, from 96% to 99.43%, at a cost of approximately $5.93/ton of sulfur feed to the claus plant. In terms of air pollution control, we have raised the efficiency of the claus plant operation from 96%



Wellman-Lord sulfur dioxide recovery sodium system.

to 99.85%.

So, in summary, we have a process, operating successfully at three locations, and demonstrating that low SO2 emissions are attainable. We have a design concept which offers an extremely high degree of reliability, and which can tolerate large variations in the feed gas quantity and sulfur content.

Controlling Pollution From Fertilizer Plants

Frank P. Achorn & J. S. Lewis, Jr.

Ammoniation-Granulation Plants

Concern throughout the country over air and water pollution has forced many ammoniation-granulation plant operators to explore effluent control measures. Even operators of plants with small discharge of dust and other pollutants and those in areas not yet subjected to strict regulations are looking into ways of reducing or eliminating pollution. Many operators are already in trouble and are forced to take emergency steps to reduce air and water pollution.

A sketch of a typical ammoniation-granulation plant is shown in Figure 1. Some plants have scrubbers, whereas others exhaust directly into the atmosphere from their cyclone dust collectors. High-efficiency scrubbers, such as a venturi-type scrubber, or a well maintained bag filter are sometimes used to remove dust from exhaust. Usually a simple impingement-type scrubber such as the one shown in Figure 2 is used. Liquid passes through the draft tubes of this scrubber and impinges along with the gas stream onto the conical section at the lower end of the draft tube. Also, as the gas passes between the clearance at the end of the draft tube and the surface of the liquid, it impinges onto the surface of the liquid, and some of the dust is collected. The rest of the scrubber consists of a low-velocity chamber for separating droplets of liquid from the gas stream.

Another simple scrubber is the cyclonic-type scrubber shown in Figure 3. This scrubber is similar to a wet dust collector, and the cyclonic action of the liquid with the gas stream is sufficient to coalesce the dust in the recirculating liquid. Figure 4 shows another cyclonic-type scrubber which has a venturi section on its inlet side. For higher efficiency a larger blower is usually required for this type scrubber than for the simple impingement scrubber. Sometimes a packed-bed scrubber is used (Figure 5).

Some work has been done in TVA field programs on the design of dust and fume collecting and scrubbing equipment. Most of the efforts have been limited to reducing emissions from granulation plants. Among the recommendations, several have been common.

1. Improved sparger design and proper location of spargers.
2. Better design of the ammoniator-granulator (size of discharge rings, design of scraper bars, and rotational speed).
3. Desirable formulations.

Figure 6 shows design data recommended for spargers (1). Designs were developed by working with commercial plants often in a trial-and-error procedure. The spargers are located deep in the rolling bed of materials near the point of greatest activity. They are usually constructed of stainless steel or Hastelloy C. The drilled pipe-type ammonia sparger runs the length of the ammoniator-granulator except for 18 inches on each end. For liquid anhydrous ammonia, the total cross-sectional area of the holes in the sparger is about 0.4 square inch per ton of ammonia in the formulation. For ammonia-ammonium nitrate solution, the are of the holes is about 0.18 square inch per ton per hour of solution. With these openings a slight back pressure is created in the ammonia sparger during operation. Spargers are often used interchangeably for ammonia or ammoniating solution with a compromise on the total cross-sectional area of the holes; a common arrangement is 1/16-inch holes on 1-inch centers. Calculations show that for a 13-foot sparger with a production rate of 20 tons per hour of a grade requiring one ton of ammonia per hour (100 pounds per ton of product) this area would be 0.475 square inch (sufficiently close to the recommended 0.4 square inch). The holes of the ammonia or nitrogen solution sparger face the oncoming stream of solid materials.

When anhydrous ammonia is used, it is helpful to add a small quantity of water with the ammonia to prevent freezing of solid materials around the spargers. The water also improves ammonia absorption. The sulfuric acid sparger is mounted 2 inches above the ammonia sparger, and its effective length is two-thirds the length of the ammonia sparger. The srea of the holes in the sulfuric acid sparger should equal about 0.6 square inch per ton per hour of sulfuric acid in the formulation. Usually sulfuric acid spargers have 1/8-inch holes on 1-inch centers. Plant tests have shown that when the holes in the acid sparger are directed upward most of the acid contacts the ammonia and is neutralized before it can react with the potassium chloride in the bed. This helps prevent the ultimate formation of ammonium chloride. Ammonium chloride that is formed is lost in the exhaust gases and is a pollutant which is extremely difficult to scrub from the exhaust gases. Also, there is a minimum of caking around the spargers with the recommended arrangement.

When phosphoric acid is in the formulation, it is usually added above the bed of material in the granulator from a drilled pipe-type sparger which is about two-thirds the length of the ammonia sparger. When steam is added to the ammoniator-granulator, our data indicate that it is best to locate the steam sparger 2 inches behind the ammonia sparger and to direct the holes of the steam sparger in the opposite direction from the holes of the ammonia sparger. The steam sparger is mounted close to the discharge end of the granulator and is susually about one-third the length of the ammonia or nitrogen solution sparger. To minimize particulate loss from the ammoniator-granulator the center line of the sparger bundle should be installed at a bed depth of two-thirds the total depth of material in the ammoniator-granulator. Also, if the ammoniator-granulator rotates clockwise, the center line of the sparger bundle should be at the 8 o'clock position – counterclockwise, at the 4 o'clock position. The height of the retaining ring and the slope of the drum determine the depth of material in the ammoniator-granulator. Average bed depth is usually between 18 and 24 inches depending on the diameter of the ammoniator-granulator. Some ammoniator-granulators are installed horizontally; others are inclined toward the discharge end with a slope of about 1/4 of an inch per foot of length. Ammoniator-granulators with minimum slope tend to have less particulate loss – a point lacking quantitative support but apparent from visual observations.

TVA has recently developed a computer program for calculation of formulations (2). The program enables calculation of numerous combinations of liquid phase and heat as variables in controlling granulation. Several formulations derived from this program were tested in commercial plants. Most granules produced were hard and resisted degradation during drying and cooling. The proper degree of ammoniation was determined for the various materials in the formulations. When these variables were considered, the amount of particulate and ammonia in the exit gas streams of the plant and the amount of solids in the exit streams from the scrubbers were decreased during operation of the plant as compared with these losses during previous operation on the same grades with formulations that had been developed without a computer study. Although the quantity of materials in the effluent was decreased during the tests with computerized formulations, it was still not low enough to be below the maximum pollution tolerances of several states.

Inclusion of superphosphoric acid in the formulation to control pollution from ammoniation-granulation plants has been tested(3) (4). Its inclusion has been beneficial in both batch ammoniation and continuous ammoniation-granulation plants.

In measurement of the quantity of pollution from continuous ammoniation-granulation plants, fertilizers of the same grades were produced to compare pollution during operation with and without superphosphoric acid.

The first series of tests was made in a plant equipped with a scrubber. A 10-10-10 formulation normally used by this plant is shown as Formula 1, Table 1. The formulation including superphosphoric acid is shown as Formula 2. The device used in sampling the exit gas from the ammoniator-granulator and the exhaust duct from the dryer and the cooler is shown in Figure 7. The exit gases were sampled by inserting a probe into each exhaust duct to an average velocity point (as determined by a pitot-tube tranverse) and withdrawing the gas through a liquid trap to remove any large liquid drops entrained in the gas. The gas was then scrubbed by three impingers in series. Each impinger contained 0.1 normal sulfuric acid to collect chloride fumes and free ammonia. Dust samples to and from the dry cyclones were collected on a filter pad as nearly as possible under isokinetic conditions.

Simultaneous grab samples of water to and from the plant scrubber were enalyzed for dissolved solids, total solids, free ammonia, P_2O_5, and pH. Ringelmann tests were made of opacity of the stacks by a qualified Ringelmann tester. The Ringelmann test is the official opacity test for Maryland – the state in which this plant is located.

The plant was operated at a production rate of about 23 tons per hour. Measurements of solid and gaseous discharges from the plant are shown in Table 1. The data shown for Test 1 is a summaiy of average data from three tests in which Formula 1 was used. The data show that when sulfuric acid was in the formulation considerable ammonia was lost from the ammoniator-granulator. Possibly part of this ammonia loss was due to the rather high degree of ammoniation calculated for the formulation. However, there was a noticeable amount of chloride, probably as ammonium chloride, in the ammoniator-granulator exhaust and the plant stack. Ammonium chloride fumes are white and very dense, and light concentrations of them are quite visible. The Ringelmann opacity test during Test 1 was about 70 percent. This is well above the tolerance allowed by the state (maximum tolerance 20 percent).

With superphosphoric acid on the formulation (Test 2, Table 1), the amount of chlorides in the exit gases was significantly lower. This major source of pollution was decreased from about 82 pounds per hour to only 0.1 pound per hour from the amminiator-granulator and from 2.6 pounds to 0.82 pound per hour from the plant stack. In Test 2 the opacity of the stack as shown by the Ringelmann test was between 10 and 20 percent.

Analyses showed that an average of 336 pounds of solids per hour was added to the scrubber water, which was dumped into the local stream, when sulfuric acid was in the formulation. With superphosphoric acid this addition was only 56 pounds per hour and was well within the tolerance allowed by the state. Although the pH of the scrubber liquor was below tolerance, it probably could be easily adjusted to 7 by adding a small quantity of ammonia to the exit stream.

The data shown in Table 2 were obtained in tests at a plant in Missouri – a conventional ammoniation-granulation plant with a preneutralizer equipped with scrubber, dryer, and cooler. The dryer and cooler have separate scrubbers. The company was having considerable difficulty with air pollution by their plant effluent. The pollution was of such extent that the local pollution-control authorities had cited the plant but were allowing it to operate during a probational period until the pollution could be decreased to a satisfactory level. Two conventional formulations were tested along with two formulations that included superphosphoric acid (Table 2). In Tests 1 and 2 the conventional formulations, with a combination of sulfuric and phosphoric acids, were used and superphosphoric acid was used in Tests 3 and 4. The phosphoric acid was added to the preneutralizer scrubber, and the sulfuric acid was added to the preneutralizer. Superphosphoric acid was added to the ammoniator-granulator, and the wet-process orthophosphoric acid was added to the proneutralizer scrubber. This scrubber was also used to scrub exhaust gases from the granulator. The gas sampling arrangement was essentially the same as that in the Maryland tests but was

operated by an independent testing group.

The 12-12-12 grade was produced at a rate of about 15 tons per hour. During Tests 1 and 2 the total weight of dust in the exit gases from the stacks varied from about 59 to 84 pounds per hour. This is well above the 27 pounds per hour allowed by the local authorities for this production rate at this plant. During Tests 3 and 4 the total dust loss varied from about 7 to 14 pounds per hour. No attempt was made to quantitatively measure the chloride lost during these tests; however, visual observations of the plant stacks during Tests 3 and 4 showed little or no white plume.

The ammonia loss during Test 4 with only 100 pounds of superphosphoric acid per ton in the formulations was about 7 percent – a high loss. However, part of the loss can be attributed to the addition of limestone as filler. Probably some of the limestone reacted with the phosphoric acid so that the degree of ammoniation assigned to phosphoric acid was high. The loss could probably be avoided by changing the formulation slightly to allow for a slightly lower degree of ammoniation.

Cost calculations show that the total raw-materials cost for Formulation 4 was slightly less than for the conventional formulations. Savings were due to use of larger quantities of filler in the formulations that included superphosphoric acid. Also, all the phosphoric acid contributed to the plant nutrient content, whereas sulfuric acid in the conventional formulations contributed no primary plant nutrient and was a more expensive filler than either sand or limestone.

Fluid Fertilizer Plants

Some fluid fertilizer producers have received complaints concerning loss of ammonia from their plants. Although the quantity of ammonia escaping from fluid plants is low and usually is not noticed by plant personnel who become accustomed to it, the general public in the area of the plant will complain about its odor.

TVA has assisted in the design of an exhaust and scrubbing system to remove ammonia vapors from plants of this type. Figure 8 is a sketch of a typical fume-scrubbing system for fluid fertilizer plants. The plants normally use either solid or liquid ammonium polyphosphate, phosphoric acid, aqua or anhydrous ammonia, potash, and urea-ammonium nitrate solution. For use of our scrubbing system, hoods are installed over the aqua ammonia converter and the liquid fertilizer mixing tank. Exhaust gases from these sources and from the liquid storage tanks are blown into the bottom of a packed tower by exhaust fans. Phosphoric acid is sprayed onto the packing of the tower and is usually recirculated until it has a nitrogen content of about 3 or 4 percent and a P_2O_5 content of about 16 percent. This partially neutralized phosphoric acid is used for the production of liquid mixtures. One fluid fertilizer plant from which ammonia vapors were escaping was closed by the state pollution-control authorities. After these exhaust and scrubbing systems were installed, the plant was permitted to operate again. TVA has also assisted in the design of earth levees around fluid fertilizer plants. Levees are required in some locations to prevent pollution if tank ruptures should occur.

Bulk Blending Plants

Many bulk blenders have received complaints about dust. In TVA tests a fluid such as used automotive engine oil, water, or ammonium polyphosphate solution has been sprayed into the mixing drum to prevent excessive dust loss during the mixing operation. Companies that have used this procedure, particularly with engine oil, report excellent results. Less dust is lost in the plant area and at stations where applicators or trucks are loaded. Oil has also decreased the amount of dust normally liberated from spinner-type applicators. Because of the sensitivity of ammonium nitrate to this organic material, the oil should be limited to those formulations containing less than 60 percent ammonium nitrate (5). Companies that have used water report that it tends to cause caking of the product if the blend remains in the applicator overnight. Excellent results have been received with the use of 11-37-0. With 11-37-0, caking of the product and sensitizing of ammonium nitrate are avoided. Usually about 1 percent by weight 11-37-0 is required.

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Table 1. Operating and Loss Data for Ammoniation-Granulation Plant—Maryland

Test	No. 1	No. 2
Grade	10-10-10	10-10-10
Production rate, tons/hour	23	23
Formulation, pounds/ton of product		
Sulfuric acid (60° Bé.)	125	—
Superphosphoric acid (76% P_2O_5)[a]	—	150
Anhydrous ammonia	85	60
Ammonium sulfate (21% N)	630	729
Triple superphosphate (46.6% P_2O_5)	68	—
Normal superphosphate (19.7% P_2O_5)	854	436
Potash	323	323
Dolomite	—	324
Solid and Gaseous Discharges from Plant		
Losses (pounds/hour)		
Ammoniator-granulator		
NH_3	155	9
Cl	81.8	0.1
F	0.05	<0.01
P_2O_5	0.10	0.06
Plant stack		
NH_3	86	25
Cl	2.6	0.82
F	0.14	0.08
P_2O_5	2.55	1.8
Net solids in waste water[b,c]		
NH_3	77	4
Water-soluble solids	94	-54
Water-insoluble solids	165	106
Total	336	56
Net P_2O_5 in waste water[b,c]		
Water-soluble	1.4	5.6
Water-insoluble	46.3	32.2
pH of waste water	9.2	5.5
Opacity of stack (% estimated)	30-80	10-20

[a] Mixed acid from furnace-acid plant contained 20% of P_2O_5 from wet-process acid and 80% of P_2O_5 from elemental phosphorus.

[b] Total discharged, less amount in inlet water.

[c] Based on 270 gpm inlet water.

[d] Negative because of precipitation of solids from sea water in scrubber.

Table 2. Operating and Loss Data for Ammoniation-Granulation Plant—Missouri

Test	No. 1	No. 2	No. 3	No. 4
Grade	12-12-12	12-12-12	12-12-12	12-12-12
Production rate, tons/hour	15	15	15	15
Formulation, pounds/ton of product				
Anhydrous ammonia	241	303	78	87
Ammonium sulfate (21% N)	250	–	857	819
Normal superphosphate	–	451	–	–
Triple superphosphate	–	–	107	–
Wet-process phosphoric acid (54% P_2O_5)	340	289	150	311
Superphosphoric acid (76% P_2O_5)[a]	–	–	150	100
Sulfuric acid (94% H_2SO_4)	560	690	–	–
Hi-Grade (42% P_2O_5)	150	–	–	–
Sul-Po-Mag	25	–	–	–
Potash (60.5% K_2O)	388	397	400	400
Filler (sand)	135	–	286	–
Filler (1/3 limestone; 2/3 sand)	–	–	–	314
Solid and Gaseous Discharges from Plant				
Losses (pounds/hour)				
Ammoniator-granular				
NH_3	b	b	25.8	48.0
Dust	b	b	3.8	6.8
Dryer stack				
NH_3	13.6	18.9	9.6	21.0
Dust	2.7	2.0	1.1	3.0
Cooler stack				
NH_3	24.2	4.1	–	22.0
Dust	81.1	56.6	1.9	4.2
Total				
NH_3	c	c	35.4	91.0
% of total NH_3 fed	c	c	3.0	7.0
Dust	83.8	58.6	6.8	14.0

[a] Mixed acid, 20% of P_2O_5 from wet-process acid and 80% from elemental phosphorus. Produced in a furnace acid plant.

[b] Ammonia fumes were too strong in this area to permit sampling.

[c] Could not include loss from ammoniator-granulator.

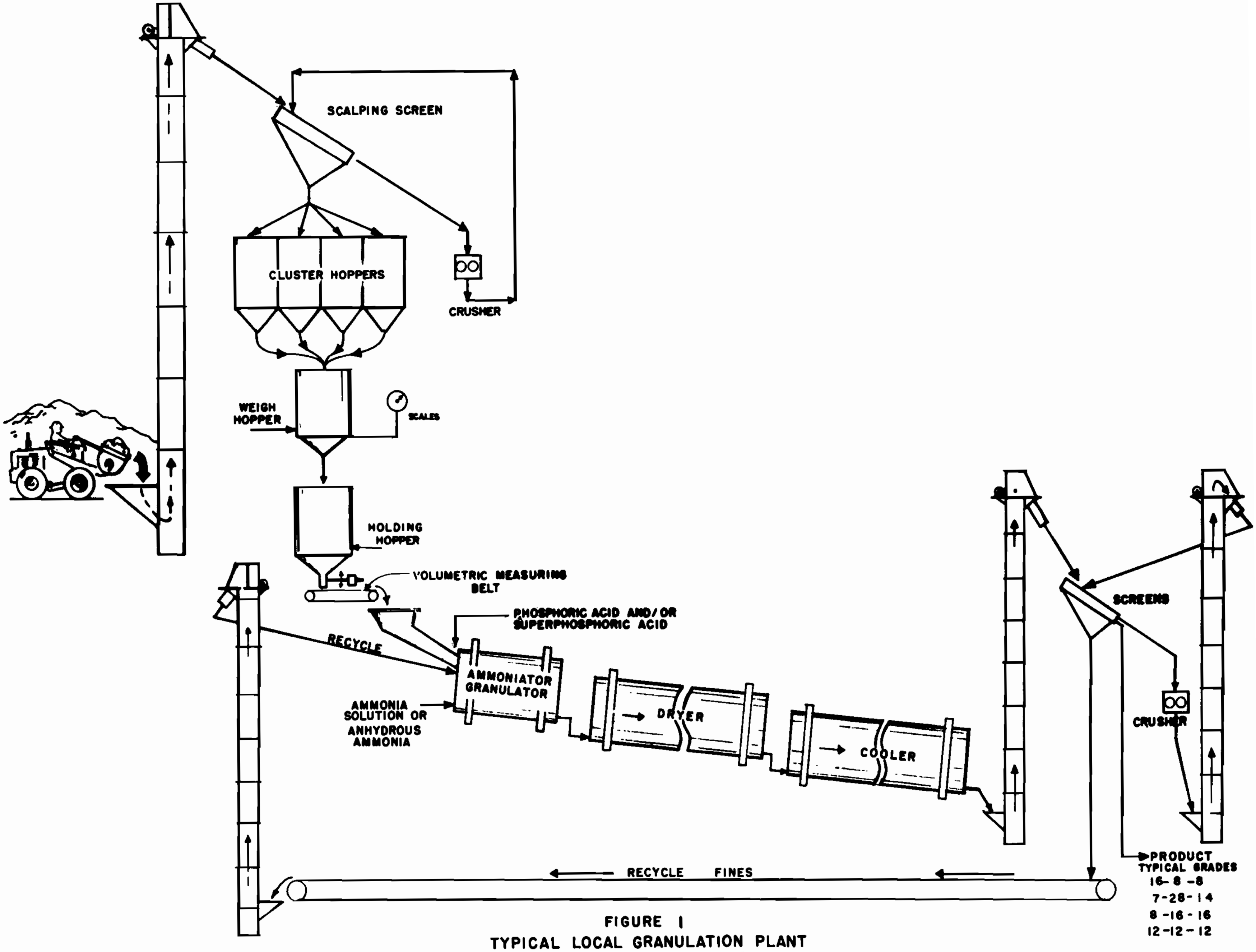


FIGURE I
TYPICAL LOCAL GRANULATION PLANT
USED IN UNITED STATES

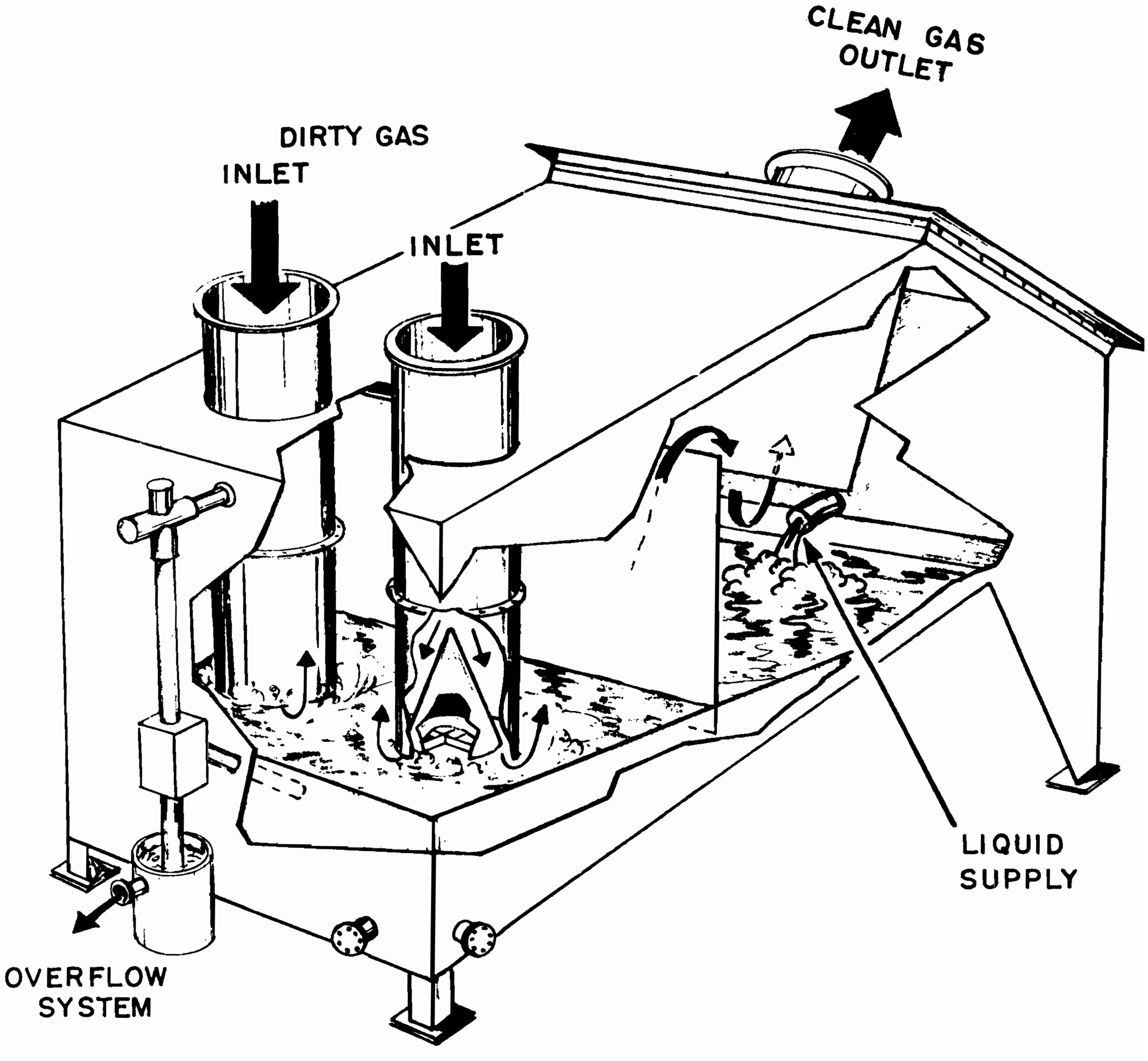


FIGURE 2

IMPINGEMENT TYPE SCRUBBER

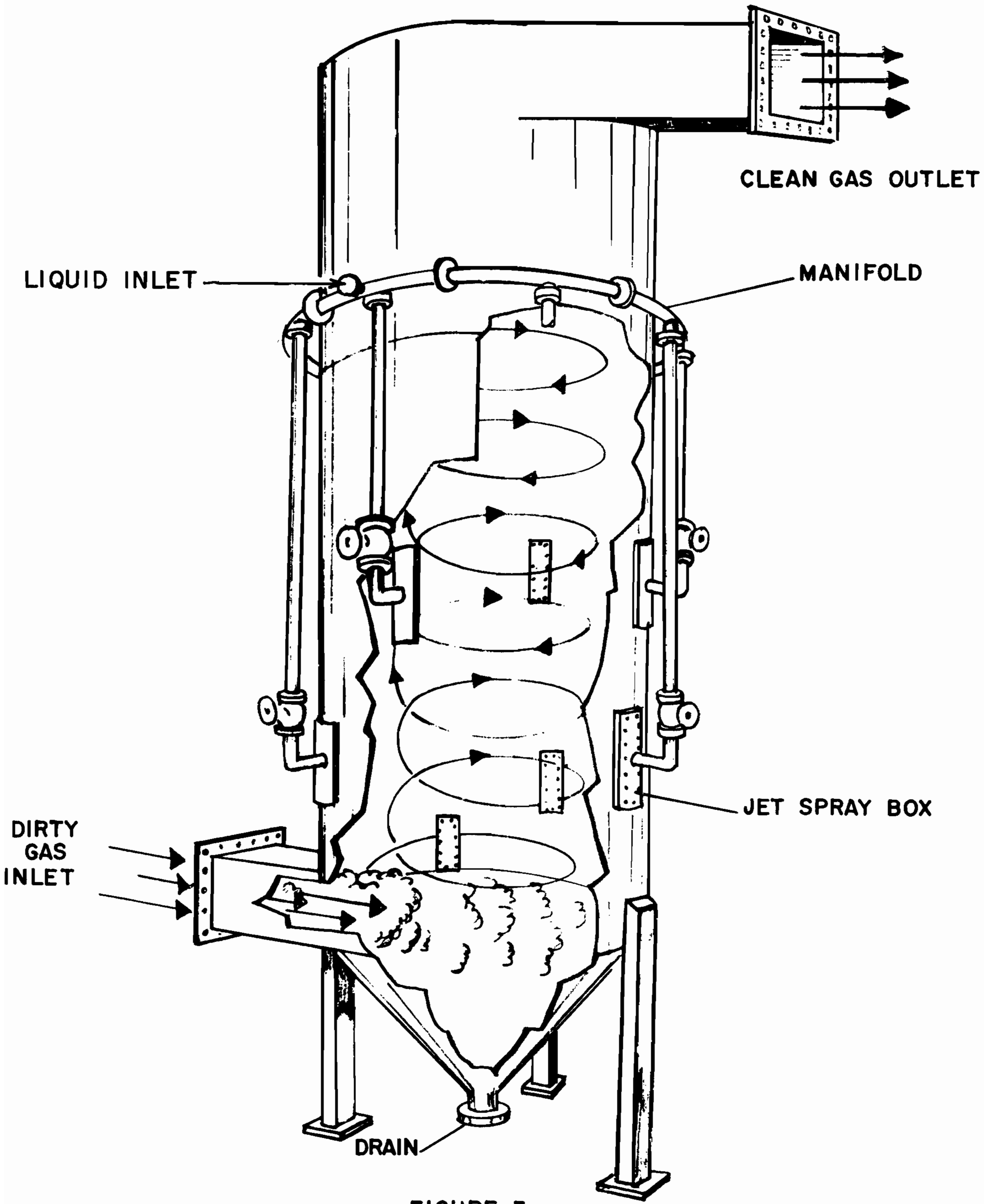


FIGURE 3
CYCLONIC SCRUBBER

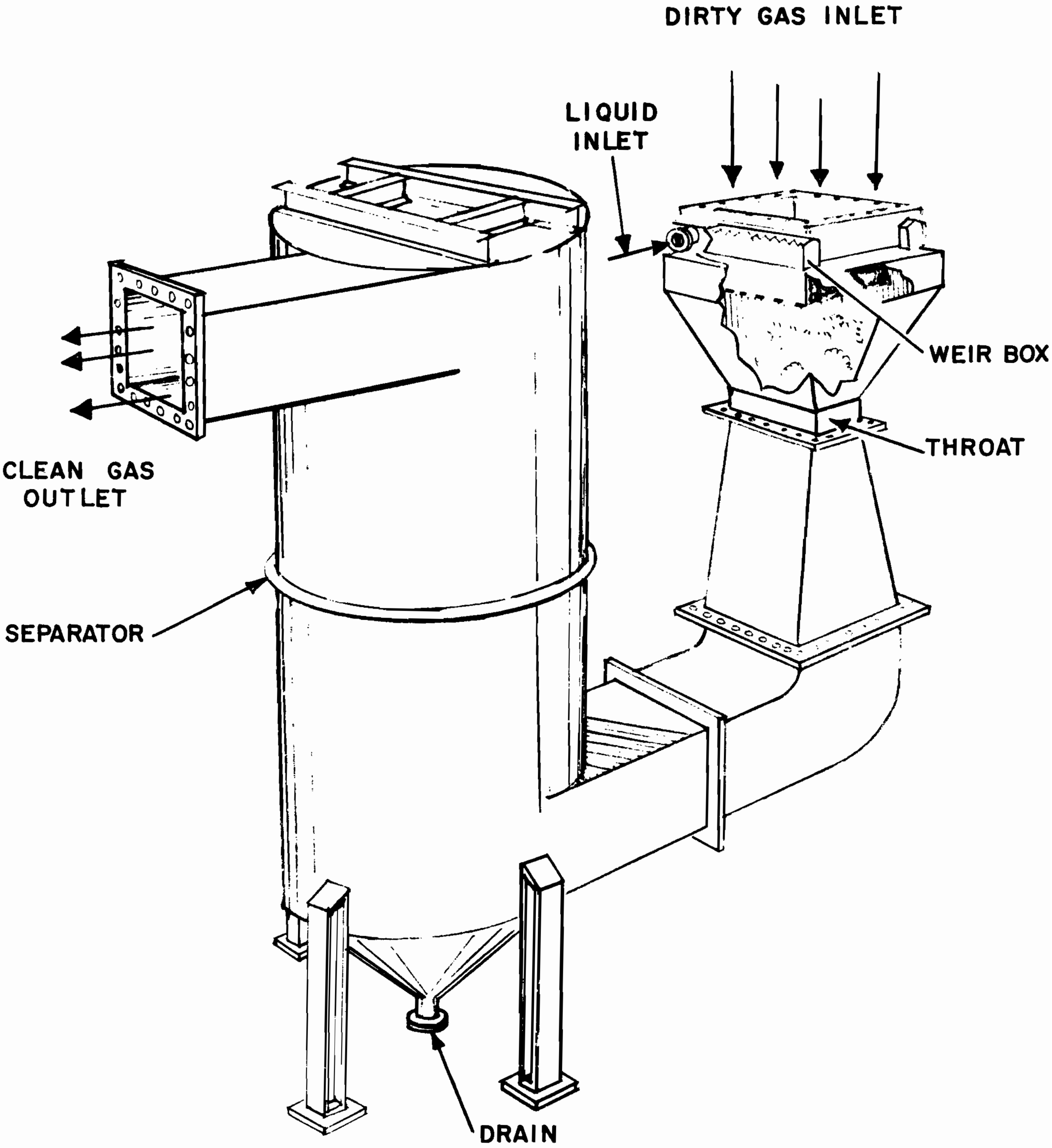


FIGURE 4
VENTURI SCRUBBER

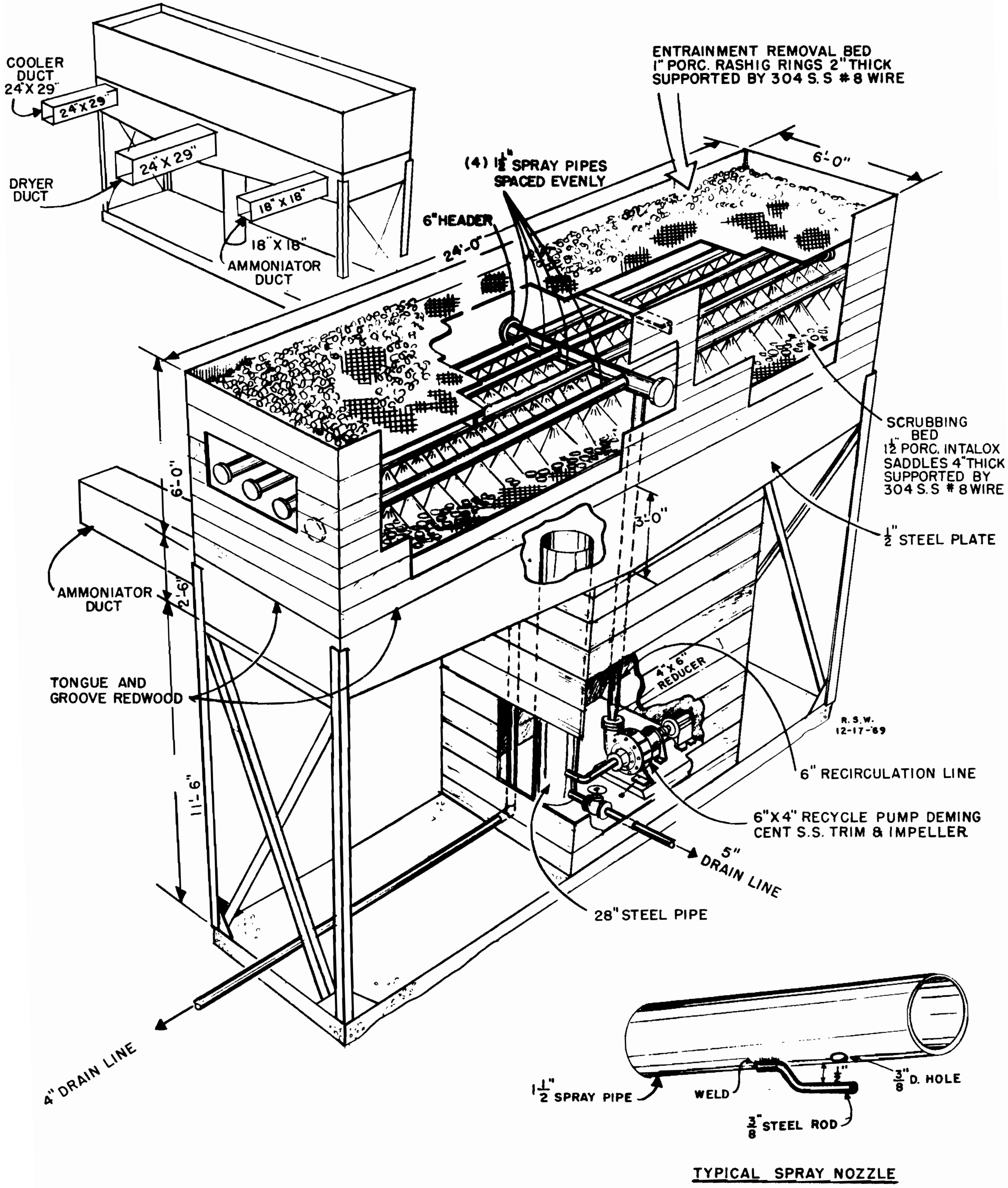
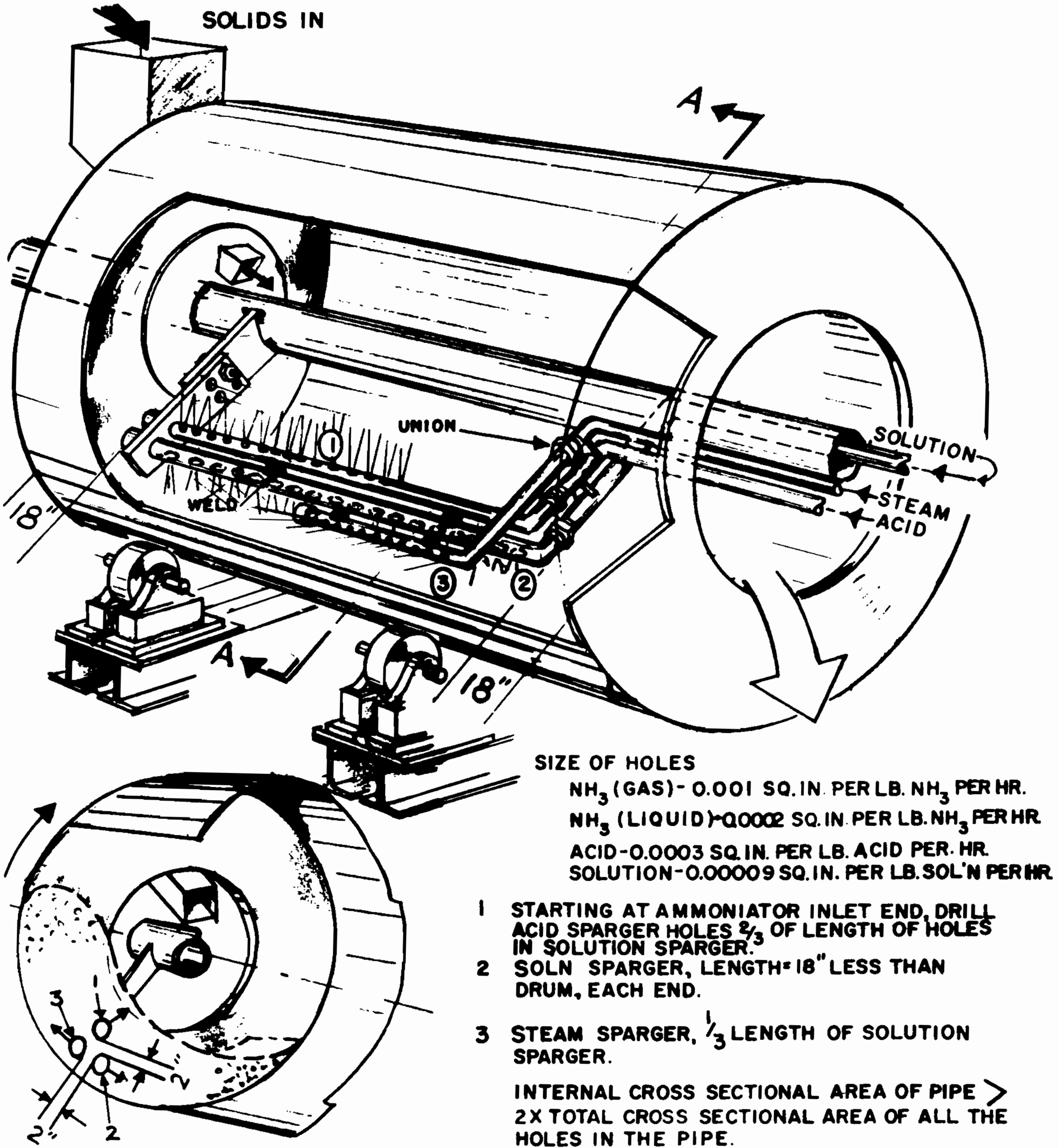


FIGURE 5
PACKED BED SCRUBBER



SIZE OF HOLES

NH_3 (GAS) - 0.001 SQ. IN PER LB. NH_3 PER HR.

NH_3 (LIQUID) - 0.0002 SQ. IN PER LB. NH_3 PER HR.

ACID - 0.0003 SQ. IN. PER LB. ACID PER HR.

SOLUTION - 0.00009 SQ. IN. PER LB. SOL'N PER HR.

1 STARTING AT AMMONIATOR INLET END, DRILL ACID SPARGER HOLES $2/3$ OF LENGTH OF HOLES IN SOLUTION SPARGER.

2 SOLN SPARGER, LENGTH = 18" LESS THAN DRUM, EACH END.

3 STEAM SPARGER, $1/3$ LENGTH OF SOLUTION SPARGER.

INTERNAL CROSS SECTIONAL AREA OF PIPE > 2X TOTAL CROSS SECTIONAL AREA OF ALL THE HOLES IN THE PIPE.

SPARGER FOR
CONTINUOUS AMMONIATOR GRANULATOR

FIGURE 6

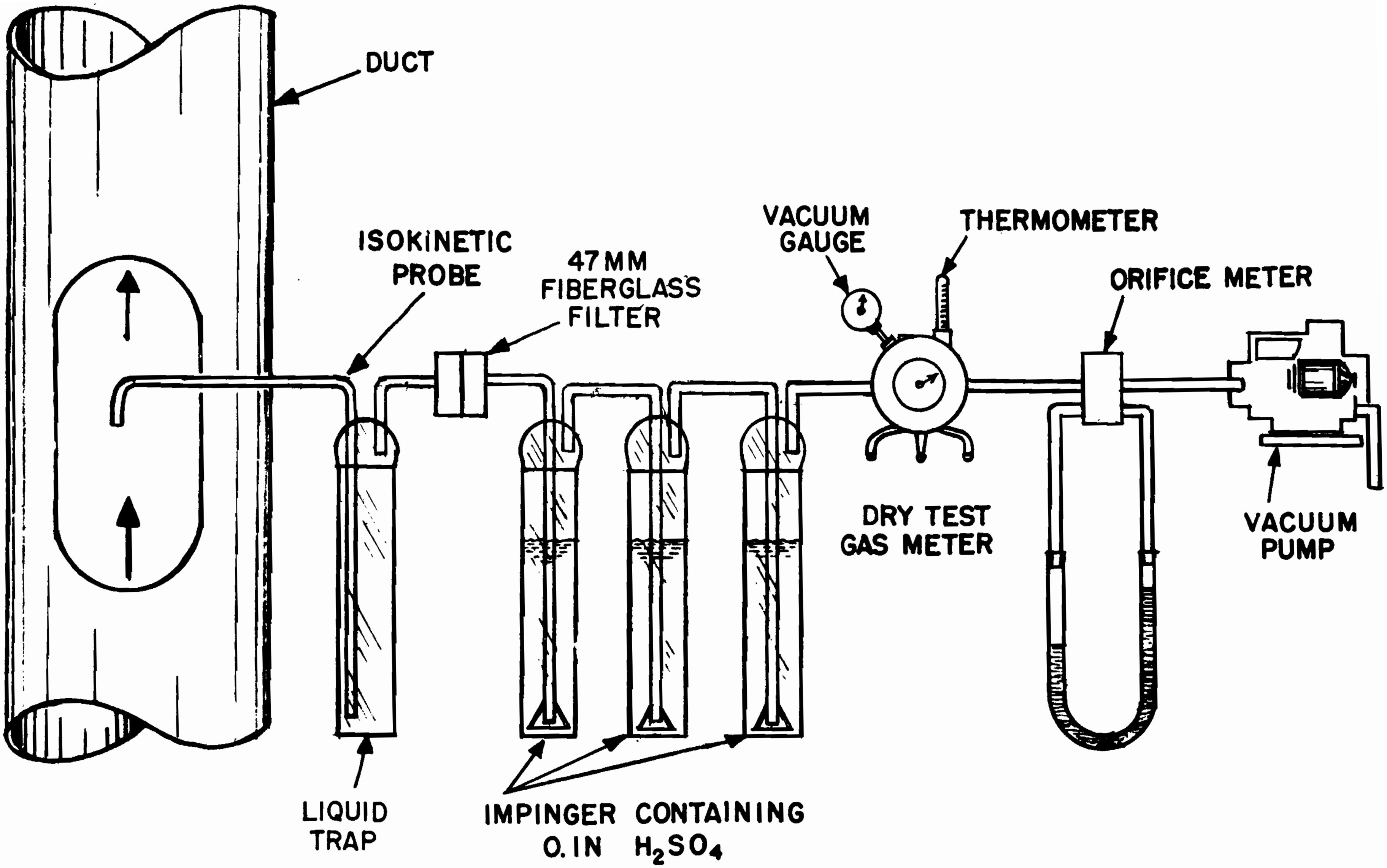


FIGURE 7

STACK SAMPLING APPARATUS

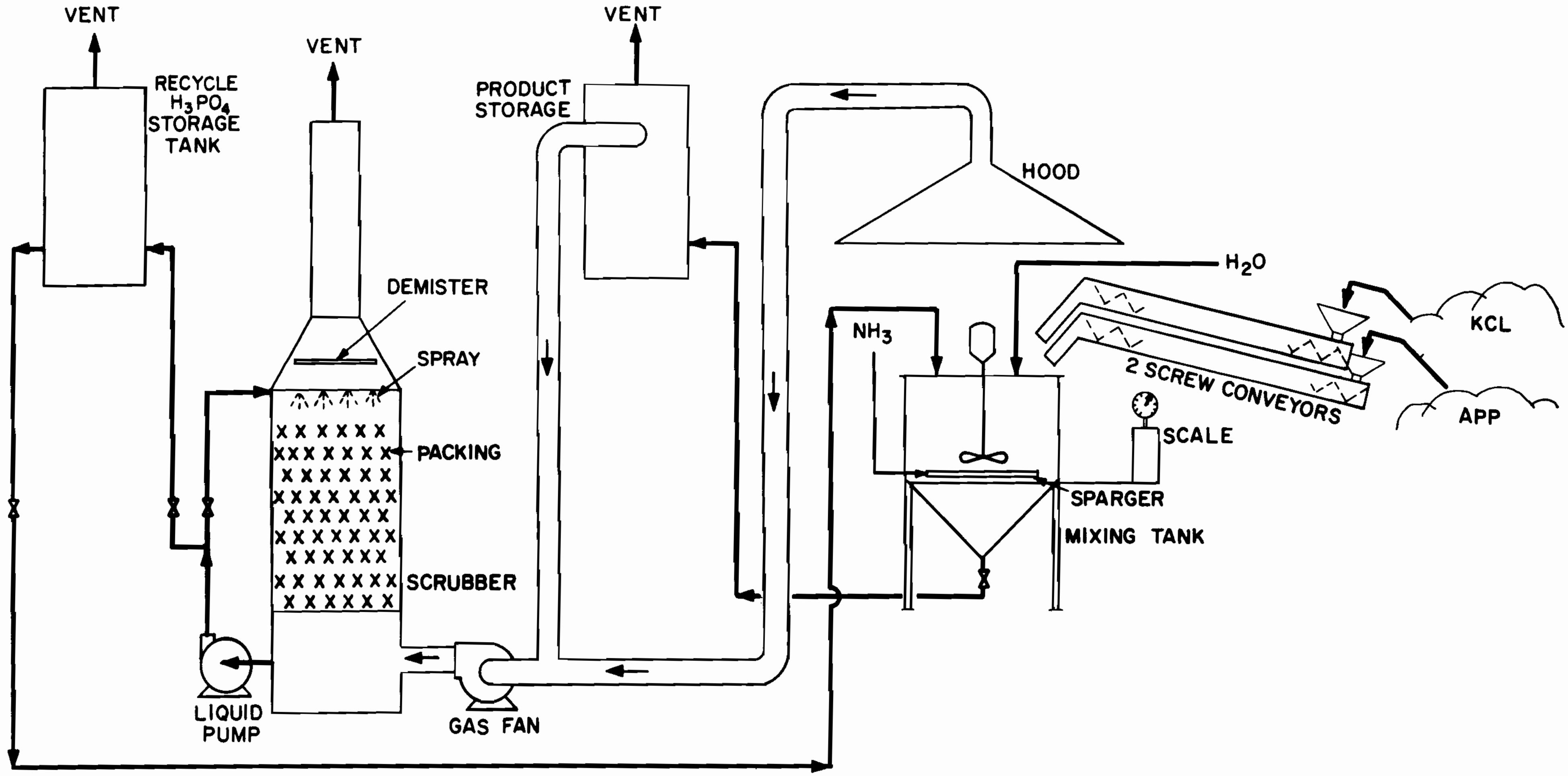


FIGURE 8

FUME SCRUBBING SYSTEM FOR FLUID FERTILIZER PLANT

Sampling Techniques For Effluents From Ammoniation-Granulation Plants

Edwin D. Myers and Charles H. Davis

INTRODUCTION

Stack sampling in the fertilizer granulation industry is generally related to measuring plant emissions to see if process material losses are within acceptable economic and legal limits and/or for process control purposes. Effluent rates are normally expressed in terms of quantity of process material per unit of time, per ton of product, per unit of gas volume, or as plume opacity. "Compliance" testing is for legal reporting purposes and often differs from sampling for process control purposes. Compliance stack sample tests would normally use the exact equipment and procedures specified by the control agency – such as the test methods issued by the State of Florida – and would probably be conducted over a period of 1 to 2 hours per test. (Continuous monitoring of granulator stacks for compliance may be a future requirement of control agencies; however, a different type of sampling train from those now specified would likely be necessary.) It is sometimes desirable and feasible to sample continuously for process control. However, sampling for short periods of time for process control purposes can provide valuable and reasonably accurate data. Each type of sampling train should be designed to serve the intended purpose, whether for compliance or for in-plant control. Each of these will be discussed separately.

Compliance Testing

On August 17, 1971, the Environmental Protection Agency (EPA), pursuant to Section III of the Clean Air Act, published "Proposed Standards of Performance for New Stationary Sources" in the *Federal Register.* These standards will become law on November 15, 1971. Specific sources cited are fuel steam generators, incinerators, portland cement plants, nitric acid plants, and sulfuric acid plants. At the present time, granulation plants are not included. However, nine test methods are described that probably will become a part of the official test procedures for granulation plants in about 18 months.

The test method most likely to affect granulation plant stack sampling is EPA's method No. 5, "Determination of Particulate Emission from Stationary Sources." The sampling train, which is shown as Figure 1, essentially consists of a stainless steel nozzle, a heated glass probe, and a box on the downstream end and firmly attached to the probe containing an all-glass cyclone and all-glass filter followed by four Greenburg-Smith-type impingers with glass ball joint fittings. The impingers are immersed in an ice bath. The first, third, and fourth impingers are modified by removing the tip and replacing with 1/2-inch-inside-diameter glass tubing. The first and third impingers act as moisture traps, the second impinger is for catching "condensables," and the fourth impinger is filled with 200 grams of silica gel for drying the air. All of these containers and materials are firmly attached to the probe. Following the impinger box is the metering system connected with flexible lines consisting of a vacuum gauge, airtight pump, dry test meter, and orfice meter in that order.

TVA has recently tested a method No. 5 sampling train and we have some experience in sampling gases from coal-burning power plant stacks. With only limited experience, we would suggest the following modification of the standard (1) EPA equipment that would be applicable to granulation plants.

1. Filter diameter be increased from about 2½ to at least 3 inches and preferable 4 inches diameter.
2. Elimination of all brass from the system such as the orifice construction and in vacuum gage parts that are subject to corrosion with ammonia.
3. Substitute 1 normal sulfuric acid for water in the impinger section to scrub out free ammonia.

TVA's discussions with EPA concerning method No. 5 have indicated that EPA will permit modifications in construction that will improve the equipment, such as use of stainless steel in fabrication of the box, strengthening of the probe connections, etc., that do not change the characteristics of the equipment.

It was the intention of EPA that legal requirements for using method No. 5 be restricted to new plants. Proper sampling sites could be selected and platforms, etc., built. However, some states are already incorporating the No. 5 method directly into their laws regulating existing plants. This trend will probably continue.

Technology for using method No. 5 is supposed to have been proved. Using this sampling method may cause some difficulties. These are as follows.

1. *Stacks smaller than 12 inches inside diameter.* The physical size of the probe and Pitot tube makes it impractical to traverse any ducts smaller than about 12 inches inside diameter.
2. *Very large stacks.* The all-glass probe has a maximum length of about 8 feet. For very large diameter scrubbers, the probe will not extend into the central areas that require sampling.
3. *Stacks with cyclonic airflow.* Some scrubbers have a demisting section that gives the air a spin as it leaves the scrubber. The air travels up the stack very much like a tornado, impinging mist on the side of the stack. Accurate measurement of air velocities is impossible with a Pitot tube and, therefore, isokinetic sampling is impractical for cyclonic conditions.
4. *Possible reaction with fluorine.* Fluorine gas entering the all-glass probe can react with the probe to form silicon tetrafluoride which is also a gas. Such chemical with fluorine-containing erroneous results. Furhter research with fluorine-containing gases is needed with this sampling system.
5. *The equipment is expensive, difficult to handle on a stack, and easily broken.*
6. *Measurement of the gas flow is dependent on*

an "airtight" or "leakproof" pump. Any leakage can result in errors of gas volume measurement.

7. *Water in the impingers could chemically react with condensable materials passing through the filter.* This could result in errors in measurement of quantity of condensables.

In addition to testing for compliance with Federal regulations, sampling to satisfy state and local governments may also be required. Sampling methodology will vary with different situations, but it seems likely that some method similar to the EPA No. 5 will be required in many situations.

Monitoring and Plant Control Sampling not Required for Legal Compliance

Plant owners and operators may be asked to produce records of losses at times other than during periods of compliance tests. For example, local air pollution control authorities might approach your plant suggesting stack emissions were in violation of permissible limits the previous night. Our experience indicates a need for stack monitoring on either a continuous or intermittent basis as a necessary step in pollution control. Such sampling is also a valuable guide in controlling many processes. Since the EPA method No. 5 is not designed for continuous sampling and is restricted to periods no longer than about 2 hours, other methods of stack sampling that are acceptable to control authorities need to be developed. Generally, any pollution monitoring train should be built for continuous or long-term operation and should be tested against standard procedures established and approved by the state air pollution control agency.

General-Purpose Sampling Train Used to Sample Granulation Plant Stacks

We have used the general-purpose train to successfully sample granulator exhaust stacks and scrubbers, even stacks exhausting substantial amounts of mist. This train, which is given as Figure 2, consists of a stainless steel isokinetic nozzle and probe followed by a 5-inch-diameter heated filter, a condenser, and a trap or two impingers in series if gas scrubbing, such as for ammonia, is desired. A dry test meter reads total volume, and an orifice meter is used to determine flow rate and establish isokinetic flow at the nozzle. Two unique features of this sampling train are the 5-inch heated filter and the polyethylene tubing connection from the filter holder to the condenser or impingers.

The 5-inch filter will handle a fairly heavy dust load without plugging. Direct application of heat to the filter will promptly evaporate any mist or condensate entering from the probe. Water vapor passes on through and is condensed in the next container. Heating the probe so that water enters the filter as vapor is not necessary.

Some care should be exercised not to overheat the filter and decompose ammonium salts deposited on the filter. However, any salts decomposed will be collected by the impingers. Temperature regulation of the filter depends upon mist load and is usually established by experience after 1 or 2 samples are collected.

Following the impingers, rubber tubing may be used.

This all-purpose sampling train probably meets or exceeds present equipment requirements for most states, but it does not meet the all-glass requirements of the EPA. However, by using polyethylene and all-glass connections the characteristics of the train should be about the same as method No. 5 without having an impinger box attached to the end of the probe.

A sampling rate of 0.5 to 1 cfm at 1 atm is used to establish isokinetic conditions at the nozzle. If the impingers are well packed in ice, gas leaving the third impinger will be about 40^{o}F. Vacuum at the dry test meter should range from 2 to 10 inches Hg. Any sudden increases in vacuum generally indicate that the filter has become wet. Application of more heat to the filter usually reduces the vacuum to the normal level.

Sampling time ranges from 2 to 6 hours. However, shorter periods may be used for plant control purposes or if plant operation is interrupted and sampling has to be discontinued.

Particulate collection on the filter should be sensitive to about ±0.5 milligram. The skill used in removing and drying the filter, washing out the probe, and handling the sample actually determines the sensitivity. With sampling times of 2 hours or more, inaccuracies of 1 or 2 milligrams are not normally too important.

Sampling Off-Gas from Thermal Phosphoric Acid Plant

One continuous monitoring method for consideration is TVA's sampling train for a thermal phosphoric acid plant. The train of equipment is given as Figures 3 and 4. A 10-point sampling probe is inserted into the exhaust duct to sample P_2O_5 fume that has passed through a venturi scrubber and mist pad removal system. The submicron P_2O_5 fume is drawn through ten 9/64-inch-diameter holes at right angles to the airflow. The holes are at right angles to prevent plugging by insoluble particulates. With this system the total of the cross-sectional area of the holes should not exceed one-half of the cross-sectional area of that portion of the sampling tube containing them (2). The gas which is under pressure flows into the control room through stainless steel tubing where condensate is caught in a trap. The gas then flows through two Greenburg-Smith impingers in series to remove P_2O_5 and to a wet test meter to measure volume.

This sampling train, which has been in operation several years, was tested in comparison with EPA method No. 5. Results were about the same. Loss data from this acid plant using the multipoint probe and impinger train were published by the U.S. Department of Health, Education, and Welfare (3). Since P_2O_5 fume is similar to ammonium chloride fume from a granulator, the multipoint probe and impinger train might be acceptable to some state or local control agencies for sampling a scrubber exhaust from a granulator.

TVA is now experimenting with a single-point isokinetic stainless steel probe at the top of a 200-foot stack in which fumes from three different phosphoric acid plants enter into the stack near the bottom. A plastic tube brings the sample from the short probe into the control room, a distance of about 250 feet, where condensate is trapped and the remaining gas is scrubbed in impingers with all-glass connections. Preliminary results are similar to those data collected with the 10-point probe previously mentioned. A sketch of this sampling arrangement is shown as Figure 5.

Sampling of Aqueous Scrubber Effluent

One method used to estimate process dust losses from specific items of equipment is to sample and analyze the liquor from the wet scrubber which scrubs the off-gases. The aqueous effluent flow is totalized by a flowmeter and a continuous sample of the aqueous effluent is obtained with a tilting pan sample splitter which is a TVA design.[1] A sketch of this sampler is shown as Figure 6. Stack losses downstream from the scrubber can be measured and added to the losses in the aqueous effluent to provide an estimate of losses to the scrubber.

Conclusions

The method used for sampling stack gases will be influenced to some degree by the objective of the work. If the objective is to get information for compliance to regulations, then the sampling equipment must satisfy the requirements of the regulatory agency. Federal regulations relating to sampling from granulation plants have not yet been set, but it is likely that EPA method No. 5 will be specified with some slight modifications. There are significant problems in using this sampling in granulation plants, and some improvements need to be made.

If sampling or monitoring is not for compliance, more expedient sampling procedures and equipment can be utilized. These procedures should conform to Government regulations to the extent practicable to minimize duplication of sampling equipment and operation.

[1] TVA drawing No. A16996 RO. Available from Process Engineering Branch, TVA, upon request.

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2. *The Institution of Gas Engineers,* "Controlled Operation of Carburetted Water-Gas Plants, Part II," Grosvenor Gardens, London S.W.I., p. 28 (Nov, 5, 1935).
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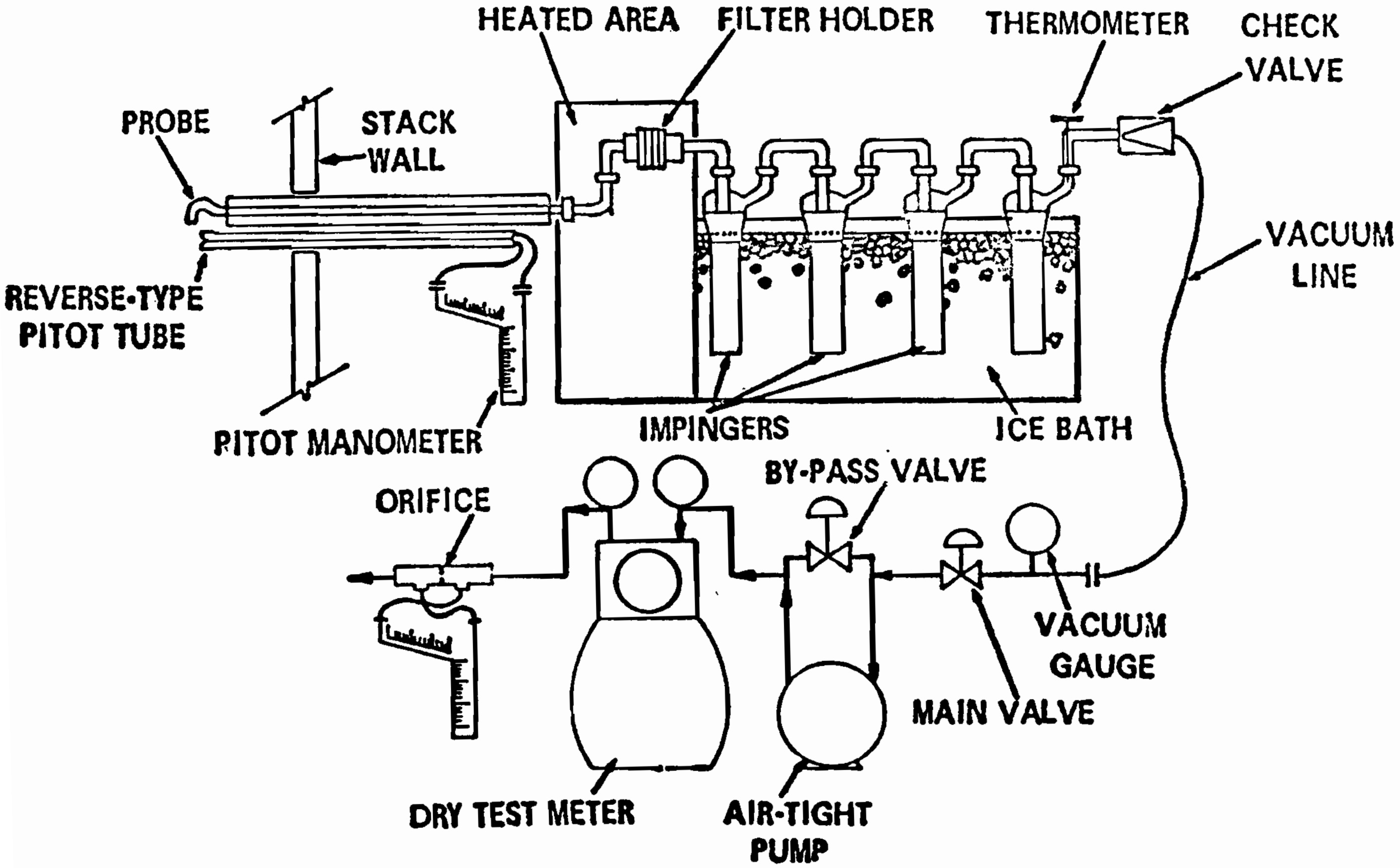


FIGURE 1

EPA Method No. 5--Particulate-Sampling Train

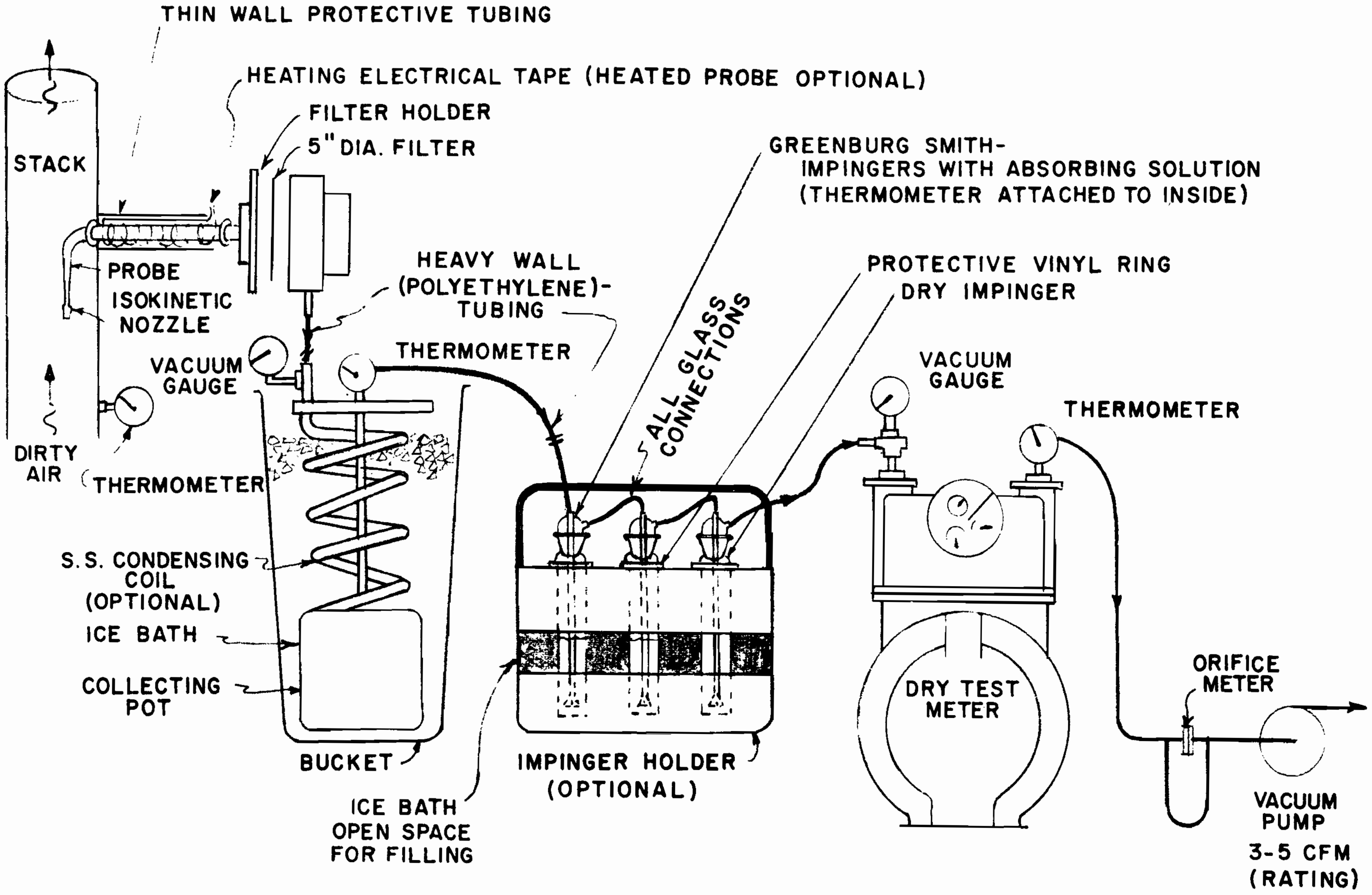
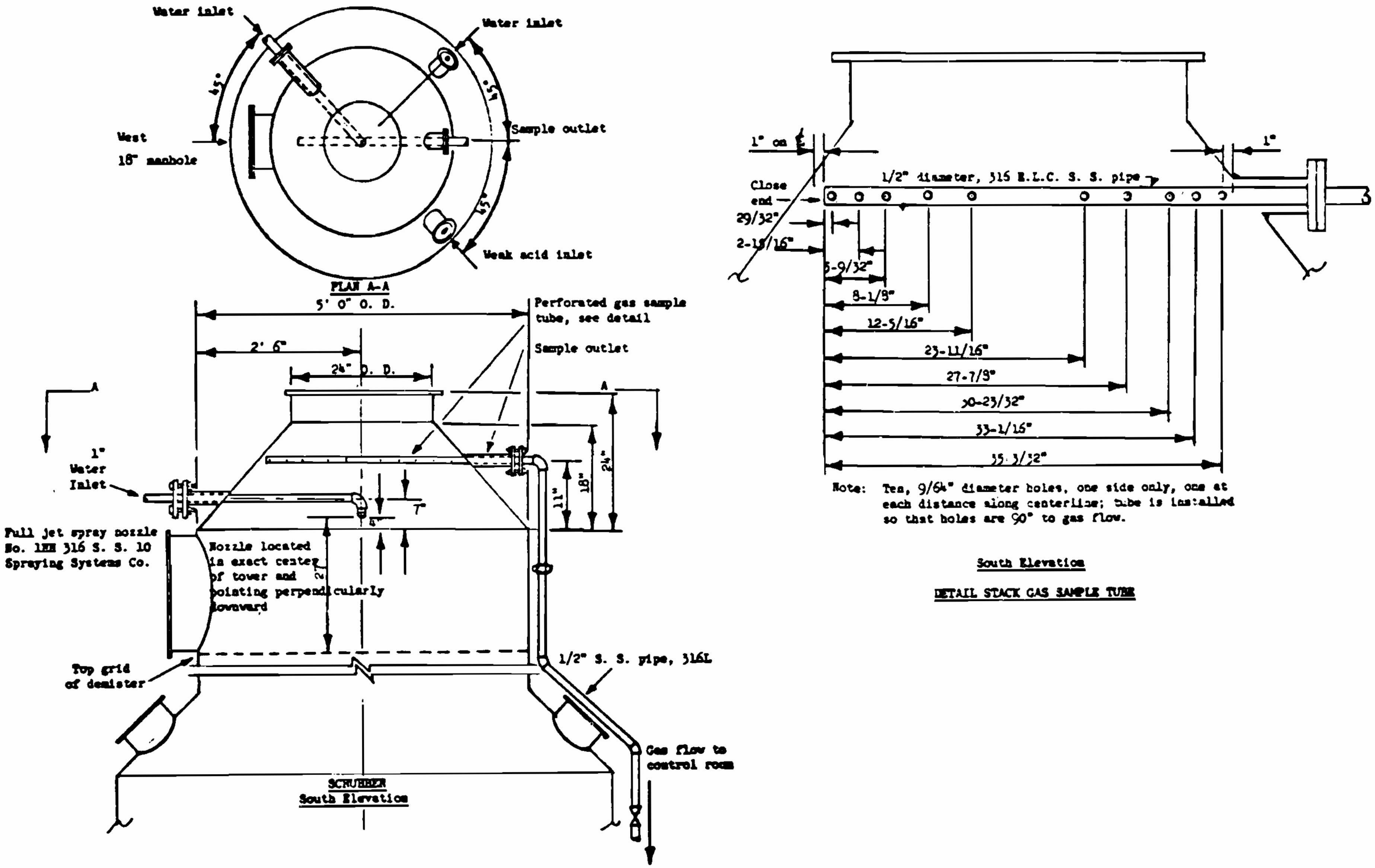


FIGURE 2

SAMPLING TRAIN FOR PLANT CONTROL PURPOSES

SAMPLING TRAIN FOR PLANT CONTROL PURPOSES IN OPERATION.

Figure 2-A



Note: Ten, 9/64" diameter holes, one side only, one at each distance along centerline; tube is installed so that holes are 90° to gas flow.

FIGURE 3

Stack Gas Sample Outlet and Water Distributor in Cone Section of Scrubber Tower--No. 6 Phosphoric Acid Plant

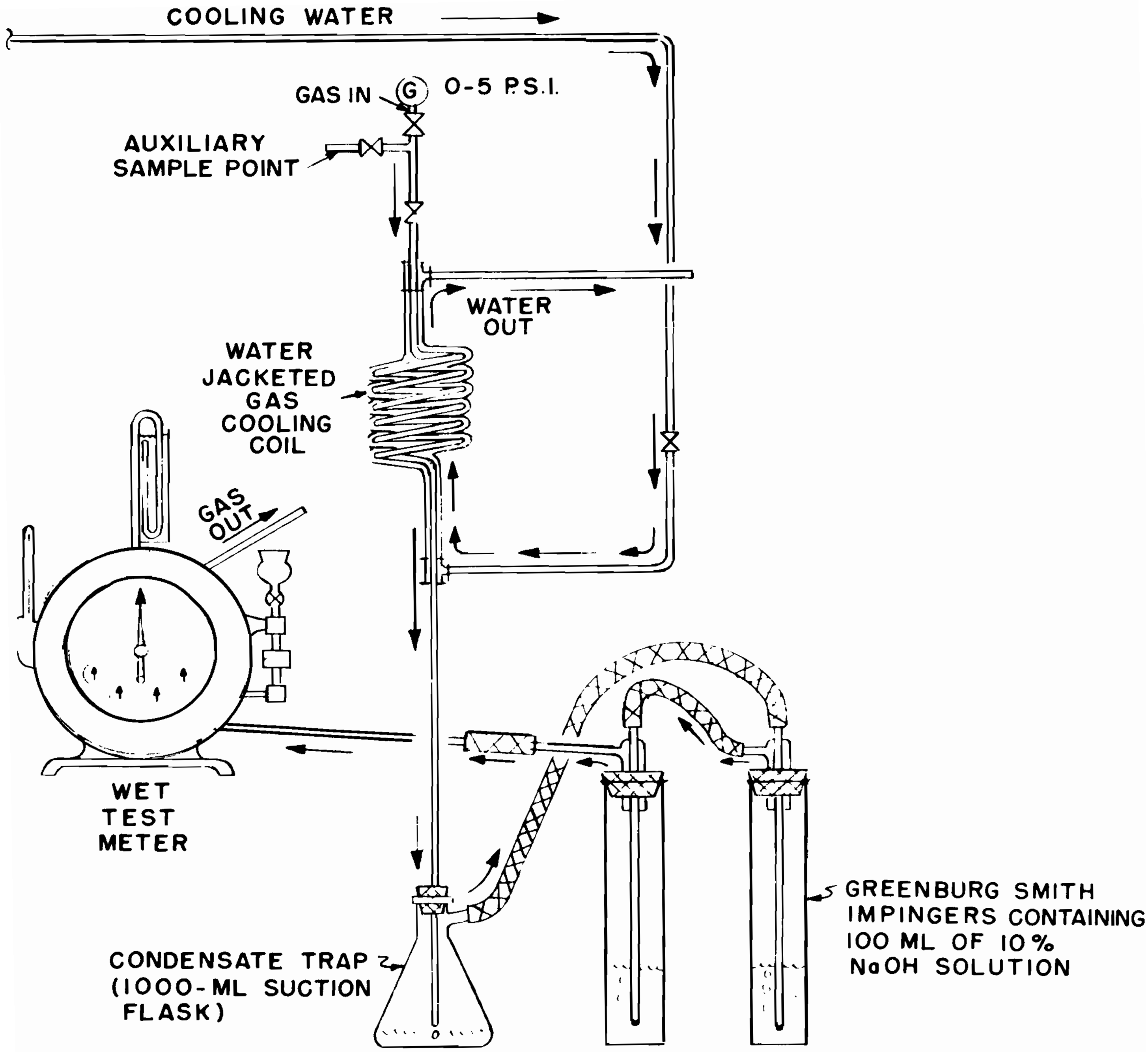


FIGURE 4
SAMPLING TRAIN FOR REMOVING P_2O_5, F AND SO_3 FROM STACK SAMPLE GAS- NO. 6 THERMAL PHOSPHORIC ACID PLANT

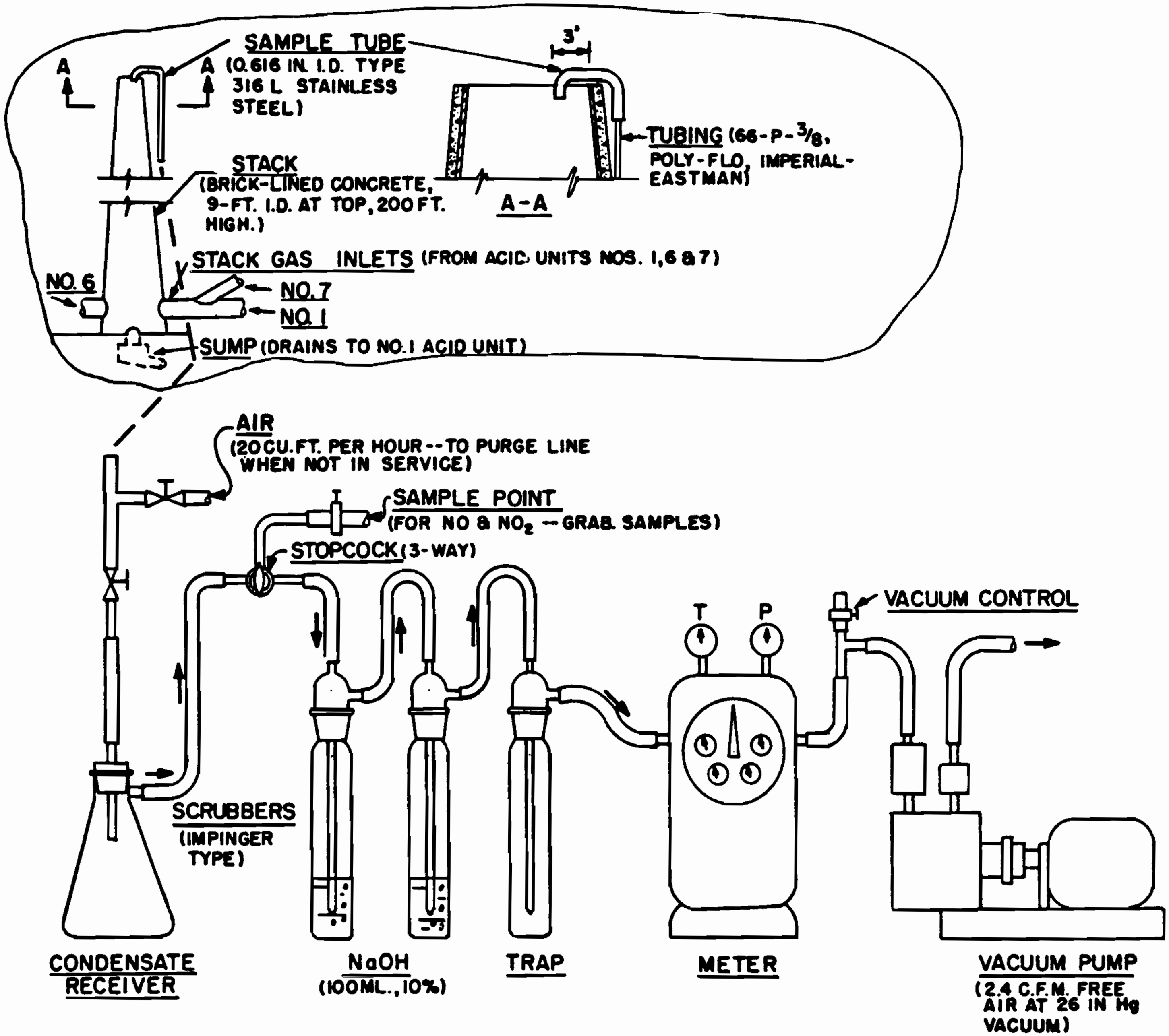


FIGURE 5

Gas-Sampling Apparatus - Big Fume Stack for Gas from Nos. 1, 6, and 7 Acid Units

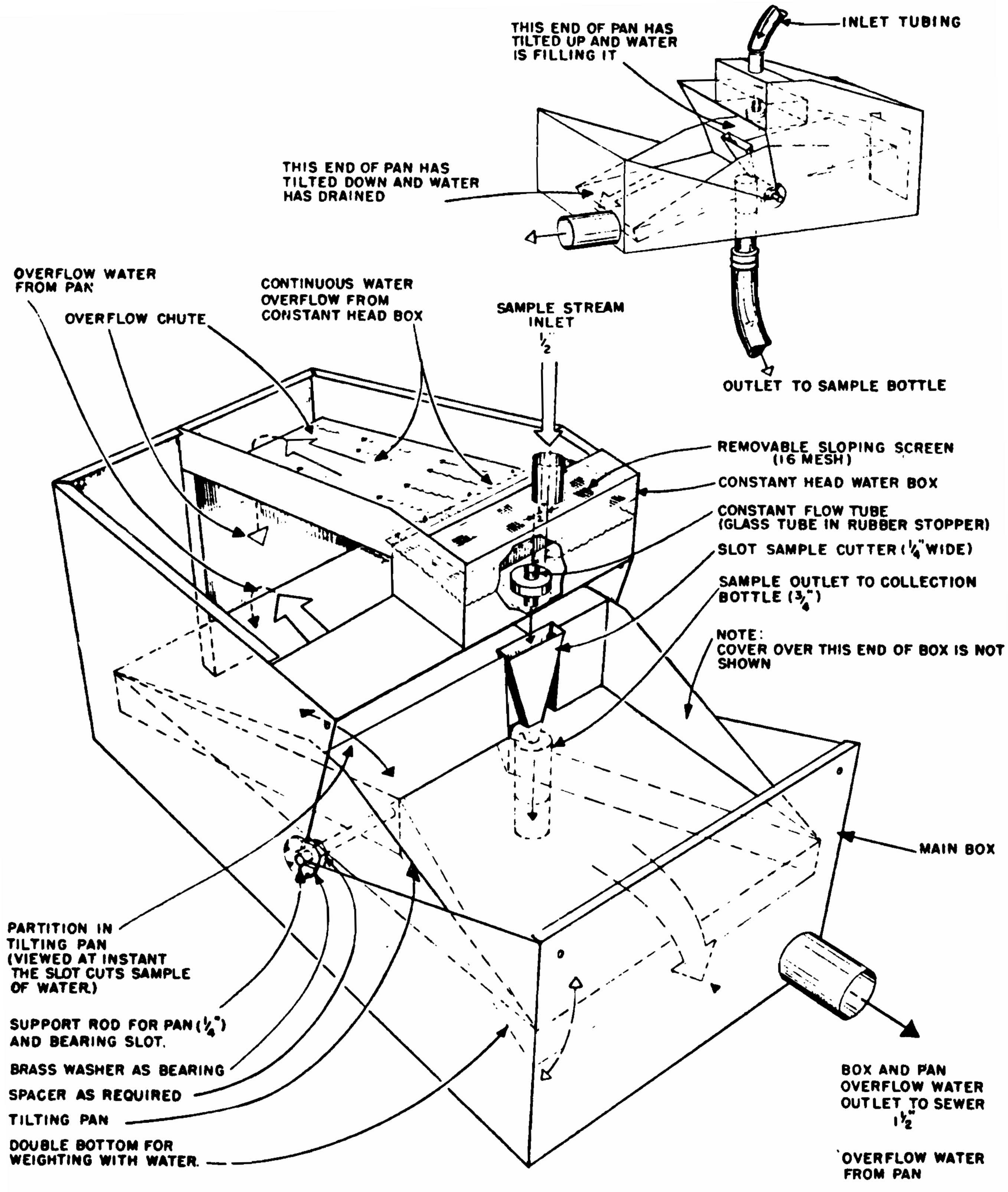


FIGURE 6

Perspective Sketch of Tilting Pan Continuous Sampler

Impact of Fertilizers on Lakes and Streams

T. H. McIntosh

Consideration of the impact of fertilizers on lakes and streams involves looking at the system wherein man resides (Figure 1). In simplest form, man is a part of the biosphere or ecosystem which exists as an interface between the atmosphere, hydrosphere and lithosphere. Modern civilization has developed as man has learned to increase his ability to manipulate the flow of energy and materials in the ecosystem. Hence, as we examine the impact of fertilizers on lakes and streams, we must be fully aware that manipulation by man of fertility levels in the biosphere has indirect as well as the direct effects in the ecosystem. For example, man has for many years incorporated in his fertility programs utilization of the sun's energy to fix nitrogen via the legume-rhizobium symbiosis. Since 1950 man has increasingly used fossil fuel energy to fix nitrogen, thereby greatly augmenting the total fixed nitrogen available for fertility management. Thus, the same farmer can now raise more grain using land and labor released from production of fixed nitrogen. The result (Table 1) during the past 20 years has been an increase in food production, a decrease in the amount of land in cultivation, and continued urbanization. The urbanization trend had been accelerated a little earlier by substitution of fossil fuel for horse power.

Now consider the net effect: 20 years ago a large percentage of the nitrogen and other elements was cycled from soil to plant to animal to soil within an area of a few miles. Today large amounts of fertilizer go from mines to industry to farm to city, where a considerable percentage now goes through either the garbage disposal or toilet to an inadequate sewage treatment plant and hence to the stream, river, lake and, eventually, to the ocean.

C. C. Delwiche estimates that the net gain in fixed nitrogen in the world amounts to 8.7 million metric tons per year (Table 2). Industrial fixation of nitrogen accounts for about 30% of the total nitrogen fixed per year, i.e. about 30 million metric tons, and probably will increase by the year 2000 to about 100 million metric tons, or 50% of the total nitrogen fixed per year by all mechanisms. The annual net gain of fixed nitrogen in the biosphere by the year 2000 depends upon how we manage our wastes, including sewage and air exhausts from combustion processes as well as those from fertilizer application. Delwiche estimates that currently 10 million metric tons of nitrate-nitrogen and 20 million metric tons of organic-nitrogen are moving from the land into the oceans every year.

I have emphasized nitrogen transformations because they form one of the few basic cycles man has learned to manipulate on a macro scale. The time-rate of change of additions as compared to losses through denitrifications becomes significant in terms of both added fertility in water systems and potential toxic effects. Animal systems, including man, have a low tolerance to nitrate. Nitrate in the digestive system is reduced to nitrite which, if abosorbed into the blood stream, has an effect (Methemoglobinemia) comparable to carbon monoxide poisoning. In most areas that have current nitrate problems in water supplies the causes are not related to fertilizer application. However, some recent studies indicate that ground or tile drainage waters at times carry substantial nitrate concentration. Some of our colleagues point out that under most farming conditions there is little opportunity for nitrogen loss by leaching during the growing season, except in irrigated lands. The danger, of course, lies in the application of nitrogen when crops are not growing but soil temperatures are above 4°C (40°F) and moisture is present. Excessive fertilization, i.e. application of more nitrogen than can be efficiently recovered in the crop plant, is also potentially hazardous. Leaching usually is a very slow but fairly continuous process. Hence, small additions of nitrate to the water table over time can add up to contaminated ground water – a very difficult problem to correct. Some recent studies indicate that ground or tile drainage waters are beginning to carry increased nitrate loadings.

Next let us consider some of the possible biological changes in aquatic systems if fertilizers and associated soil materials enter those environments. Such considerations should include not only fertility sources, but also related mechanisms of transport and physical-chemical changes influencing the amount and availability of fertilizer nutrients to the aquatic organisms. We can only touch briefly on these items here, but detailed information on the state of the art is available elsewhere. Whether the ultimate effect of a fertility change in an aquatic system is of no consequence, desirable, or detrimental depends upon the specific aquatic system in question and thus is beyond the scope of this paper.

As a starting point, consider the question of "Why are fertilizers applied to Agronomic and Horticultural Crops?" The economic or aesthetic returns derived from *increased* productivity of a desired plant component influences the decision. Note that changing the availability of a nutrient in amount or time is the major mechanism used in arriving at a desired goal. Thus, although a nutrient is rarely so limiting as to *prevent* plant production, it is nevertheless quite possible to obtain increases in numbers of plants or quantity of plant material with augmentation of natural or background fertility. Most lakes and streams contain sufficient natural fertility to support the growth of a sizable amount of biological material and a great diversity of types of species. Like a terrestrial system, increasing the fertility level of an aquatic system can lead to increased total biomass production or occasionally favor the accelerated growth of a specific biological species.

However, in a specific aquatic system as in a specific soil type, a single factor may limit total production of biomass. Introduction of increased quantities of a limiting nutrient (or elimination of a limiting factor) can lead to dramatic increases in biomass production. As you may recall, the introduction of anhydrous ammonia fertilizer 20 years ago permitted some rather dramatic demonstrations of biomass being stimulated by removing a single limiting nutrient – nitrogen (Figure 2). A similar phenomenon in an aquatic system where a single factor barrier is overcome may result in an algal bloom, also quite dramatic. You may also recall that a vocal group in the 1950's claimed nitrogen is the key – put on plenty and your crop production problems are solved. Some of the instant environmentalists more recently have claimed that phosphorus is the key – keep it out of our aquatic systems and our problems with algae blooms are solved. Such simplistic approaches are doomed to failure because biomass production is part of and regulated by a complex system of controls collectively known as an ecosystem. One must consider not only nutrients but also *energy, environment* and *presence of specific organisms.*

In Table 3 are listed most of the nutrient factors necessary for biomass production, especially for algae and rooted aquatic plants. Carbon is taken up as CO_2 by algae. Much CO_2 is released from bacterial action when sewage effluents or other sources of organic materials enter lakes and streams. Hence, sewage effluents have been suggested as the major if not only cause for algae blooms. However, any physical mechanism which causes mixing of water and air can increase the CO_2 content of water and help stimulate a bloom if the other requirements for biomass production are present. Reducing the B.O.D. content of sewage by proper treatment is very important, but sewage also contains sizable amounts of nitrogen, phosphorus, sulfur, trace elements and growth factors such as vitamins, all of which are important to algae growth, especially the blue-green algae. The blue-green are responsible for or are a major component of most undesirable blooms. We know little about the importance of trace elements in regulating the species or development of algae blooms. We do know that 60 to 70% of the algae studied benefit from or require specific vitamins for growth, even though the algae are otherwise phytosynthetic autotrops. Both sewage and surface soil materials are good sources of vitamins. It has been suggested that differential vitamin availability during the growing season may be important in regulating algae succession.

The undesirable feature of eutrophication, i.e. the accelerated aging of a lake, is not simply the enrichment of water with nutrients such as nitrogen and phosphorus. Furthermore, eutrophication is not algae production per se, as for instance a bloom of diatoms may be beneficial to fish production. Rather the change in type of algae which result in "obnoxious" blooms is the most important consideration. The blue-green algae are usually associated with the obnoxious bloom not only because of excessive production of biomass but also they produce toxins which adversely affect the food chain. Such change leads to production of trash fish or no fish, if the algae die-off depletes the 0_2 supply. In addition, the algae bloom clogs filters and water intakes of potable water supply plants, can produce odors in the water, and the toxins produced may be harmful to animals including man.

Another fundamental concept necessary for considering the potential impact of fertilizers on aquatic systems comes from the basic laws of physics: "Conservation of matter – i.e. mass or matter can neither be created not destroyed." There is one exception involved with certain nuclear or radioactive changes where subatomic mass is converted to energy. However, this phenomenon is of no consequence in our considerations here. The environmentalists state the conservation law in colloquial terms as "Everything must go some place." Unfortunately some vocal groups proclaim that fertilizers are rapidly moved in large quantities from land to lakes and streams in storm runoff. Equally unfortunate is the counter claim by some agriculturalists that so little movement occurs and the amounts moving are so insignificant that fertilizer materials are not a contributor to eutrophication. Again we deal with complicated systems including transport phenomena and physical-chemical transformations. Thus, even "properly applied" fertilizers increase the probability that adjacent aquatic or ground water systems will receive additional nutrients. Whether any significant contribution to biomass production or toxicity occurs depends upon the amount and rate of fertilizer entry into the aquatic systems plus the nature of the aquatic system.

Because of the high sorptive capacity of most soils for added phosphate ions, the ground water drainage tends to reflect the phosphate status of the soil minerals and is little influenced by fertilization at present. However, erosion removes the finer textured materials preferentially from the soil surface. These silt and clay-sized particles can carry into waterways substantial amounts of phosphate in mineral and organix forms Suspended sediment can even be a detriment to algal growth when light penetration is substantially reduced. As the sediment load of a stream is carried into lakes, reservoirs or large pools, most of the material will settle. Decompostion of organic materials in the sediment and of organic debris added by aquatic organisms tends to induce anaerobic conditions in and near the sediment layer. Three anaerobic or reducing conditions increase the solubility of phosphate compounds, thus increasing the concentration of phosphate in the aquatic system. The net effect is to permit increased nutrient cycling in the lake, thereby encouraging eutrophication.

An eutrophic body of water generally has higher rates of nutrient cycling, content of biomass, higher numbers of trash fish if fish are present, and lower numbers of kinds of organisms, oxygen content, depth, and volume (Table 4). Pollution or "eutrophication" of a river generally occurs downstream from point discharges of sewage outfalls or large feedlots. Erosion, surface runoff, and ground water additions are diffuse additions to a stream. However, where a stream enters another body of water such as a lake or reservoir, the stream discharge can act as a point discharge and can thus create eutrophic conditions.

In Tables 5 and 6 estimates are shown of the percentage contribution of nitrogen and phosphorus to surface waters in Wisconsin derived from various sources. Point sources (Table 5) which are largely associated with urban centers and thus small land acreages account for 36.7% of the nitrogen and 68,7% of the phosphorus entering surface waters. This large contribution, especially from sewage, illustrates why we must be concerned with the indirect effects of fertilizer in our technical society.

In the rural areas of Wisconsin, manured land is a major source of nutrients to surface water. However, Wisconsin is a major dairy region and thus has a much smaller acreage devoted to intensively fertilized row crops as compared to Illinois and Iowa, for example. Here is a case where economics and law encourage environmental pollution. The dairy farmer is under legal pressure to remove manure from his dairy barn and milking area. Economically, he cannot afford, at present, to develop expensive manure holding bins and, hence, spreads manure during the winter. Manure spread on frozen ground has been shown to be a major contributor to surface water pollution.

A significant contribution of nitrogen to surface water comes from ground water flow to streams and lakes. Decompostion of soil organic matter and plant residues undoubtedly is a major source of this nitrogen. How much of the nitrogen comes directly or indirectly from fertilizers is not known. Also, it is not known how much additional nitorgen was released by accelerated decomposition of soil organic matter due to bringing land under cultivation. The point here is that a major pathway of nitrogen flow in the ecosystem is through the recharge of ground water.

SUMMARY: The direct contribution of field fertilization to changes in stream and lake water quality, while still not accurately known, appears to be small at present as compared to other sources. Proper application of fertilizers and careful management of crops and soils will minimize the risks of water pollution. Practices which minimize leaching of nitrates and erosion of soil are especially important and should receive vigorous support through research, legislation and sales promotion activities.

Of great importance is the recognition that as part of a large complex biological system, we should be interested in the indirect effects of our activities. It is not a question of which is more important – fish or humans – but the realization that we are both part of a life support system wherein adverse effects on one species may altimately destory the other species. Thus man as a manipulator of energy and material flow in the system must be concerned with the total system – not just the fate of a fertilizer granule in a corn field. Hence, we also need to support *research, legislation* and community activity at the outlet end of the materials flow as well as the input end. Improved methods of reclaiming or disposal of wastes are just as important to minimizing the impact of fertilizers on lakes and streams as attention to fertilizer application techniques. The responsibility of those of us in the fertilizer industry is not over when the fertilizer goes through the farm gate.

Table 1
AGRICULTURAL PRODUCTION AND POPULATION* CHANGES 1950) 1968

1950 = 100%

U.S. Population	132
Farm Employment	48
Farm Output	142
Cropland	90
Fertilizer & Lime	171
Machinery & Power	135

*From Agric. Handbook No. 359, U.S.D.A. 1968

Table 2
ANNUAL TRANSFORMATION OF FIXED NITROGEN IN THE BIOSPHERE*

	Metric Tons x 10^6	
FORM	LAND	OCEAN
Natural Fixation		
Non-biological	4.2	3.7
Biological	44.0	10.0
Industrial Fixation	30.0	–––
Runoff (Translocation)	–30.0	30.0
Denitrification	–43.0	–40.2
Net Gain	5.2	3.5

*Modified from Delwiche, 1970

Table 3
SOME "NUTRIENTS" REQUIRED BY ALGAE

Carbon
Nitrogen
Magnesium
Boron
Copper
Cobalt
Biotin

Sulfur
Potassium
Chlorine
Iron
Manganese
Thiamin

Phosphorus
Calcium
Sodium
Molybdenum
Zinc
Vanadium
Vitamin B_{12}

Table 4
SOME LAKE CHARECTERISTICS*

	Non-eutrophic	Eutropic
Nutrient Cycling	low	High
Biomass	low	high
Number of Species	high	low
Trash Fish	low	high or absent
Oxygen	adequate	low or absent
Water Quality		
Drinking & industrial	good	poor

*Modified from Moran, et. al. Environmental Analysis 1971

Table 5
ESTIMATES ON N & P REACHING WISCONSIN SURFACE WATERS*

SOURCE	N	P
	%	
Municipal Sewage	24.5	55.7
Private Sewage	5.9	2.2
Industrial	1.8	0.8
Urban Runoff	5.5	10.0
Precipitation	8.5	1.2
Rural Sources	53.8	30.1

*From Armstrong and Rohlich in Willrich and Smith Agric. Pract. & Water Quality, 1970

Table 6
DISTRIBUTION OF N & P FROM RURAL SOURCES REACHING WISCONSIN SURFACE WATERS*

SOURCE	N	P
Manured Land	9.9	% 21.5
Non-manured Cropland	0.7	3.1
Forest & Pasture	1.2	3.2
Ground Water	42.0	2.3
Precipitation	8.5	1.2
Total	62.3	31.3

*Modified from Armstrong & Rohlich, in Willrich and Smith Agric. Pract. & Water Quality, 1970

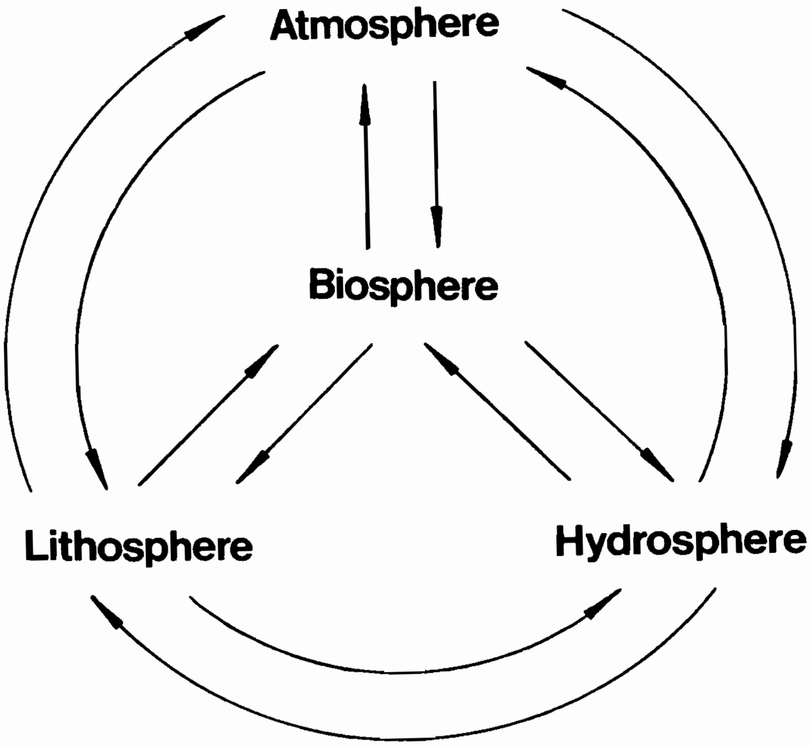


Figure 1
The biosphere as an interface between atmosphere, hydrosphere and lithosphere

Figure 2
Response of corn to anhydrous ammonia fertilization – Mississippi Agricultural Experiment Station, June 1950

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Thursday, November 11, 1971

Afternoon Session
Informal Round Table Discussions
Moderators: Joe Whittington and Wayne King

Table No. 1
Pollution Control — Wet and Dry

Leaders: Allen Jackson and Herman G. Powers

Discussion was directed toward the various systems wet and dry used to get total reclamation of solid effluents back into process.

The wet system discussion used a model plant with a normal dust loading to the scrubber of 100 pounds per hour and an upset system dust loading of 1000 pounds per hour.

The percentage of solids or dissolved solids that would be the equilibrium condition at the model unput conditions are tabulated on the schematic flow sheet for each scrubber arrangement.

It can be seen that under normal conditions any type of reclaim system will operate satisfactorily. It is the ability to handle upset conditions that the various systems have significantly different operating characteristics.

Discussion at the table ranged from general uses of the scrubber system to specific application in specific plants.

The dry (bag collector) systems were discussed as to how they are frequently added to existing systems, (1) (2) and the experience of a major company when arranged in a series system (3).

The series system with its double use of the air offered advantages of minimum particulate discharge from the plant. Emphasis was placed on satisfaction with this system.

Discussion again ranged from general uses of the systems to specific application.

This discussion will relate to the use of cloth dust filters for controlling the emissions from dryers or coolers in a granulation plant. We can call this the "Dry" approach as compared to Mr. Jackson's remarks on the employment of a wet scrubber.

Referring to the chart, the following systems will be discussed:

I — Add On Bag Filter

In this system, a bagged filter is added to an air system in which cyclone collectors are used. In short, it is a secondary stage in the emission control system.

II — Bag Filter Only

Most manufacturers of bag filters have recommended to us that the cyclones be removed as it is desirable to have the larger particles of dust in the air stream going to the bag filter; the reason being that the larger particles are beneficial in developing maximum filtration efficiency with the cloth bags. We have taken this approach and have had satisfactory operations with the cyclone removed. Naturally, the removal of the cyclones eliminates a piece of machinery to operate and maintain.

III — Single Air System

This system is the one we employ for our dryer and cooler operations. Air enters the cooler and passes through the cooler cyclone to remove most of the dust. The cyclone exhaust in turn discharges as secondary air to the combustion chamber of the dryer. The dryer exhaust gases are introduced to the bag filter prior to exhaust to the atmosphere.

The main benefit from the single air system is that a bag filter has to be sized only for the dryer to obtain maximum emission control. It is important that atttention be paid to the design of the combustion chamber and the method used to introduce air from the cooler. The design also has to appreciate the proper balance of air between the dryer and cooler.

It should be noted that all three systems can be so designed that filtered dust can be continuously fed back to process during operations.

Table Discussion centers around the following points:

Air to Cloth Ratio — Recommend a maximum ratio of 2.25 to 1.

Duct Velocity — For these applications, a minimum velocity of 4500 FPM should be maintained.

Filter Cloth — Have found acrylic material to be the most satisfactory, and, can take temperatures up to 275°F. Costs of bags in the 4 to $5.00 range depending on quantity purchased.

Bag Life — Naturally, this is influenced by tonnage, but, for an average plant, we are experiencing approximately 18 months before complete bag replacement is required.

We think that collector design and specifications are the key to obtaining longer bag life. Low air to cloth ratios must be considered. One of the culprits that accelerates bag wear is velocity impact. Further, a collector with high ratios will more likely cause blinding of the cloth.

Moisture – In dryer applications, you have to watch out for moisture. With the higher temperatures, humidity comes into the picture. We have found that if we operate at least 50°F above the dew point of the operating temperature, we do not experience difficulty such as "blinded bags or mud."

We can not over-stress the importance of properly training operating personnel. Regardless of engineering design, if the operators don't appreciate what they have, or are not educated on how the system must be run, you will have sad experience.

Installation Costs – Most of us will be faced with installing a bag filter in an existing plant. The usual problem is to find space to put the "box car" up in the air some place around the dryer. These conditions definitely influence the overall installation costs. Offhand, a good "ball park" number is $4.00 per CFM for an installation on an existing plant in accordance with System III.

Note: Charts on Pages 60 and 61:

Nominal Plant.

Pond.

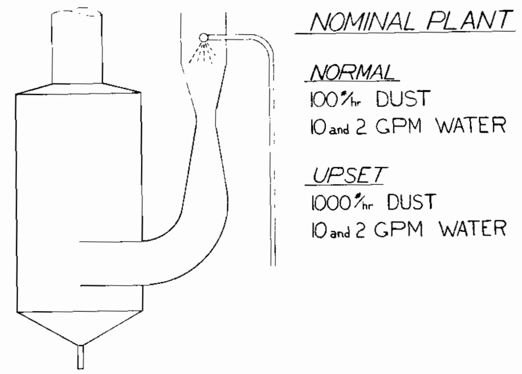
Dry Control with water.

Wet Control with recycle.

Add on bagger filter.

Bag Filter only.

Single Air System.

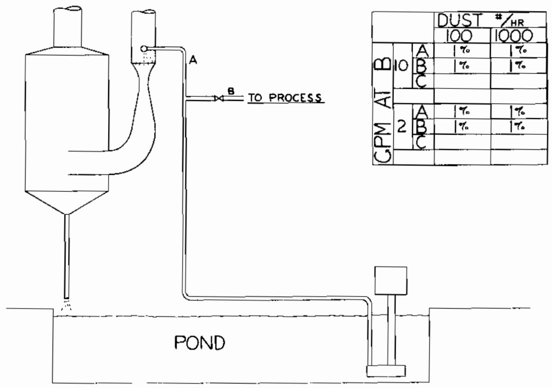


NOMINAL PLANT

NORMAL
100#/hr DUST
10 and 2 GPM WATER

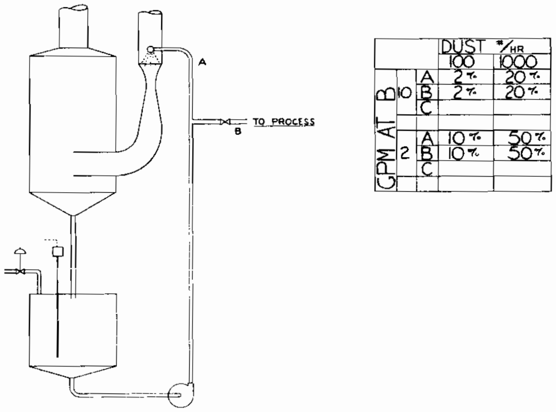
UPSET
1000#/hr DUST
10 and 2 GPM WATER

1



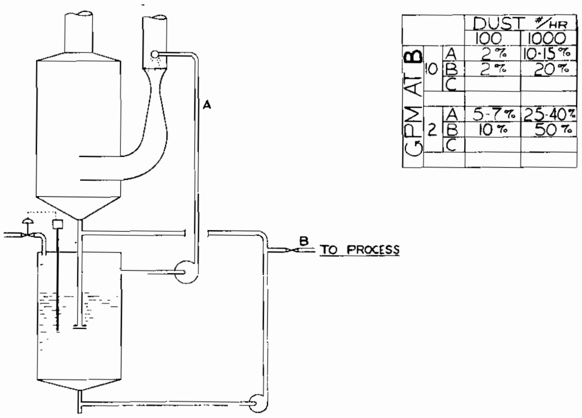
GPM AT B			DUST #/HR 100	1000
	10	A	1%	1%
		B	1%	1%
		C		
	2	A	1%	1%
		B	1%	1%
		C		

2



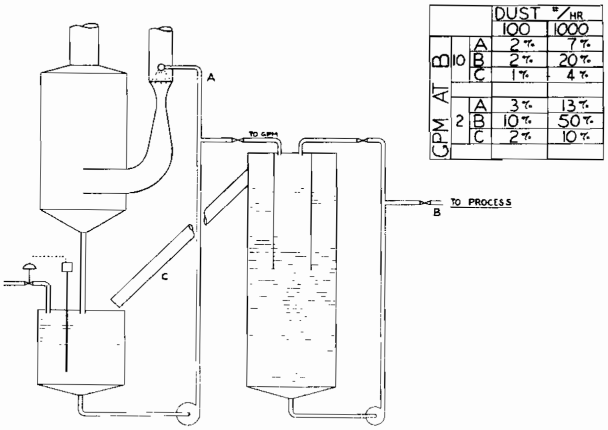
GPM AT B			DUST #/HR 100	1000
	10	A	2%	20%
		B	2%	20%
		C		
	2	A	10%	50%
		B	10%	50%
		C		

3



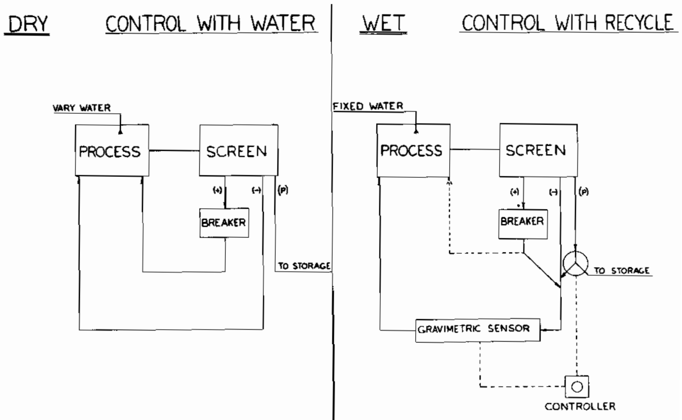
GPM AT B			DUST #/HR 100	1000
	10	A	2%	10-15%
		B	2%	20%
		C		
	2	A	5-7%	25-40%
		B	10%	50%
		C		

4



GPM AT B			DUST #/HR 100	1000
	10	A	2%	7%
		B	2%	20%
		C	1%	4%
	2	A	3%	13%
		B	10%	50%
		C	2%	10%

5



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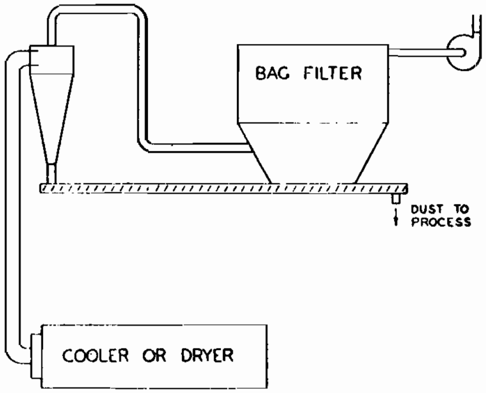
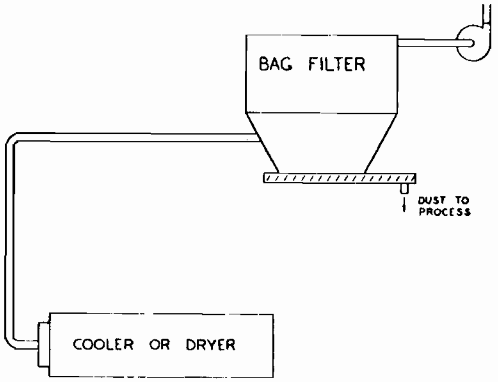
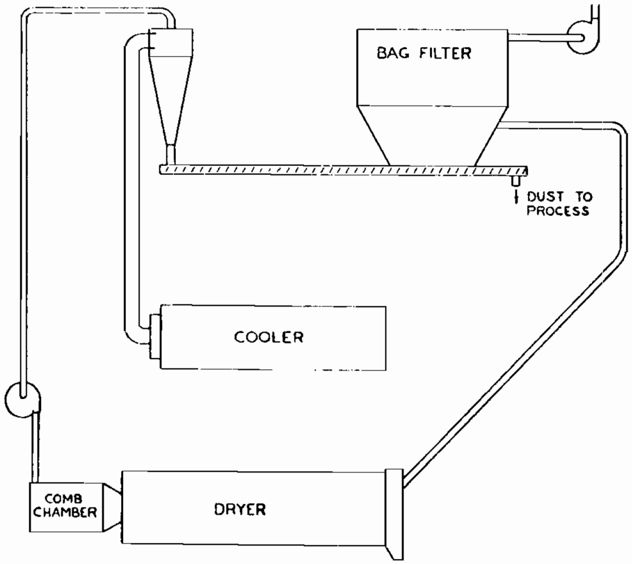


I
ADD ON BAG FILTER



II
BAG FILTER ONLY



III
SINGLE AIR SYSTEM

Table No. 2
Controlling Pollution from Ammoniation-Granulation Plants

Leader: Frank P. Achorn

Extensive discussions were held relative to the use of superphosphoric acid in granulation. Many of those in attendance wanted to know the exact quantity of superphosphoric acid which was used in the formulations. They were told that usually about 150 pounds of superphosphoric acid per ton of product was satisfactory to control air pollution from the ammoniator-granulator. They were told that this quantity of superphosphoric acid was also helpful in eliminating the loss of particulate in the exhaust gases from the dryer and cooler.

An extended discussion was held relative to the use of wet-pross orthophosphoric acid. It was mentioned that wet-process phosphoric acid helps to minimize the amount of particulate lost from ammoniation-granulation plants. However, it is not as effective in eliminating this pollution as superphosphoric acid. Data was given to show that the main pollutant from the ammoniation-granulation plants was ammonium chloride. It was stated that the other particulates were easy to remove by means of dust collectors, scrubbers, and pack filters whereas it was very difficult to remove ammonium chloride particles because of their very small size. It was agreed by the conferees that the maximum quantity of phosphoric acid (54 percent P_2O_5 which could be used in a formula for a conventional ammoniation-granulation plant which does not have a preneutralizer is 400 pounds per ton of product.

A discussion was held relative to the effectiveness of venturi-type scrubbers to remove ammonium chloride particles. It was stated that the higher-efficiency venturi-type scrubbers could remove the small particles, provided the pressure drop across the venturi was high. It was mentioned that blower motors of extremely large size were required for these venturi-type scrubbers and the investment cost was at least two or three times the cost of the conventional impingement-type scrubbers.

The participants discussed the possibility of using urea, phosphoric acid, ammonia, triple superphosphate, and normal superphosphate combinations in the production of granular N-P-K mixtures in the ammoniator-granulator. It was mentioned that when some of the European companies used urea, triple superphosphate, and potash combinations along with heat and steam for granulation there was a minimum of pollution from their plants. It was mentioned that possibly some tests should be conducted with combinations of urea, ammonia, phosphoric acid, normal superphosphate, and triple superphosphate to produce N-P-K mixtures. Some of the companies agreed to conduct tests of this type if TVA personnel would assist them. TVA personnel agreed to assist in conducting these tests.

A lengthy discussion was held concerning formulations for ammoniation-granulation plants. Items discussed were:

1. Liquid phase factors
2. Heat requirements
3. Particle size of materials used in the formulations
4. Types of materials used

A lengthy discussion was also held concerning sparger designs. Several variations of sparger designs were discussed. However, the most frequently used design is the one that was presented in the paper entitled, "Controlling Pollution from Fertilizer Plants."

Table No. 3
Technical Service

Leader: J. M. Delong

Both attendance and interest ran high at our Table where the subject was Technical Service and the experts, representing all field of the fertilizer industry, fielded such questions as:

1. What is Technical Service?
2. How and why is it changing?
3. Has our industry benefited from its efforts?
4. What services can be offered to large, basic, and/or intergrated companies currently manufacturing conventional products?
5. Should Technical Service be product-sales-profit oriented?
6. Should Technical Service require budgetary justification?
7. Can the fertilizer industry afford to dispense with Technical Service?
8. What does the future hold for Technical Service?

These and other discerning questions stimulated open discussion on the general merits of Technical Service, its practical role in today's changing technology, and its monetary value to the supplier as well as the manufacturer.

Technical Service was described by one panelist as a sales "gimmick" brought into vague early in the 1960's when profit margins were higher and increased fertilizer production required technical liaison with the markets. Those providing customer service felt it necessary to accommodate the many process and product changes taking place at that time. Another participant likened Technical Service to a continuous "round table" activity which involved discrete translation of new skills, process changes, quality improvements, and cost reduction innovations. It was the general consensus, however, that Technical Service is a sales oriented staff of specially talented individuals whose dual role is to keep abreast of all technological improvements and to be able to professionally translate and implement such activities for the benefit of his company and its customers.

It was observed that Technical Service groups have changed significantly both in organizational structure and in activity throughout the last decade. As a staff function lacking direct responsibility for profit generation, the degree of Technical Service activity appears to vary directly with overall industry profits, i.e. the more profit, the more services available.

Companies which have maintained their service staffs, recognizing their versatility and professional exposure, have directed these talents toward internal problems and/or projects. Many such projects have led technical personnel into new areas of greater management responsibility, such as product managers, technical sales, plant operations, product development, and corporate planning.

To cite the direct industry benefits resulting from Technical Service field efforts was not the purpose of this panel. It was mentioned, however, that technical improvements, whether innovative or routine, were a major criteria for maintaining a successful fertilizer operation.

There was mixed opinion among the panelists as to the effectiveness of Technical Service in the promotion of technical improvements. Some indicated that the service, because it was free, was treated too lightly by those who could most benefit from technical consultations. On the other hand, some companies solicited continuous service but were unwilling to recognize or translate its value into a purchasing relationship. Another panelist indicated that service was available until the sale was arranged and then doled out very sparingly.

It was generally agreed that Technical Service has little to offer large basic manufacturers of conventional products. It was conceded that large scale basic companies usually had their own Technical Service which, in addition to maintaining technical proficiency within the company, was kept abreast of industry trends via industry meetings, technical articles, routine liaison with outside experts, and internal research and development activity. One panelist expressed the need for rmphasis on techno-economic evaluation of major company operations. This panelist felt that a technical consultant well versed in the translation of the technical into cash flow analysis and profit oriented innovation had basically much to offer the large manufacturer of conventional products.

Although it was unanimously agreed that the service representative should be product-sales-profit oriented, it was stipulated that his knowledge of pricing, terms, and other economic consideration be limited to avoid conflict of interest and overlapping of responsibilities with the sales function. It was felt that much of the information provided the technical representative was proprietary and confidential.

It was generally agreed that a Technical Service staff should require budgetary justification both for the purpose of planning its activities and measuring its effectiveness as a sales support function. In other words, each specific activity should be evaluated and assigned priority in terms of both its short and long range potential contribution to corporate profits. Objectives must be assigned and results measured accordingly. Both of these responsibilities require close cooperation with Sales personnel who, if effect, have a similar responsibility toward the same effort.

It was generally agreed that the industry could not afford to withdraw Technical Service without acknowledging the risk of losing touch with the technical and/or manufacturing motivations behind product selection. As the eyes and ears of the manufacturing entity in the field, the translator of customer comments on product quality, versatility, and general acceptance, and as the general liaison between production and sales, it was felt that Technical Serivce is an indispensable function. The titles and responsibilities will, undoubtedly, change, but the basic responsibility and resulting benefits will gain in importance. The question arose as to the merits of charging for services rendered. It was noted that this has been successful in Europe, but was an unlikely approach in the U.S. for the near future.

Table No. 4
Bulk Blend Operations

Leaders: Harold Blenkhorn, Wayne LeCureux,
Russel E. Weiss, Henry Plate
Notes: Harold Blenkhorn

Potash

- Some companies have tight specifications for blending ingredients, and use only granular potash.
- Others use both coarse and granular – coarse for direct sale and granular for blending.
- Appears that most blenders use only coarse potash.
- As to particle size of coarse potash, appear to be general agreement that it contains an undesirably high fraction of fines, and is not compatable with other blending ingredients.
- High tonnage blender pointed out that 0 – X – X goods (eg. 0 – 25 – 25) are, more than any other grade, most likely to segregate and show deficiencies when sampled. This is true of both bulk and bagged goods.
- Appears that use of coarse potash is the prime cause of deficient analyses. Opposite is also true – users of granular potash have fewer deficiencies.

Urea

- Due to recent pricing trends, urea has become a widely used source of supplemental N.
- It is well known that mixtures of urea and ammonium nitrate are extremely hygroscopic – they cannot be mixed in any proportion unless the blend is to be delivered and applied *immediately.*
- Some blenders have experienced caking of urea when putting it into a bin which previously held Ammonium Nitrate. In such a case, it is advisable to clean the bin thoroughly making sure that there is no ammonium nitrate on the floor and none "hanging up" in the partitions. As an extra precaution it is advised to line the bin completely with poly.
- Urea has certain agronomic restrictions – a high

N grade based on urea, or urea and DAP is known to cause seedling damage when applied banded or drilled. It is advisable to restrict urea based blends to pre-plant broadcast situations

GENERAL TOPICS

Storing bagged blends

- An Iowa blender reported that only MAP blends (1 – 4 – 4, 1 – 4 – 2) are bagged for long term storage (say November to Spring season). A blender from Ohio reported good experience with 16 – 16 – 16 formulated with ammonium nitrate. This blender stored in a multiwall Kraft bag with two moisture barriers.

Micro nutrients

- Zinc and Boron are the most commonly applied. A few blenders use a finely sized source of micro nutrient and mix with the aid of a sticking agent – usually oil. Most common practice is to dry blend granular zinc sulphate or a granular source of boron.

Pollution

- Pollution problems of blend plants are mainly confined to dust emissions. In some areas, pollution complaints have made it necessary for blenders to take routine control measures.

- Most common control measure is to add oil to the blend. This is usually done by spraying oil on the belt exit the mixer. Diesel oil, 3 in 1 oil, or a mixture of the two have been used. Usual rate of addition is about one gallon per ton of blend. Oil cannot be added to blends containing ammonium nitrate.

- Another method of minimizing dust at the plant is the use of a telescopic movable load out leg with a flared canvas sock at the bottom. This system serves the dual purpose of keeping dust emissions at a minimum and preventing coning.

Notes: By Wayne Le Cureux:

Q. What is proper size for blend plant installation?

A. 3500 ton minimum average up to 6000 ton. At least 4 ton mixer. Installation cost $95 – 100,000 depending on site and rail siding cost.
Some larger formerly granulation plants are being converted to dry blend mixing.
A minimum plant would be 2000 ton annual at investment of $60 – 65,000, with side track in. Best to use flat storage with belt-veyor outside to shuttle belt to bins.

Q. What are dust and pollution problems and solution?

A. On bulk spout use telescope spout and sock. Add oil to help keep down dust.

Q. Cleaning machinery?

A. One operator at end of each season borrows 2 ton of oiled stoker coal to run thru his plant to clean it out and oil the machinery.

Q. What are material size problems?

A. Potash variation too much. Some coarse grade too fine and some granular grades too large.
Urea runs too small for good mixing.
DAP and ammonium nitrate are sized okay most of the time.
Granulated triple breaks down too much in handling.

Q. Hydroscopic problems?

A. Avoid more than one if Urea, Ammonium Nitrate or Triple Superphosphate in some mix.

Q. Use of Plastic buckets on elevators?

A. Seem to be okay from experience of panel members. Fiberglass better for long wear but more expensive.

Notes: By Russel E. Weiss

Q. How are bulk blends going?

A. Generally speaking, the economics are superior to granulation.

Q. Can blend plants of less than 1,000 tons be economical?

A. One participant said no; they felt they must have 2,500 tons.
Second answer: Suggested with the dealer system, plants with 1,000 tons storage could be economical with an inventory turn-over of at least twice a year.

Q. Is there a real pollution problem with bulk blending?

A. Sometimes, when loading out of plants into delivery vehicles. No problem at all.

Q. Why did you stop using the baffle blender?

A. Economics and volume.

Q. Do you need bag facilities at blend plants.

A. Have none in our facilities.
Our business is primarily bagged (75%).
No baggers encouraged at blend plants.
Bags serve as a good bulk container and allows the storage of product in the country off-season. Some dealers breaking bags into bulk spreaders.

Q. Do you furnish special trucks for delivering bulk blends to the country.

A. Generally, bulk trucks to unload into flat storage on farm.

Q. What is the trend of nitrogen in the Midwest?

A. Solutions are strong, however, NH_3 still holding its own in many places. The cost of handling and the cost of storage and safety has affected NH_3 volume some.

Q. How real is the loss of urea through hydrolysis?

A. In the south it is extreme; possibly as much as 30% of the urea N, if surface applied. About 85% efficiency when applied on Coastal Bermuda sod.

Q. What about losses from prilled urea?

A. Possibly greater loss than with UAN.

General comments made:

1. We always try to get all the DAP in the blend we possible can, because of low cost of N.
2. Consensus of group; that it will be a long time before DAP or 13-52-0 will be replaced by lower N grades for blends.
3. We are not "selling" in the fertilizer business today.

Notes: By Henry Plate

Q. How do you prevent dust pollution when loading trucks?

A. Use a metal shoot with a flared canvas skirt on the bottom flaring out like a pyramid. This is gradually raised as the truck is filled. Sufficient power is present to pull the skirt out of the fertilizer should it get buried.

Q. How do you clean your equipment?

A. At the end of the season we run two loads of stoker coal through the equipment, which does an excellent job of cleaning and oiling since it is rather abrasive. The coal is then returned to the neighboring coal yard with the only cost being shrinkage.

Q. What is the difference in terminology between dry mixing and blending?

A. Usually the connotation is on the size of the operation with the dry mixer being larger. A blender is a dry mixer, but a dry mixer is not necessarily a blender.

Q. Is 18-46-0 the best material in the mixes?

A. Depends on the final ratio. We could use mono-ammonium phosphate in the 1-4-X rations, but in higher nitrogens the 18-46-0 is more economic since nitrogen is as cheap as NH_3 many times. Ammonium polyphosphate mixes generally are not economically competitive.

Q. What about the particle size and shape of materials for homogeneous mixes. Coarse and granular potash raises a problem since neither one fits too well.

A. Coarse potash initially was a crutch for granulation. Granular potash was designed for blending. Potash is screened by crushing and to be better would cost more money.

Q. Will coarse and granular potash be combined into an in between size?

A. This may come although there is a problem with fines resulting from this and recompaction will take extra money.

Q. Will each potash company have to make the decision individually as to whether they make an in-between product?

A. Yes.

Q. Only the white potashes are usually used in suspension since the red color is objectionable to the growers. Is there an answer?

A. We don't sell fertilizer materials, we only handle them. If we sold these to the farmer it should not make any difference.

General Comment:

We find the fines in potash may help prevent segregation if you are spreading the material, but not if you are bagging it.

Q. Is it the size or the shape of materials used in blending that causes segregation?

A. Based upon the TVA work in the early 60's size is a primary factor in causing segregation. If materials are closely matched and all materials are within the same 6 screen size spread, little problem will be experienced with segregation. Shape and specific gravity have little to do with the segregation.

Q. Do O-X-X and particularly 0-1-1 PK mixes stay together as well as nitrogen containing blends or do they segregate worse?

A. Several comments indicated that the 0-1-1 was a bad segregator and that the O-X-X in general segregated worse than nitrogen containing grades. This may be partially tied in with the fact that the nitrogen grades frequently employ an ammoniated phosphate which automatically holds part of the nitrogen and phosphate together.

Q. Could basic producers add phosphate and potash together and form a granular product in an O-X-X ratio?

A. Economics of transportation bringing materials together from two different directions and granulating would raise transportation charges to a non-economic point. Also this product would be hard to sell since everyone would want a different ratio.

General Comment:

A wide range in total weights of materials added together will affect analyses worse than when weights are nearly uniform. For instance 1,800 pounds of product X mixed with 200 pounds of product Y will produce more off analysis than the 1,000 pounds of each one added together.

General Comment:

We have experienced considerable variation between the first portion of discharge from a drum mixer compared to the middle and end of discharge insofar as analyses of product is concerned.

General Comment:

A review of the analysis of one plant in a state that was using granular potash in their blending indicated that they had one of the best analyses within the state of all blenders.

Q. Why is the particle sizing of potash shipments so poor during the spring period?

A. Due to the large piles put into storage, segregation occurs particularly towards the end of the shipping season.

Q. Why would the segregation of the potash in large piles be worse towards the end of the shipping season, when these piles are long and loaded up from one end?

A. Possibly due to less care in taking potash across the surface of the pile, or due to lack of distribution of material as it goes into the pile.

Q. How can potash be put into the basic producer storage to prevent fines?

A. Use of tripper devices or other spreading mechanism.

Table No. 5
Environmental Regulations and Impact of Fertilizer Usage

Leaders: William C. White and Thomas H. McIntosh

Dr. White noted that, at present, the regulations in effect cover labeling, quality, and registration and do not cover application techniques, amounts or kinds of fertilizer applied.

The following states have bills under consideration or have considered and killed a bill:

California:

A bill to require farmers to obtain a permit prior to application of fertilizer was rewritten to require county reporting of fertilizer usage. More states need to adpot county reporting of fertilizer usage as per a model bill recommended by the Plant Food Institute.

Illinois:

Currently is holding hearings on a proposed regulatory bill. Serious deficiencies were noted wherein soil conditions were largely ignored and the state divided into two regions with demarkation being Route 50.

Wisconsin:

The Department of Natural Resources is studying the influence of farm practices on water quality. At present, most efforts are concerned with manure disposal and timing and placement application to soil.

Massachusetts:

A bill aimed at elimination of using inorganic fertilizers was killed.

Ohio:

Considering a bill which is aimed at sedimentation control. If passed in present form, license or conservation plan approval may be required of farmers.

Dr. White called attention to an article by Dr. Viets in Bioscience. Using 1960 data from the State Agricultural Experiment Stations, he calculated the probable yield reductions for the first year if no inorganic fertilizer was used. Yield reductions varied by crop and geographic region and ranged from 0.3% soybeans to 20.3% for corn in S.E. Iowa to 93.7% reduction for grapefruit in Florida.

An important point was brought out with respect to E.P.A. There is a research and development grant or contract which permits funding directly to industry for work in air or water pollution abatement. The funding can be all federal for basic research study or shared for pilot or plant scale demonstration type projects.

Friday, November 12th, 1971

Morning Session
Moderators: Joseph E. Reynolds, Jr. and Albert Spillman.

Business Meeting:

Secretary-Treasurer Report.
Housden L. Marshall.

Financial:

November 1, 1970. Cash on Hand		$ 827.27
Income 1970–1971		
Registrations 1970	$5240.00	
Sale of 1970 Membership lists	375.01	
Reprints and Back Issues Proceedings	866.80	
Total Income	$6481.81	$6481.81
Total Cash handled Nov. 1, 1970 to Nov. 1, 1971		$7309.08
Disbursements 1970–1971		
Payable Due	$1025.58	
Printing 1970 Meeting Proceedings	2500.00	
Meeting Costs 1970–1971	1545.31	
Printing 1970 Membership Lists	225.92	
Expenses Executive Meetings	346.81	
Office: Secretarial, Postage, Supplies, Etc.	1476.44	
Total Expenses 1970–1971	$7120.06	$7120.06
Cash on hand November 1, 1971		$ 189.02

Election of Executive Committee and Officers

Wayne W. King – Chairman Nominating Committee

Albert Spillman "Our Chairman" and Housden L. Marshall "Our Secretary-Treasurer" asked to be relieved of their offices at the conclusion of this meeting. Al and Housden are two of the original Round Table Founders. They agreed to remain members of The Executive Committee and help as much as they possibly can.

The Membership, by standing ovation and lots of applause, showed their appreciation to Al and Housden for their outstanding services to the Round Table during the past 21 years.

The Membership, by unanimous vote relected the present Executive Committee and the following additional members to serve on the Executive Committee.

William C. Childs, III
Asst. to the President
Harry T. Campbell Sons Co.
Towson, Md. 21204

James M. De Long,
Manager Technical Services
Occidental Chemical Co.
Houston, Texas 77027

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

Lou Hubach,
Application Engineer
W.S. Tyler Co.
Menton, Ohio 44060
Replacing S.J. Janovac–Tyler.

Dan O. Walstad
Production Manager
Plant Food Department
American Cyanamid Co.
Princeton, N.J. 08540
Replacing W.E. Jones - Cyanamid.

The Membership, by unanimous vote elected the following officers:

Herman G. Powers	Chairman
Paul J. Prosser, Jr.	Secretary-Treasurer
Joseph E. Reynolds, Jr.	Vice-Chairman
Billy E. Adams	Vice-Chairman
Robert E. Heck	Vice-Chairman

Meeting Date and Location
For 22nd Annual Meeting

November 1, 2 and 3, 1972
Joseph E. Reynolds, Jr., Committee Chairman

Considerable discussion took place on best location for this meeting. The following proposed locations were thoroughly discussed: Baltimore, Chicago, Memphis, Miami, New York and Washington.

By majority vote the membership decided to hold the meeting in Memphis, Tennessee, at The Sheraton-Peabody Hotel, Wednesday, Thursday, Friday, November 1, 2 and 3, 1972.

Cocktail Party

Tom Athey – Chairman
Entertainment Committee

On behalf of our members I wish to thank our "Hosts" for the nice Cocktail Party last night. We all enjoyed ourselves.

Hosted By:
Atlanta Utility Works
Dorr-Oliver, Inc.
Fertilizer Engineering & Equipment Co., Inc.
Fesco, Inc.
Kiernan-Gregory Corp.
Mikropul Div. of Slick Corp.
Northern Blower Co. Div. of Buell.
The Prosser Company, Inc.
Edw. Renneburg and Sons Co.
The A. J. Sackett and Sons Co.
Wellman-Power Gas

The meeting was turned back to Joe Reynolds who moderated the remainder of this Session.

Pesticides in Mixed Fertilizers

Rodger C. Smith

At the September 1971 National Meetings of The American Chemical Society at Washington, D.C., there was a full day symposium on fertilizer pesticide mixtures of which I was Co-chairman. As this type of product is on the one hand increasing in popularity and also an irritation to some fertilizer manufacturers, your executive committee asked that a summary of that symposium be presented at this time.

"High costs" necessitate that farmers use the yield producing power of fertilizer to generate a management profit. To obtain the full potential from the fertilizer, the crop grown must be protected from insects and weeds. It is only normal and natural that progressive farmers would like to combine these two management objectives of feeding and protecting a crop into a single physical application, " so stated Dr. John Strauss, American Oil Company, one of the early innovators of this practice. Another was Dr. Glenn Klingman, when on the staff at North Carolina State University, now director of plant science, Eli Lilly & Company.

In an attempt to put this practice into perspective, let us look at its application to a major crop, corn . . .

TABLE 1:
FERTILIZER / PESTICIDE USAGE
% OF CORN ACREAGE TREATED

	1966	1967	1968	1969	1970
Fertilizer-Insecticide	14.2	11.6	11.2	4.5	4.2
Fertilizer-Herbicide	1.1	1.6	2.9	3.3	5.3

The popularity of Fertilizer-Herbicide combinations is increasing while the fertilizer-insecticide combinations are declining. The decline of fertilizer-insecticide combinations is due to decreased use of aldrin and heltachlor as a result of state and federal restrictions, and also to the spread and importance of resistant corn rootworms. For soybeans and sorgham, it is estimated that 1-2% of the herbicides are applied with fertilizers. It is prediced that herbicide combinations will continue to grow in usage. More farmers will elect fertilizer-pesticide combinations if these are available to them uniformly mixed and they can be evenly applied so that each component functions as well in the combined form as if applied individually.

Field results show that this is possible and, at times a synergistic effect is claimed by both farmers and operators. In a paper presented by Mr. Frank Achorn, Head, Process and Product Improvement Section, TVA, he stated that agronomic and biological tests by the University of Nebraska and the University of Wisconsin indicate that an insecticide-fertilizer mixture can serve effectively both as a control for corn rootworms and as a source of starter nutrients provided the mixture is placed on both sides of the seed bed.

As to uniformity of mix, the quantity of pesticide in relation to the quantity of fertilizer to be applied is very small, in the order 1:100. The farmer very correctly wants a precise quantity of pestidice applied and to slightly less extent wants precise quantity of fertilizer application. This necessitates:

1) Uniform mix
2) Uniform Application

Achieving uniform mix offers somewhat different problems depending in form of fertilizer mixture, as follows:

1) Fluid fertilizer
    A) Nitrogen material
    B) Full Liquid Mixture
2) Solid fertilizer
    A) Granulated mixture
    B) Bulk Blend

First, as to fluid fertilizers . . . Dr. Strauss stated, "Premixing ahead of time, use of a sparger system, use of an educator, pumping around and use of a stirring device are all methods used in the field to attain uniformity. Mixing pestidices with suspensions has simplified the process in that the suspended solids help separate the additive and help keep it in a uniform state. Suspension fertilizers also allow the use of dry pesticides where before only liquid pesticides could be used." The speakers were of one voice in advocating a simple compatibility test for each combination to guard against separation within a tank or a tank full of "jellied" products.

In this regard compatibility agents such as complex and enhance are useful additives. A simple procedure is:

1) Place pint of fluid fertilizer in jar.
2) Add two teaspoonfuls of pesticide.
3) Close jar and shake well.
4) Observe at once and again after 30 minutes.

Table 2:
NITRIGEN SOLUTION COMPATIBILITY
WITH TREFLAN

Nitrogen solution 30 or 32 –
1) Must be agitated
2) Compatibility agent – less agitation

Ammonium nitrate solution –
1) Must have compatibility agent and agitated

Aqua ammonia –
1) Add directly
2) Compatibility agent – assists

In reporting on the application of treflan and balan in fluid fertilizers, Dr. L.R. Guse, Eli Lilly & Company, stated that a combination of treflan (Table 2) and nitrogen solution 30 or 32 may not require a compatibility agent, while ammonium nitrate solution *must* have both a compatibility agent and vigorous agitation. Aqua ammonia does not generally need a compatibility agent when mixed with treflan, but the addition of one generally results in improved stability and redispersion.

Dr. Guse also reported on compatibility of 10-34-0 (Table 3), 2-4 pints of adjuvant per 100 gallons giving very satisfactory redispersion.

Table 3:
10-34-0 Compatibility with Balan

ADJUVANT PER 100 GALLONS	STABILITY (MINUTES)	REDISPERSION
2 Pints	15	VERY GOOD
4 Pints	25	EXCELLENT
NONE	2	POOR

The transitions in application equipment to accommodate additives was traced in Mr. Frank Achorn's paper as follows:

Figure 1 – The conventional attachment for application of starter fertilizers lacks a means for positive agitation in the tank. As a result, many pesticides tend to separate and to float on the surface.

Figure 2 – The floating can be prevented by installation of a recirculation pump so that the mixtures can be agitated. A typical liquid starter attachment so equipped is shown. Note in the upper right corner of the slide the detail of the tanks, pump and sparger arrangement as mounted on the tractor.

Figure 3 – Agitation is important. As shown in the truck applicator, a recirculation pump forces the liquid

through a sparger pipe installed in the full length of the 1,000 gallon tank with force sufficient to mix the pesticide into the fertilizer and to keep it dispersed.

Figure 4 – A typical pull type applicator with jet eductor is shown as illustrated at base of slide.

Now as to solid fertilizers, relatively little was mentioned during this symposium by happenstance or because of limited techniques and initiative. The impression is gained understandably that solid fertilizer granulators or blenders produce fertilizer-pesticide mixtures more as a competitive necessity than as a promotional tool. The problems of uniformity of mix, of contamination of other fertilizers, and uniformity of application are real. Probably their greatest success is in turf fertilizers where a substantial tonnage of specialized fertilizer is manufactured.

Mr. D. R. Murphy, Stauffer Chemical Company, stated, "about 10 years ago, we first became involved in the mixing of our thiocarbamate herbicides and solid fertilizers, when we started marketing eptam® for use on dry beans and later Tillam® on sugar beets. We are presently doing some testing of mixing dry fertilizers with dry pesticides. New techniques are being developed whereby this can be done with little or no segregation of materials during handling and application."

Foliar application of nitrogen and potassium is practiced in Florida and California. in particular where calcareous or alkaline soils make it difficult to raise adequately the potassium content of citrus and other fruit trees. Small fruit size, fruit abnormalities and tree damage result.

Dr. David V. Calvert, University of Florida, reported on his work with the correction of potassium deficiency of citrus with potassium nitrate sprays. This fertilizer is fully compatible with pesticides and is now applied with a wide range of insecticides and fungicides in both Florida and California (Table 4). Since potassium nitrate is a low salt index fertilizer, 10-20 pounds can be added per 100 gallons spray on dilute spray basis. Dr. Calvert reported that under field conditions in Florida and California, Foliar applications of KNO_3 produced larger oranges, thicker peels, and slightly greater yields, (Table 4).

TABLE 4:
10-20 POUNDS POTASSIUM NITRATE (13.75-0-44.5)
PER 100 GALLON SPRAY MIXTURES FOR
CITRUS ON ALKALINE SOILS

Larger Fruit
Better Quality
Higher Yields
Dr. D. V. Calvert

Dr. John T. Hays, Hercules Incorporated, reported on a unique development. Ureaform fertilizer-herbicide combination products have been prepared with phenoxy acids or norea (herban) occluded uniformly throughout the fertilizer particles. These herbicides retain their normal activity in these combinations, are leach-resistant, provide sustained activity for at least three months, and show reduced phytotoxicity. Other pesticides could be used with similar advantages. Dr. Hays suggested that such products should offer cost savings by reducing pesticide loss or crop damage and by avoiding frequent applications.

At Ft. Lauderdale, Florida, (Table 5) freshly cust plugs of floratine St. Augustine and 137 Bermuda grass were placed in clean soil containing a large variety of weed seeds. After 2½ months of growth, there were essentially no weeds in plots treated with ureaform-herban. Good treatment of specific species, crabgrass excepted, was obtained with ureaform-phenoxy.

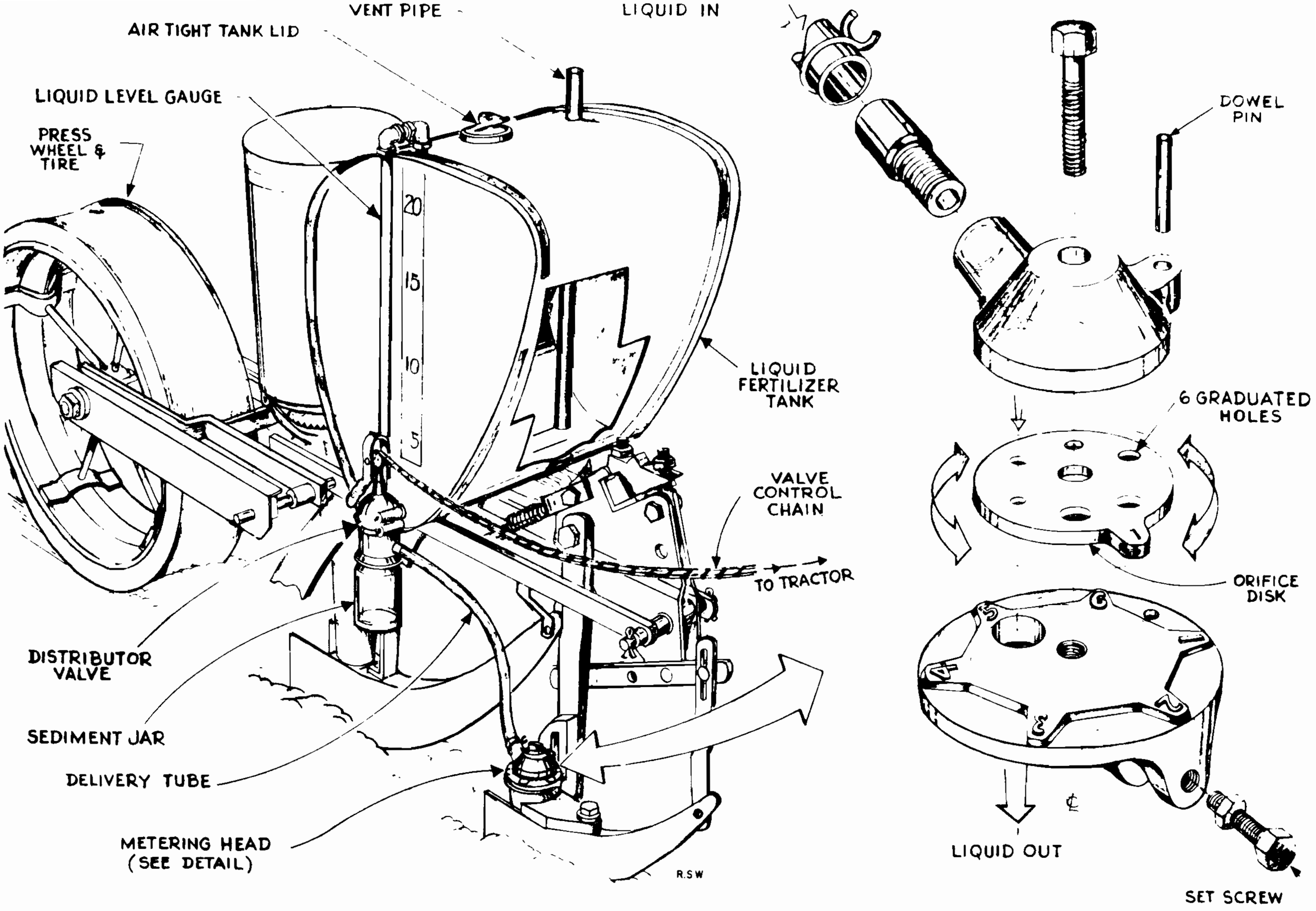
HERBICIDAL EFFECT

TREATMENT	% WEEDS AFTER 2½ MONTHS FLORATINE ST. AUGUSTINE	137 BERMUDA GRASS
None	96	59
Ureaform	100	68
Ureaform-Herban	0	0
(3 Lbs. Herban/Acre)		
Ureaform-Phenoxy	20	13
(4 Lbs. Phenoxy Mixture Per Acre)		

CONCLUSION:

1) Farmers accept fertilizer-Pesticide combination.
2) Technical know-how and equipment is available.
3) The pesticide additive determines the method of application and the placement.
4) Fluids are a practical way of combining pesticides with fertilizer.
5) State & Federal regulations will be a dominant factor in determining the rate of growth of fertilizer-pesticide combinations.

Having reported on this symposium, let me observe that fertilizer-pesticides will indeed expand in usage, especially fertilizer-herbicides. The usage is now relatively small; the rate of growth will be related to the expansion of use of liquid fertilizers and nitrogen solutions applied at a time and place appropriate to application of the pesticide. Usage could be accelerated by further development of pesticide products having greater latitude as to application time and which are otherwise safer and better adapted to blending with fertilizer materials or incorporating in mixtures.



METERING HEAD COMPONENTS

FIGURE I

CONVENTIONAL STARTER—FERTILIZER ATTACHMENT

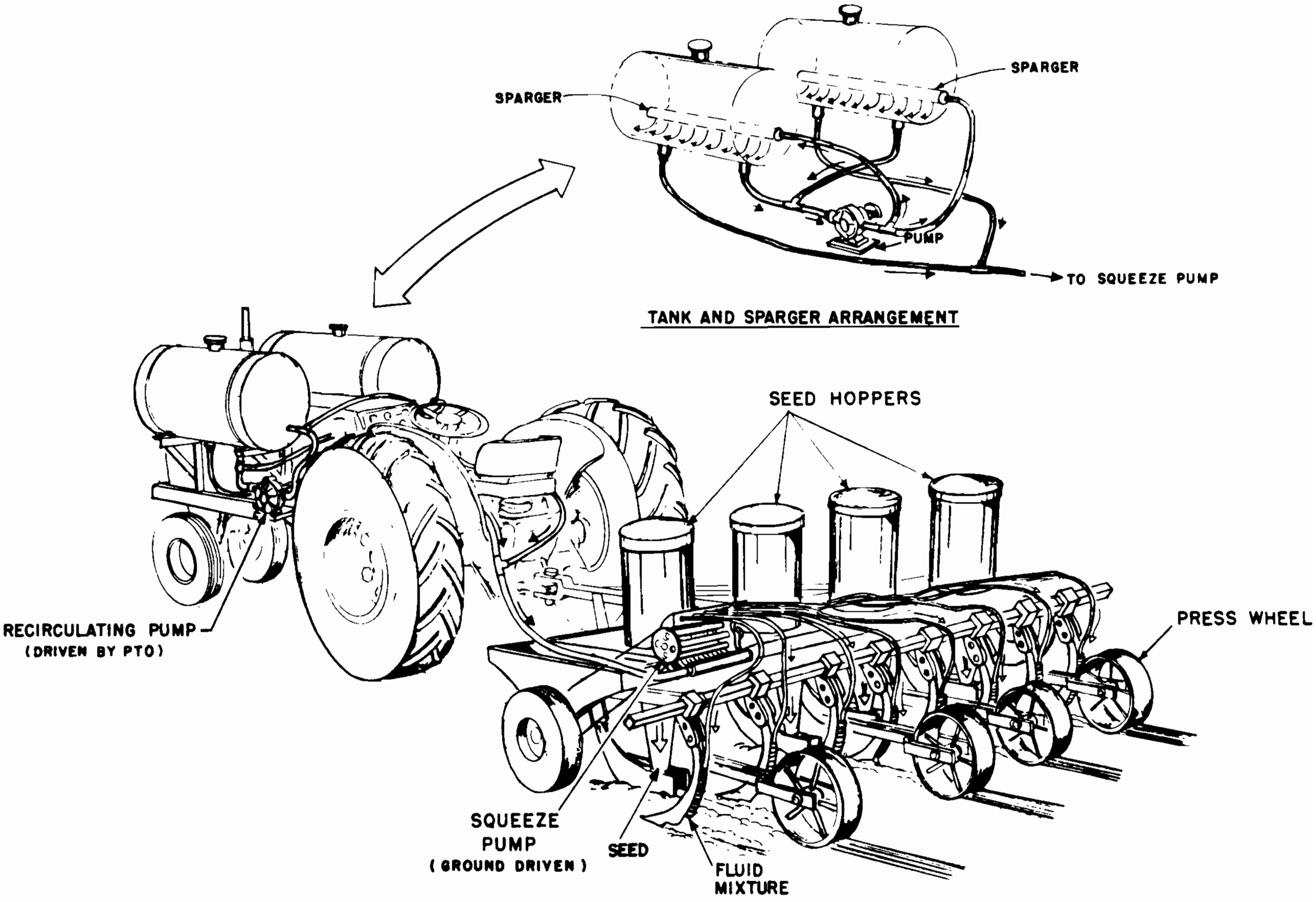


FIGURE 2

STARTER FERTILIZER ATTACHMENT FOR FERTILIZER-INSECTICIDE MIXTURES

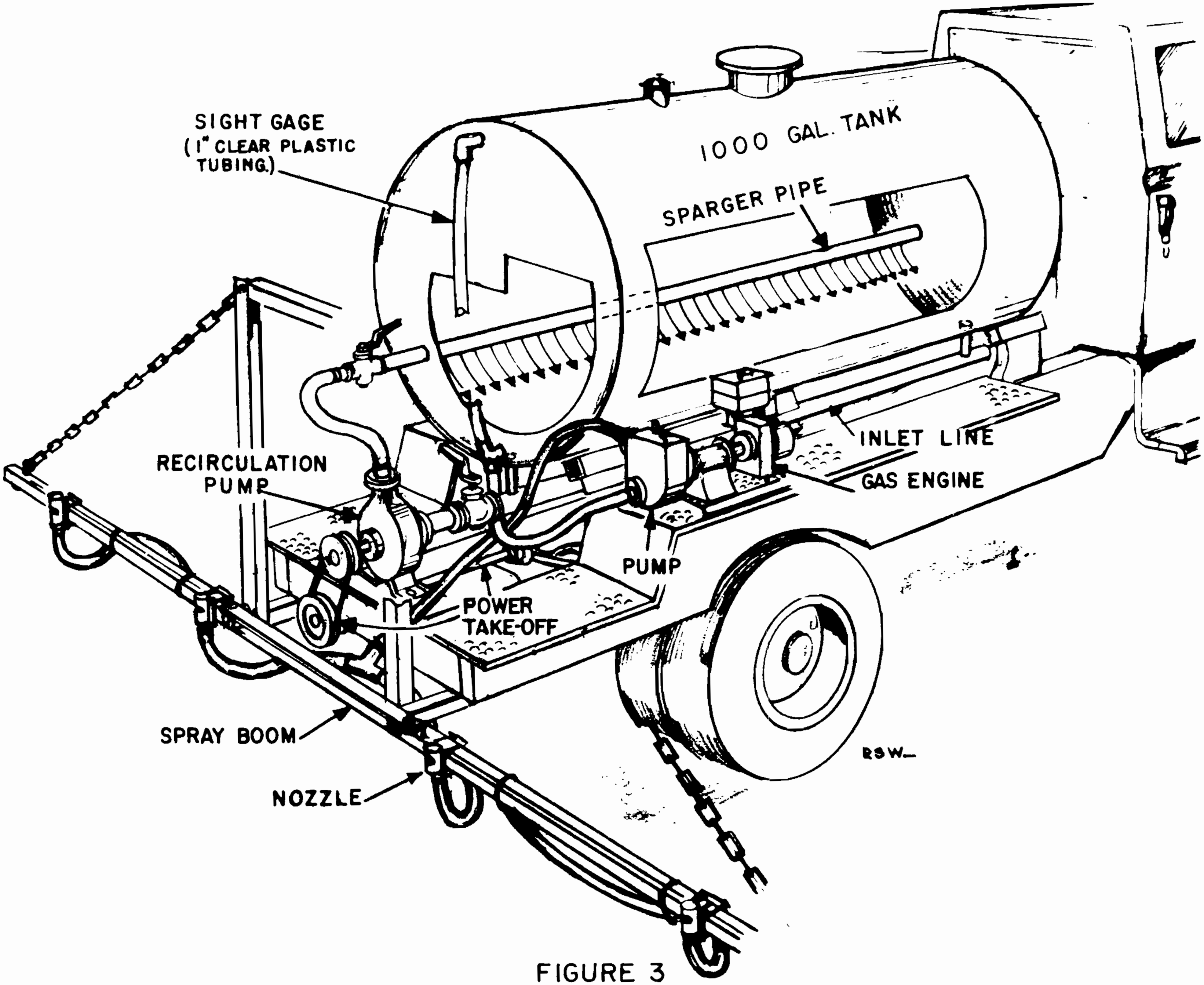


FIGURE 3

APPLICATOR FOR SUSPENSION FERTILIZERS

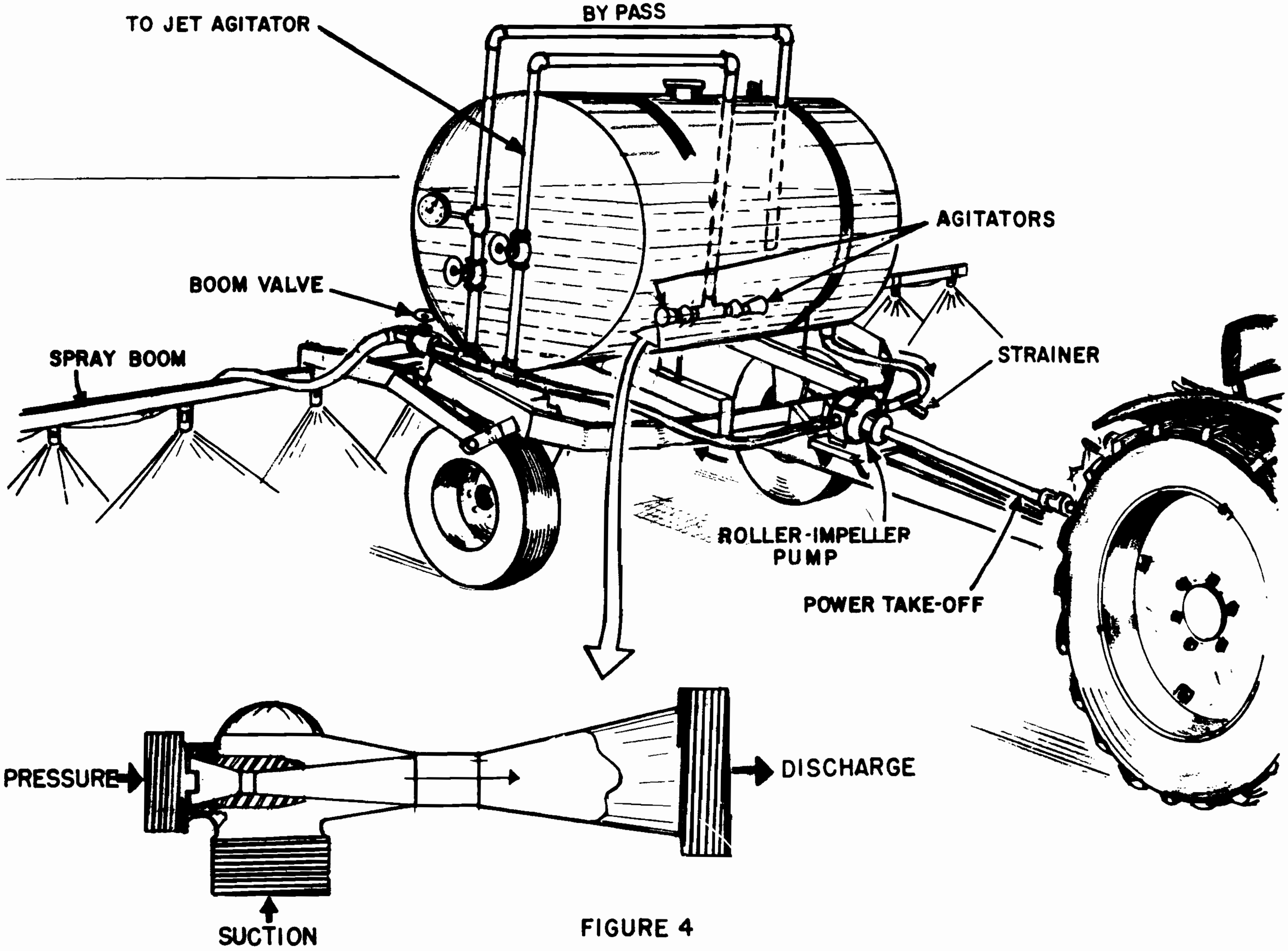


FIGURE 4

JET EDUCTOR AGITATOR

Fertilizer Distribution Challenges

R. R. Baxter

I have been asked today to discuss the distribution of fertilizer materials from basic manufacturing plants to regional and local outlets. Mr. Farmer of Agrico will discuss the movement of materials from retail outlets to the farm later in today's program.

My comments will be referenced primarily to our approach and experience at CF Industries. Although it may sound like a commercial, let me quickly set the background for our experience in distribution.

As most of you know, CF Industries is a manufacturer and distributor of basic fertilizer materials with production facilities located in Florida, Louisiana, the midwest and Canada. CF owns or leases regional distribution facilities in Canada and in many parts of the United States, although a substantial amount of our regional storage and distribution capacity is located in the central and upper midwest.

CF Industries sells principally to its 18 owners, regional farm supply cooperatives which market through several thousand local sales outlets in 42 states and the Province of Ontario, Canada. The company's total tonnage sales in the 1971 fiscal year were 4.6 million tons.

CF Industries operates an anhydrous ammonia complex at Donaldsonville, Louisiana with an annual rated capacity of 700,000 tons; and two nitrogen products plants at Fremont, Nebraska and Terre Haute, Indiana, producing ammonia, prilled ammonium nitrate and various nitrogen solutions. The company's two phosphate manufacturing facilities in Florida have a combined annual rated capacity of 780,000 tons of acid P_2O_5. CF Industries has a partnership interest in the Central Canada Potash facility in Saskatchewan which is capable of producing up to 1.5 million tons of muriate of potash annually; and, the company also obtains approximately 500,000 tons of potash products from the National Potash operation in Carlsbad, New Mexico.

So much for the commercial – now, the problem. The crux of the fertilizer industry's distribution problems is the heavy use of fertilizer during a few weeks each spring. Usually this problem period is only four to six weeks. Present U.S. fertilizer consumption totals about 41 million product tons, with about 70 per cent of this total (29 million tons) moving to the farm in the January-June period.

This past spring challenged the distribution capabilities of the fertilizer industry as never before, and I think clearly focused our attention on the magnitude of the industry's *current* and *future* distribution problems. As an example, CF Industries moved from manufacturing and regional storage points approximately 25 per cent of its total yearly tonnage volume – more than one million product tons – in the month of April. While we were pleased that our system was able to move this tremendous amount of material in just thirty days, we recognize that this type of movement calls for optimum utilization of our distribution system. Needless to say, this was a most unusual season due primarily to the weather. It dramatized the need for the industry to strengthen distribution capabilities to handle future growth.

Since we must first define a problem before seeking a logical solution, let us take a look at the component parts of the problem – namely, solutions, liquids, chemical mix and bulk blend – direct application materials. The industry has a number of major companies with marketing programs that cover one or more of these product groups. regardless of the original marketing thrust, it finally comes down to the same basic question for all of us – who can *service* the customer, *when* he needs, and *where* he needs it? In this commodity market, service sells!

Solutions and liquids, including anhydrous ammonia, appear to present no major distribution problem from manufacturing plants to the local outlet. For example, there is a great deal of flexibility in the distribution of ammonia, with the availability of river transportation, pipelining, rail and truck transportation.

CF Industries utilizes both river barging and the Gulf Central ammonia pipeline to move product from the Gulf Coast to the midwest. Our company operates a network of ten ammonia storage and distribution terminals along the pipeline and the inland waterways, plus two midwestern plant terminals. These terminals operate around the clock and are strategically located relative to major consumption areas. Reasonable proximity of these terminals to retail outlets allows maximum utilization of trucking equipment, reducing freight costs. Over 90 per cent of CF Industries' anhydrous ammonia market is within 100 miles of these terminals.

Virtually all of the ammonia moving from CF Industries' terminals goes by truck to members' outlets. Trucking is handled by our member companies, either with their own equipment or by arrangements with local trucking firms. This trucking system has been effective in providing good service to local cooperatives, and ultimately the farmer. This past April, CF Industries shipped approximately 275,000 tons of ammonia from its midwestern terminals and plants, with a peak of 200 truckloads moving one of our terminals in a 24-hour period. We believe that with modest expansion and reasonable planning, the present modes of transporting ammonia should prove equal to the task of meeting future growth in this market.

Chemical mix tonnage appears to have leveled out; thus, the long established supply systems appear more than adequate to supply this market's esssentially uniform intake of raw materials. So these operations do not contribute significantly to the industry's distribution problems.

Obviously, the biggest distribution problem our industry faces is in the movement of dry bulk blend – direct application products – primarily because there is considerably less flexibility than with ammonia, and because of heavy dependence on a rail system that has not kept pace with shippers' needs. More on this later.

Although distribution of prilled ammonia nitrate continues to be most troublesome due to the seasonaility of demand, the limitation to land transportation, and because the market for this product is gradually moving further away from existing production points. The increased usage of urea, which can move via the inland waterways through a regional warehouse system, should help to relieve the supply problems for dry nitrogen products. However, the magnitude of the dry nitrogen distribution problem is not nearly as great as that of moving dry phosphates and potash products.

Potash, because it leaves the mines in Saskatchewan and New Mexico only by rail and must be moved great distances to consumption areas, is much more inflexible to distribute than phosphate. However, the distribution problems are about equally difficult.

The Carlsbad mines serve the South and Southeast where the planting season starts earlier than in the midwest. This has proved a greater incentive for certain railroads to invest in more cars because it is possible for these railroads to utilize hopper cars for grain shipments following the end of the spring fertilizer season. Consequently, only minor transportation problems are encountered in moving potash from Carlsbad.

However, this is not the case in Canada where the movement of greater potash tonnage does not mesh well with grain movement. As a result, there is presently little incentive for the Canadian railroads to invest in the additional hopper cars needed to serve the Saskatchwwan mines. The car shortages in Canada are serious now and will become more acute as the New Mexico reserves are gradually mined out and more potash must come from Canada to supply the growing midwest market. Last year, 52 per cent of U.S. agricultural potash requirements came from Canada, compared to 22 per cent in 1965.

The Canadian National and Canadian Pacific railroads presently dedicate approximately 6,000 covered hopper cars to serve nine potash mines in Saskatchewan. It has been estimated that about 12,000 cars are needed to effectively handle the present, peak spring movement from Canada.

Car supply in Canada is further complicated because the major portion of Canadian grain facilities are not equipped to utilize hopper cars. This preference for using box cars, together with the extremely low rail tariffs on grain movement in Canada, provide little incentive for the Canadian roads to purchase more hopper cars. It is obvious that the solution to Canadian potash distribution is the construction of the necessary storage capacity at the local outlet and more uniform movement of the product throughout the year.

U.S. and Canadian consumption of potash is expected to grow within the next five years from the presnet 8.0 million product tons to 11.0 million tons. If the present potash rail fleet continues at about the same level, approximately 1.2 million tons of local storage will be needed to serve the market in 1976. Not only does local storage appear to be more economical than additional cars; storage close to the point of use offers several other advantages:

- availability of product to the farmer when needed.
- distribution costs are reduced by avoiding intermediate storage.
- the installed cost per ton of storage capacity of incremental local storage is estimated to be about 2/3rds the cost of large, regional storage units.

The tremendous cost involved in leasing the additional hopper cars needed to serve the peak potash movement is not realistic for several reasons:

- the high cost involved in leasing cars for 12 months when it is likely they will be used for only two months is not economically feasible.
- there are not enough short-term leased cars available to serve the peak movement.
- even if enough leased cars were obtained, the seasonality movement problems would not be solved.

It is obvious that ways must be found to stimulate the construction of additional storage for potash at the local outlets. This is a big challenge to the fertilizer industry and one we must face up to very soon.

With each spring presenting the same logistical headaches in phosphate distribution, CF Industries has taken the following steps:

- Phosphate products are moved by water to regional warehouses for transhipment to local outlets when it is economically feasible to do so. CF Industries and others in the fertilizer industry have established terminal warehouses on the Illinois, Ohio, Missouri and Mississippi Rivers.
- Phosphates and other fertilizer products are distributed via a total cost distribution method. At CF Industries, for example, variables are fed into a computerized distribution model. The model simulates the various alternates available and determines the means of optimum cost.
- Rail cars have been leased to shave off the peak rail car demands during the crucial spring period.

These moves were necessitated by the railroads' failure to keep up with the equipment demands of the fertilizer industry. The U.S. Class 1 railroads, as of August 1, 1971, had about 130,000 serviceable hopper cars. If the railroads fail to add to their hopper fleets, increased tonnages of dry phosphate fertilizers will have to be moved by a combination of water and truck transportation. This will be especially true in the midwest.

A good example of this trend is the two major phosphate products – triple superphosphate and diammonium phosphate. In 1965, (based on Corps of Engineers data), about 10 per cent of the Florida produced triple and diammonium phosphate was moved from Florida by water. In 1970, it is estimated that the water movement from Florida of these two products increased to about 35 per cent.

If the railroads had added to their hopper car fleets and encouraged more volume movement (and even unit trains where economically feasible), most of the tonnage now moving by water would be moving instead by rail. The fertilizer industry did not want to get into the warehousing of fertilizer at intermendiate points, but was left with no choice but to do so if markets were to be protected. Unless the railroads take steps to improve their service for dry phosphates, it is very likely 50 per cent of the dry phosphates sold in the midwest will arrive there by water with a sizable portion reaching the local outlet by truck.

Obviously, a continuing and major cause of our distribution problems is the railroads themselves. The railroads have not kept pace with the increasing needs of shippers and give no indication of doing so in the future. The truth is that the railroads generally have become disenchanted with railroading and have embarked on an aggresive diversification and railroad disinvestment program. Thus, it would appear that while the railroads are off plowing greener pastures, the government and shippers are likely to be left holding the bag.

Recently, the chairman of the Interstate Commerce Commision noted that railroad diversification poses a serious threat to "the economic vitality of the nation's railroads". His remarks came in the wake of increasing examples of the railroads diverting to non-transportation ventures, revenues derived from transportation services.

Continued de-emphasis on transportation activities by the railroads can only lead to increased transportation costs that will have to be borne by shippers, and would possibly result in costly lifesaving operations by the federal government. Only through aggressive and continuous political action by shippers, can we hope to persuade the railroads to live up to their transportation responsibilities.

But, let me caution you, the political arena is one in which the railroads are experienced and extremely skilled. A case in point is the proposed Surface Transportation Act of 1971 currently before the U.S. Congress. The primary beneficiary of this bill would be the railroads, although benefits would also accrue to the regulated motor and water carriers – all at the expense of shippers and the Federal Government. Department of Transportation officials have described this bill as one of the most "cynical" pieces of legislation in recent memory, with the "full weight of the carriers being thrown against other, smaller interests", such as the various shipper groups and the agricultural community. A quick review of the Surface Transportation Act proves this analysis to be an accurate one.

The first section of the bill requests $5 billion in guaranteed loans for the railroads and regulated truckers and water carriers. In view of the diversification and disinvestment activities of the railroads, the effectiveness of such a massive financial aid program is questionable indeed, especially in the absence of safeguards to assure that revenue derived from transportation services is not diverted to non-transportation uses.

Another section of the Surface Transportation Act advocates a "sky's-the-limit" approach to rate regulation wherein the I.C.C. would be requested to promulgate standards and procedures for the establishment of rate levels to cover operating and capital costs, including a reasonable return on investment. The bill further states that in establishing these standards the I.C.C. would be required to include in operating costs the cost of replacement of equipment and facilities at *current* prices. It is not hard to visualize the disastrous effect this type of rate regulation would have on present rate schedules and the tremendous cost to the fertilizer industry.

Another section of this proposed legislation that would have a most detrimental effect on the fertilizer industry is one that would give the I.C.C. authority to require water carriers of dry bulk commodities, such as fertilizer, to publish rates. This battle was fought just a year ago in the Water Carrier Mixing Bill when it was ruled that these exemptions should continue for a three-year period while the entire matter is given a thorough study by Congress. If this were ever to be enacted into law, it would remove the one lever the fertilizer industry has in controlling rail rates for certain fertilizer products.

This is the type of legislative competition the fertilizer industry is up against and it will take our best combined efforts to defeat bills like this one. As major shippers who are dependent on rail service, we must devote more of our time and efforts to the legislative arena. Only through enactment of positive, foresighted legislation, can we hope to get the railroads back to railroading.

I know that I did not offer today any simple, sure solutions to our industry's distribution problems. I do hope that I put some of these problems in perspective and identified the major challenges we all face. It is certain that the next few years will be most interesting and challenging ones for the fertilizer industry.

Thank you.

Distribution of Fertilizer

B. J. Farmer

INTRODUCTION

In the past decade the fertilizer industry has made outstanding advances in developing production technology which created the modern chemical fertilizer complex of today. The result is that the distribution side of our business has not kept pace with our production know-how. Therefore, it seems only logical that a group asuch as the Fertilizer Industry Round Table should begin to look at and discuss the portion of our industry where our biggest opportunity is: the distribution of our business.

MEANING OF DISTRIBUTION

Mr. Webster tells us "distribution" means "the marketing or merchandising of commodities". It seems to me that the distribution of fertilizer includes all those activities which take place between the factory gate and the farmer's field. Probably, something like two-thirds of the total cost of fertilizer to the farmer is accounted for by "distributing fertilizer" from the production point to the time it is put on the soil.

Distribution, therefore, includes such functions as Basic Transportation (either pipeline, railroad, barge or truck). It includes the functions of *terminals* and *intermediate* storage areas, whether used for ammonia, solutions, dry bulk, or bag field warehousing. Distribution is concerned with our *retail outlets:* the independent dealers, company-owned installations, dry blenders and the liquid mixers.

And, finally, the distribution process also includes something we call "Marketing Service" without which the goods produced by our industry would never be consumed on the farm. Marketing Service includes the advertising, the selling function, the credit, and the variety of services the fertilizer industry provides the farmer in the way of equipment, delivery, and application service.

May I repeat, *basic transportation, terminaling, intermediate storage, retail outlets, and Marketing Services* all work together as tools for the successful plant to farm operation. In the past decade, improvements have been almost completely in two areas: basic transportation and in terminaling. Very little has been done in the area to improve the distribution of fertilizer from the time it leaves a terminal location until it gets to the farm. (As Joe Sullivan said so well Wednesday, "The Last 20 Miles") It is the opportunity for improvement in this portion of the industry's system that I would like to examine with you.

THE RETAIL DISTRIBUTION PROBLEM

Retail fertilizer distribution is one of the most complex pieces of the industry. Today, we supply the farmer about 40 million tons of product a year. This is more than *twice* as much as supplied in 1950, and only *two-thirds* of what it will be necessary to provide in 1980. However, sheer volume is not the whole problem. Presently, the farmer is supplied with a much larger variety of rpoducts than in the past. For example, in 1950 we supplied practically no anhydrous ammonia, no nitrogen solutions, and no liquid fertilizers. Today, about a fourth of all the fertilizer the farm uses is in liquid form (nearly 10 million tons of product a year). By 1980, liquids will probably double that amount. In addition to marketing more liquid products, we have also provided the farmer with bulk products, much of which is mixed specifically to his particular requirements. In 1950, about 90% of the farmer's purchases were bagged products with a great deal produced locally. Presently, bulk sales predominate.

Another shift in the market that has complicated the distribution system has been the change in the farmer himself. In 1950, there were nearly 6 million farmers buying fertilizer. These farms averaged only 200-250 acres each. Today, there are half as many farms with the average size running around 400 acres a unit. Predictions are that, by 1980, there will be only 2 million farms of 500 acres, with less than a third of these accounting for nearly 90% of all production inputs used by agriculture. Thus, we have fewer customers than before, but each is a much larger consumer.

Now, what *has been* and what *will be* the impact of these changes on distributing fertilizers? First of all, we have a much *larger volume* of product to move in the same period. While some effort has been made to extend the period of fertilization, particularly by promoting fall application, farmers still apply about 70% of their fertilizer in the spring, a practice not materially different from that employed 20 years ago. This means we now move nearly 30 million tons of product in the spring alone, which is 50% more than we moved in a whole 12-month period in 1950.

A most critical problem in distribution was created with the shift to *bulk fertilizer,* both in dry and liquid form. A shed, or small building, to store bagged goods and possibly a pick-up truck for delivery used to suffice. Now, the retail outlet must have bulk unloading and loading facilities, including pressure storage tanks, pressure nurse tanks, and specialized application equipment for anhydrous. In addition, the outlet may need a parallel set of equipment to handle nitrogen solutions, and a third set, including payloaders, tenders, and spreaders for handling bulk fertilizer. Now, instead of having a building and a truck idle during the offseason (actually, the old dealer was able to use this equipment for other purposes), today's dealer has a large investment tied up in several sets of specialized equipment which may have little or no alternate use during the off-season. This shift to bulk has virtually eliminated pre-season movement of product to farm, and has *shortened* the distribution period.

The third change mentioned previously that has complicated the retail distribution is the changing nature of the farmer himself. Our typical customer today is no longer the small family farmer we used to serve. There are still many of those left but, as pointed out before, they are rapidly being replaced. Today's customer is a businessman or "agribusiness manager", who increasingly makes his purchases of farm production inputs, including fertilizer, much as any businessman does: that is, a rational business decision. In addition, the new farmer makes many more purchases today than previously, and now, not only buys seed and fertilizer, but also purchases labor, machinery, chemicals, agronomic services, credit, and delivery and application services. We, in the fertilizer industry, have been very accommodating in expanding our product line to include many of these.

The change in the nature of our customer and the expansion of our product line has complicated distribution of fertilizer. Many marketers are just beginning to realize that our customer is changing, and must be approached differently. Many of us are also beginning to realize that we really "sell" a much broader product line than fertilizer.

In addition to these three basic structural changes in the market, *larger volume, bulk sales,* and the *agribusiness managers,* there is one other important factor that should be mentioned . . . "over-investment".

As you all well know, during the 1960's, hundreds of millions of dollars were invested in retail fertilizer distribution in the U.S., either by new firms attempting to buy their way in the market-place in order to find a market for the output of the large chemical complex fertilizer plants, or by the established fertilizer firms who vowed they wanted a "piece of the action". and were not about to give up market share to any newcomers. I need not dwell on what happened; the results are too well known. Everyone took a "blood bath" in red ink! There was, however, another result: the fertilizer distributor increasingly offered the other farm inputs he handled as free bonuses to the farmer when he purchased fertilizer. Instead of selling service, delivery, machinery use and credit, the seller *gave* these to the farmer and, of course, the customer was only too happy to accept the bargain. Unfortunately, the bonus items were not free to the distributor.

SOLUTIONS TO THE RETAIL DISTRIBUTION PROBLEM

Now, how can the question of retail distribution be solved? There is no utopian solution, and if there was, I certainly wouldn't let my competition in on it! However, some actions are being taken and others can be taken which will begin to move us along the way to finding anawers. Just the fact that we recognize distribution as a *major* cost element and are talking about the complications associated with it is a major step in the right direction. I would classify the actions the industry might consider into three areas: (1) *recognize,* (2) *rationalize,* and (3) *systematize.*

A first step we must take is to *regognize* all the elements of retail distribution and *recognize* the real world costs associated with them. Many of us already realize that the incremental cost of a fertilizer product is not the "real" cost we can afford to use as a basis for pricing fertilizer, but how many of us *know* the real cost associated with supplying a farmer with delivery service, or delivery and application equipment? How many of us know the real cost of providing agronomic services to the customer, the taking of soil samples, the analysis of the samples, the development of a fertilization program to meet his particular needs? How many of us know the "real cost" of providing the farmer with considerable working capital in the form of extended credit terms on the fertilizer purchases he makes? How many of us even know the "real cost" of having two or three sets of parallel storage and distribution systems in order to provide the farmer several product forms to choose from? Recognition and identification of each element of real cost is a necessary first step?

The second step that must be taken is to *rationalize* retail distribution. Each firm, after identifying its real costs must dispassionately examine the cost of each element if its retail distribution system and equate those costs to the earning potential of that element of the system. If after adequate analysis, the distribution facility or service is not, and will not be in the near future, earning an adequate return on the associated investment, the firm must *cease the operation* and *dispose of the asset.* Only in this manner will the industry as a whole be able to return this part of its distribution system to an economic and profitable basis.

Finally, in addition to *recognizing* our real costs and *rationalizing* our asset base, we must *systematize* our retail distribution. The farmer is no longer buying just a bag of fertilizer from us, he is buying a total fertilization program beginning with identification of his fertilizer needs and carried all the way through to application on his field. What is needed is imagination and innovation that will develop new methods of providing this total package to the farmer at the lowest cost to him, but at the same time, at a cost that will provide a return to the capital invested in the system. One approach might be to develop alternative total retail distribution packages and let the farmer choose the one that best meets *his* particular need. What I have in mind may be something similar to the capital invested in the system. One approach might be to develop alternative total retail distribution packages and let the farmer choose the one that best meets *his* particular need. What I have in mind may be something similar to the way the auto industry distributes its auto package. Today, if one buys an auto, the basic car is priced and then each of the accessories is priced separately and the customer can combine those accessories he needs with the car and eliminate those that have no value to him. At the same time, the auto dealer knows his costs for each element of the package and can be sure he does not sell any item below his cost. If the retail fertilizer distributor were to do the same thing, he would price his basic item, that is fertilizer, and then price his accessories, such as agronomic service, equipment, delivery, application, credit, etc., separately. In this way, both the customer and the seller would know all cost elements of the transaction and would be able to make the most intelligent decision on what to purchase and how to price.

This is only a rather poor example of what might be done to help make the retail distribution of fertilizer stand on its own economic feet again. I'm sure better and more profitable total system approaches can and will be developed.

The important thing to remember is that profiund changes have taken place in our industry and will continue in the future. The volume moved has increased rapidly; the customer to whom we sell is different and still rapidly changing. In addition, industry investment in retail distribution facilities has been large and because of the resultant intense competition, many of us have lost sight of the real costs of distributing fertilizer in the rush to obtain another ton of business. The industry cannot move all product in a 60-90 day period from production point to farm with all present services at today's system of up-charges. All other farm input costs have increased annually to the farmer except fertilizer. Today's farmers are paying less per pound of N-P-K on the field than they were 20 years ago with many more services included. The fertilizer industry cannot continue to absorb all costs of these many services if it hopes to return to a reasonable level of profitability again.

The fertilizer industry has laready made progress in solving their problems, and I am sure that if we will apply the same energy and imagination to the distribution problem in the 1970's that we applied to overcoming the production in the 1960's, the industry will emerge with both an economic and profitable retail distribution system.

The Present Status and Future of Bulk Blending

Russel E. Weiss

Several years ago the management of many of our companies watched with skepticism a new approach to merchandising dry fertilizer. Naturally, their first question was – "Would it be accepted by the consumer?". It is not my purpose this morning to bore you with a lot of historical data, showing how this merchandising concept got off the ground and gained momentum. Each of you know this information from your respective areas.

Our concern is one of apprasing our present situation and trying to evaluate this to enable us to project into the future. Our performance has been good – the demand for our product accelerated so rapidly it was seemingly difficult to make errors in judgement. This development has been a normal evolutionary process, so that today, according to some predictions, 80% of all dry fertilizer sold in the United States is sold as bulk material. During the last year 29% of all the fertilizer sold in the United States was dry blended product. If one is to critize the past performance and development of bulk blending, I think the only honest criticism could be lack of constructive vision by the industry and to gear our activities accordingly, which, in essence resulted in poor planning.

I say this because today most of our dealers' dry bulk fertilizer facilities are not adequate to meet their current marketing demands. True, we have had new innovations appear on the scene, but I have reference to the age old problem, planning too small. On the wall of the board of directors' meeting room in our home office is this saying, "Make no small plans, for they have not the power to stir men's souls". This says concisely what I mean.

Presently our bulk blending programs are facing somewhat of a dilemma. Many of our facilities have too little inventory capacity. It is common for a dealer to have inventory for only three or four days' sales during the peak season. Rail service is being curtailed to the point that many facilities must be served by trucks, which can't keep up in peak periods.

We then must make a decision. Do we sit idly by and let our merket slip away; let new and perhaps less desirable products take over, and eventually let our dealers join the society of 'Once We *Were* Successful Fertilizer Dealers', or do we agressively undertake a strong marketing program to inject a new vitality into our programs?

The theme for this 21st Annual Fertilizer Round Table is "From the Ground, Back to the Ground". Many interesting talks have been presented and much discussion has been made at the 'Round Table' sessions about product quality, logistics of fertilizer distribution, and the gentleman following me will discuss a very important subject respective to bulk blending – particle size.

As I discuss the future of bulk blending, let me confine my comments to what I see ahead for us in helping our dealers get dry bulk blended fertilizers 'Back to the Ground'. To set the stage, let me say this, at no time has the challenge been bigger, nor the apparent rewards greater. The future is now!

Producers of food and fiber continue to increase their plant food requirements. We have seen some efforts in the direction of limiting or regulating amounts of plant food applications. Whether we appraise these as political or ecological is our individual choice. Only last week I read about group movements being organized, with a part of their objectives calling attention to a possible food shortage as soon as 1980. Recent published statistics have indicated the American family spends less than 16% of their income for food. I am of the opinion the American living standards will not: One, stand still for a food shortage, and two, stand still for increased costs of food.

Herein lies the challenge for our industry to continue to aid the producer to produce food and fiber as economically as possible. This, to me, is the future of bulk blending in this country.

To date the use of dry bulk blended fertilizers to supply crop requirements of phosphorus and potash, and limited amounts of nitrigen, complemented by a supplementary economical source of nitrogen, has given us a winning fertilizer program for most all agricultural areas. It is the most economical plant food program for the producer today.

We try to anticipate what our customers will demand in the future. Each of us could make a list for our respective areas, and undoubtedly the ranking of importance would be different. Whether a particular item is first or last is not of as great importance as the fact we do not overlook or slight any area which will give our consumer a sound, economical fertilizer program.

For just a minute let's place ourselves in the position of Mr. Producer of the future. This may well be tomorrow. Production costs are high; net margins are low; our abilities are taxed to manage costly operations; we don't have time to do the menial tasks of the operations; these must be left to someone else. Then let's approach only one segment of the program, soil fertility. As I see it, the producer of the future will be asking his fertilizer dealer for a fertility program which will produce a yield that will give him the maximum return. The producer will not see the fertilizer product to be used; he will not apply the fertilizer; he will see only what the job costs, and later, how much net profit he made on the crop. In the producer's desire to produce higher yields, more economically, he has recognized the value of fertilizer research. He did not wait for recommendations that would change his fertilizer application practices. He changed them himself. He began making heavy fall plowdown applications for his spring row crops. He began broadcasting his starter fertilizers weeks before planting time and so on. These were the breakthrough trends the dry bulk blend fertilizer industry had needed. Our future depends on our ingenuity to keep ahead of the producers' demands. With a sound dry bulk blend program for the future, our dealers can meet these demands.

What will constitute a "sound dry bulk blend program" of the future? Our thinking will have to be expanded. The crossroads facility of yesterday is inadequate; storage capacities must be enlarged so that a dealer will have adequate inventories to meet consumer demand while waiting for replensihment dupplies.

Future products which industry makes available to the bulk blender must continue to follow an upgrading program, both physical quality, and analysis, to keep the bulk blender abreast of the dynamic change taking place in agriculture. An important selling point for bulk blended fertilizers has been economics for the consumer. This has been possible because of high analysis products available for blending. The future success and growth of bulk blending then depends on a continuing program of product upgrading.

The mechanical aspect of bulk blending fertilizers is important. The fertilizer dealer who continues to use his original blending equipment, just because it's paid for, will be watching the competition, with increased blending capacity, capture his market. One, two and four ton blenders won't suffice to serve tomorrow's blanded fertilizer requirements. The capacity of equipment must be updated to meet sales volume at peak demand.

Expanded merchandising techniques must be employed:

1. Continued emphasis in selling plant food, and not tons of product.
2. Point out the advantages bulk blend has over other marketing concepts of N-P-K fertilizer.
3. Sell the correct blends of N-P-K to do a specific job.

Again, the fact that 29% of all fertilizer sold last year was dry blends indicated clearly the acceptance of this method of marketing. Once the farmer recognizes the savings in this type of program, it is not a difficult task to continue selling him dry blends. It will not be difficult to expand the concept and ultimately sell crop yields, rather than fertilizer. As I mentioned a minute ago, this is actually what the producer wants anyway.

The dry fertilizer industry must demonstrate aggressive leadership in the years ahead to achieve the ultimate objections I pointed out above. Other phases of the industry are challenging this position. They are doing it with hard selling. We could well take a lesson from them. However, we do not have to take a backseat. A strong sales approach, plus the crop yield concept, gives us an unbeatable N-P-K program for the farmer.

The future dry blend dealer programs will demand high caliber personnel. These must be men with product knowledge, sales ability and agronomically tained, and must be properly compensated for these abilities and knowledge. We are past the 'weak mind, strong back' era in the dealership area of the fertilizer industry.

The fertilizer industry is facing the greatest challenge ever today. This is in the current ecological movement. How you accept or appraise this challenge really isn't important. The fact is, we have it. We must find a way to cope with it. This opens the door even wider for dry bulk blending of fertilizers.

Going back to my previous comments about selling plant food on the basis of crop yields, herein lies the answer to the ecological critics of fertilizer use. This fertilizing concept meets the approval of most agronomists, so we gain them as an ally. The concept meets the approval of the farmer because it economizes his production costs. It meets the approval of our fertilizer dealers because it allows them to handle less total weight of material to supply adequate plant nutrients. And it meets the approval of management in our industry because it affords them a method of marketing product in the face of adversities. Would we agree this is z winning combination?

In the future what will be trends in bulk blending? We will see continued efforts in the development of higher analyses materials for bulk blending use. We are now seeing a constant change in the N-P-K ratios of blending materials. The fluctuations in the N-P-K market will largely dictate these changes. The bulk blender will need co-operation from his supplier to continue blending the farmer's fertilizer requirements as economically as possible.

1 predict methods of blending trace elements will be streamlined even more – both physically and chemically. The trace element suppliers will find it to their advantage to continually improve their product. Farmers' requirements for trace elements will expand and become more complicated. The bulk blend plant can meet this situation better than the granulator. Engineers will make continued efforts to design plants and blending equipment that will increase productive capacity. They will be giving us improved designs and equipment which will improve blending micro amounts of trace elements. Automation of the blending plant could destroy one of the strongest psychological merchandising advantages bulk blenders have with farmers; the personal touch to the farmer's blend. Some may disagree with this because earlier I said the farmer of the future may not see the custom mixed, custom applied fertilizer that is put on his fields.

New crops, hybrids and variety introductions will have a promounced effect on the bulk blending of fertilizers in the future. Farmers are excited about hybird wheat, high lysine corn, new forage and fiber crops, limited tillage, and increased production methods. All of these new things require special fertilization. The bulk blender must be ready to meet these new farming conditions.

We should consider how quickly today's farmer accepted bulk blending. Tomorrow's farmer will place even heavier demands on our industry for things that may not be entirely related to the physical blending of fertilizer. If he demands special tillage equipment, special types of seeds, special chemicals, why hasn't he the right to demand special fertilizers tailor made to his soil, crop and anticipated yield?

We recognize labor is a serious factor in farm production and it is becoming even more critical. Earlier I talked about services which have brought the producer to our bulk blend plants time and again. If he is to return and do business with us tomorrow, we must offer a dynamic program that is equal to the change he is making to new farming methods.

In closing, I suggest we remember fertilizer is of little value until it is in the hands of the producer. Only he can put it to its ultimate use. Then its full measure of value is not realized until it has produced as we tell him it will. Fertilizer must prove its worth more often then most other farm supplies. This is our challenge of the future. A bulk blending program is better equipped to answer the challenge than most of our fertilizer merchandising programs.

Factors For Analysis Control Dry Blend Plants

Wayne LeCureux

1. Mixing Equipment –
Type and design of mixer has considerable influence upon the uniformity. You need to decide which are the most important factors as to batch size, tons per hour, power, and location in the system. We prefer the paddle type for uniformity, speed, and tons per hour but it takes considerable more power than drum or other type mixers.
2. Mixing Time –
Is related to above. To get a good mix in a short time takes alot of power. You should run time tests on your mixer to check the minimum time needed to get the desired mix.
You may find also the order of ingredients has an influence on the mix. Potash seems to be the most difficult to mix. It is a good idea to add the potash first for the longest mixing.
3. Loading Spouts and Dust Control –
The proper design of loading out spouting can help in both analysis and dust pollution control. A design which we have found helpful in this is a telescoping spout with a canvas sock at the end. The telescoping spout is powered down and up by an operator using a winch and reversible motor. A flared canvas sock on the end permits the spout to be powered down into the truck to completely enclose the material as it flows into the truck. The powered telescoping feature permits the spout to be raised by the operator as the truck fills. This idea when properly designed and handled will practically eliminate dust pollution in bulk filling trucks and helps to prevent separation in coning.
4. Bulk Transport and Unloading –
Separation of particles in unloading is a factor that needs to be considered in design of transport and unloading equipment. The tendency for bulk transport trucks to go to high speed conveyors and bulk throwers may help to speed unloading but at the same time make for problems in separation. We need to be aware of this factor in securing equipment.
5. Size, Shape and Density of Particles –
This is a whole subject in itself. Some of the best studies which I have seen to date on the subject was the research work done by TVA. Some of their findings were interesting in that they found where size was a greater factor than density in separation. There needs to be more research on this subject along with a more complete study of sampling techniques to be used in analysis control.
6. Uniformity of Materials –
Particle size of materials was to be my subject which I have enlarged upon with these other factors. On the basis of the TVA findings alone one can see serious consideration that needs to be given to buying materials of a uniform size range. It even pays you to have screen size testing equipment to check the particle size range of your materials. You cannot depend upon supplier specifications sheets as to what you may be getting.
The problems of fines and dust can be most difficult from an analysis and pollution control. It may become necessary to put in removal equipment for fines and dust which then becomes a disposal problem. It is a production and handling matter which must be given more consideration in the future.
The question of potash sizing I know is one under serious study by the industry. Should they continue to offer the two grades, coarse and granular and what should be the specifications. Here is typical screen sizing of coarse and granular as now being offered by 3 companies:

	COMPANY			COMPANY		
Tyler	A.	B.	C.	A.	B.	C.
Mesh		COARSE			GRANULAR	
8	5%	––	12.7%	21%	28%	30%
10	31%	23%	49.9%	72%	82%	85%
14	71%	74%	86.2%	97%	97%	98%
20	96%	96%	99.2%	––	99%	99%
28	––	99%	99.6%	––	––	––

Moderator Reynolds: Ladies and Gentlemen, we had an excellent morning session, good attendance, most interesting timely papers and real good discussions. I shall now turn this meeting back to Chairman Spillman and I thank you for your kind attention.

Chairman Spillman: Our registered attendance for this five session meeting is 265, approximately the same as our registration at Memphis last year. Comparing Memphis meetings 1970 and 1971 with Washington 1969, we had at Washington about the same registration. The difference was around thirty-five less from the Washington area and around thirty-five more from the Memphis area.

This morning you voted to have our next meeting, 22nd Annual Meeting, at Memphis, November 1-2 and 3, 1972. Please note the dates in your Meeting Calendar and possibly make your reservations before you leave for home.

Note:

22nd Annual Round Table Meeting
Sheraton-Peabody Hotel
Memphis, Tennessee
Wednesday, Thursday, Friday
November 1, 2 and 3, 1972

Planning for our 1972 Round Table is already in motion. Your suggestions and ideas are solicited. This direct information is vital to "Our Program Committee" to assure that the program reflects your thoughts and ideas. Questionnaires soon will be sent to all of our members as a reminder to encourage suggestions promptly coming back. This is "Your Round Table". It can only grow as your interest in it continues to grow and this has been a real factor for the past 21 years.

I wish to thank all of you for attending this meeting. Copies of the printed proceedings will be mailed to you as soon as possible. My thanks to our entire Executive Committee and to our members for their excellent cooperation.

Registrations from outside the United States totaled twelve. From Canada 5, Australia 1, Ireland 2, Italy 1, Mexico 2 and Spain 1. Glad you could come and hope that you will be with us at Memphis next November 1-2-3, 1972. I wish you a safe and enjoyable trip back home.

My special thanks to our Moderators, Panel Leaders, Panelists, all the moderators at our "Informal Round Table Sessions", Wednesday and Thursday afternoons, Members of the Press, Hotel Personnel, Memphis Chamber of Commerce and others for helping us conduct a real good seccessful meeting.

Housden and I have enjoyed serving The Round Table as Secretary-Treasurer and Chairman respectfully. We resigned these offices because we wished our younger members to take over. However, we shall continue as members of the Executive Committee and do whatever we can to help our Round Table. We extend our best wishes to Herman and Paul and wish them success in the leadership of our Round Table. God bless all of you.

This concludes our meeting. [Lots of applause].

Meeting adjourned at 11:45 A.M.

Changing the guard. Herman Powers, left, is congratulated by Albert Spillman on his selection as chairman of the Fertilizer Roundtable. At right, Paul Prosser receives similar congratulations from Housden "Doc" Marshall, whom Prosser succeeds as secretary.

Photo courtesy: Agricultural Chemicals and Commercial Fertilizers, Cedargrove, N.J.

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Entertainment	Athey—Prosser—Sackett
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Finances	Prosser—Spillman—Marshall
Program—Annual Meeting	Reynolds—Adams—Spillman—Marshall
Nominating	King—Whittington—Countess
Public Relations	Sackett—Whittington

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