Ag and Food Interprets

- **Full effect of St. Lawrence Seaway on agricultural chemicals is years away**
- **Direct sale of fertilizer by manufacturers to farmers is on the increase**
- **Weed killer 2,4-D stays in top-selling place as selective herbicide**
- **TVA finds some causes of nitrogen losses, recommends preventive measures**

Seaway

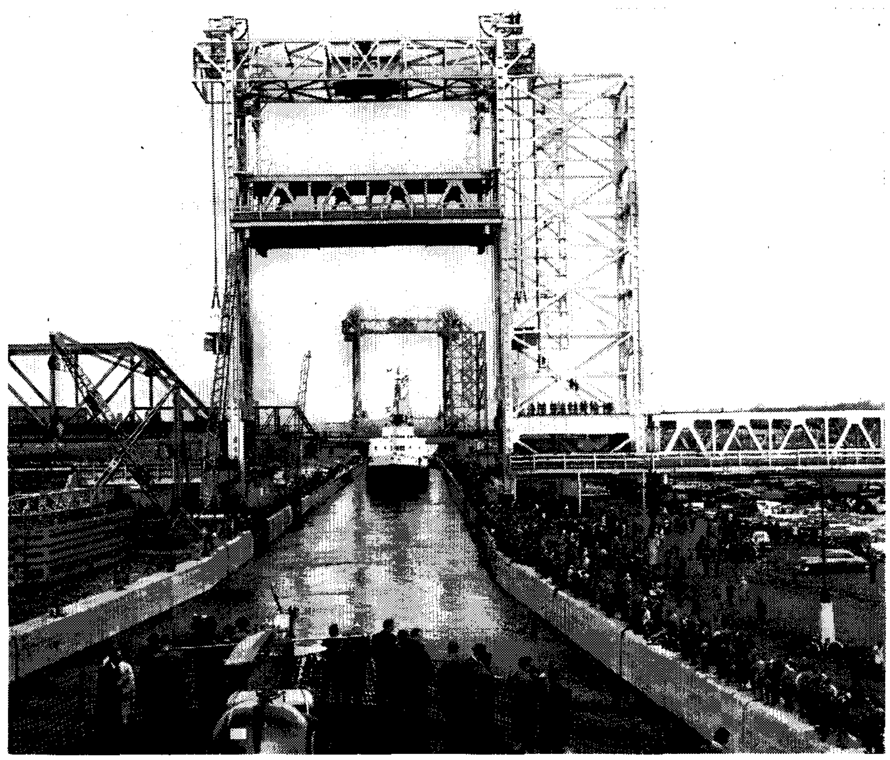
Immediate effect on plant foods and ag chemicals will be slight. Full potential is years away

THE ST. LAWRENCE SEAWAY is halfway through its first year of operation. Between late April of this year and sometime in December, when winter ice closes in, the seaway will have carried about 25 million tons of cargo. This is roughly twice the annual traffic that the old system of shallow locks and canals handled in recent years.

And seaway volume is expected to increase each year at a smart pace until a level of around 50 million tons is reached. That is the level needed for the U. S. and Canada to pay off the seaway's capital cost within 50 years as required by law. If current predictions prove out, the 50-million-ton mark will be hit within 10 years.

What does the seaway mean to producers and users of fertilizers and farm chemicals? For the present, it will have little effect. With some exceptions, the industry is waiting—waiting until the bugs are worked out, and the seaway's advantages and disadvantages are more clearly outlined. "We are watching developments, but haven't made any specific plans," is a typical industry comment. "It will take years, perhaps 10 or 20, to develop the seaway's full potential," says another observer.

For one thing, fertilizer shippers wonder about service on the seaway. The ship lines, naturally, are most interested in large volume cargoes—grain, iron ore, coke, for instance. Less profitable items may take a back seat, at least in the beginning. One traffic manager for a large fertilizer company explains it this way: "Some delays are bound to happen during the first couple of years while ship operators learn the ins and outs of sailing the St. Lawrence and the Great Lakes. If a ship line must choose between meeting a schedule with us or a big grain firm, it will logically take care of the big user first."

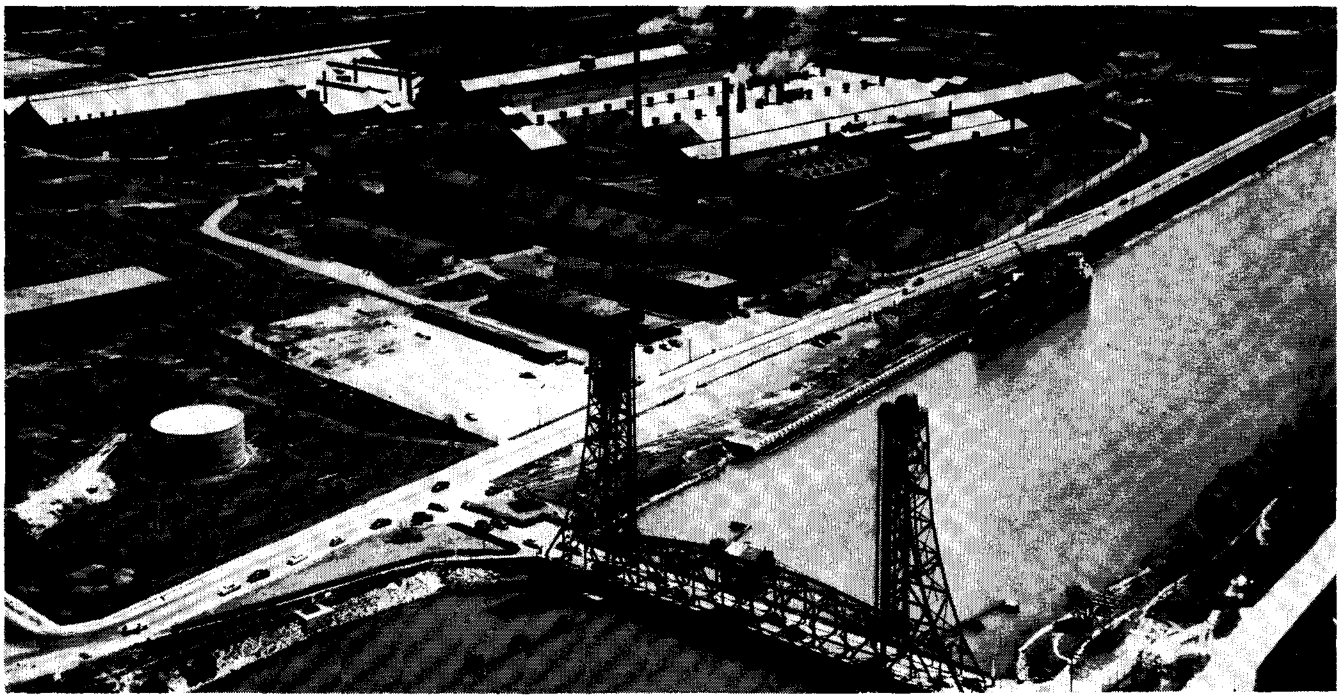


Ceremonies at lock near Montreal mark opening of St. Lawrence Seaway

More Work to be Finished on Port Facilities

Another short term problem is that of port facilities. Even though construction of the seaway itself is completed, much still needs to be done to improve Great Lakes ports. Harbors are being made deeper, piers and terminals are under construction. Still, many shippers feel that it will be several years before service and facilities along the Great Lakes can come close to matching those at ocean ports.

Perhaps the most important reason for fertilizer makers' waiting is their desire for cost information. Here the key is comparative cost—how the seaway stacks up against overland transportation or, in a few cases, alternate water routes. Some rail rates have already been reduced because of seaway competition. Other cuts are expected. Experts believe that the seaway will eventually cause a general lowering of transportation rates in the areas affected. Shippers hesitate to make extensive plans or investments based on



Plants located along the Seaway are likely to benefit most from new trade route. This one, at Welland, Ont., belongs to Union Carbide Canada, Ltd.

the seaway until the rate picture firms up.

Two-Edged Sword

U. S. fertilizer producers look forward to a gradual shift toward utilizing the seaway. But also they realize that it could be a two-edged sword. With the seaway, foreign fertilizer companies now have access to Midwest markets which formerly could not be easily reached from overseas. One shipment of iron-curtain potash reportedly turned up in Cleveland this spring. Over-all, however, there has been no noticeable increase in fertilizer imports because of the seaway.

Another possible negative effect of the seaway is an increase in insect control problems. Regulatory workers here and in Canada are concerned about having "ocean" ports located far inland. For instance, USDA inspectors recently found khapra beetles, a pest from the Far East, aboard a grain ship docking at Cleveland. The ship was fumigated before any cargo was unloaded.

Canada, too, may have problems with imported pests. The Canadian Department of Agriculture points out that before the opening of the seaway most imports arrived at just a few all-year ports on the coast. Now, inspectors will have to branch out to supervise unloading all along the St. Lawrence and the Great Lakes.

Although most companies have a wait-and-see attitude toward the seaway, others are actively exploiting its potential. Take Dow for instance. In 1955, Dow's Midland Division began shipping to Europe through the Port of Detroit. By late 1957, when the opening date for the seaway was fairly firm, Dow had put in terminal facilities at Bay City, Michigan, a few miles from Midland. The following year some 30 vessels docked there, handled 16,000 tons of general cargo for Dow. When the seaway opened this year, the company was all set to use it.

International Minerals & Chemical offers a specific example of how the seaway can benefit the plant food industry. Next year IMC will open a potash mine near Yarbo, Sask. The firm's traffic department is now working on a plan to put down Yarbo potash on the East Coast at a price competitive with those of European imports.

Using a rail haul from Saskatchewan, IMC's price on the East Coast would be $3.00 to $5.00 per ton above that of imported potash. But the seaway should be able to shave off enough transportation expense to let IMC compete. The company would ship by rail to Fort William, Ont., on Lake Superior. While Fort William is used mostly for iron ore shipments, its excellent bulk loading facilities could be used equally well for potash, says IMC.

The seaway has been a dream for four centuries. It is gigantic in scope. Anything that big and that long in coming can hardly be expected to work perfectly the first year. Manufacturers in the chemical and plant food industries feel that it will be 15 to 20 years before the seaway's position in the economy of this continent is secure. But the end result should most certainly be a boon to industry.

Direct Selling Affects Dealer

"Bypassing" sales by fertilizer producers are reported on the rise in many farm areas

DIRECT SALE of fertilizer to farmers, with the manufacturer bypassing the distributor and the dealer, is decidedly on the increase. In some areas the idea has been adopted for as much as 50% of the tonnage sold in heavy consuming localities, and for about 20% in others.

In some states such as New Jersey it is estimated that the amount of fertilizer sold directly by producers is only a small percentage of the total, but that it will increase. In parts of New England it ranges from 30 to 35%. Farther down the East Coast the tonnage is said to be limited to less than 20%.

Beneficiaries of the practice, as might be expected, are the farmers who are able to buy large tonnages of fertilizer, usually those who take more than 50 tons. However, in parts of the South it is said that anyone who can buy a 10- to 18-ton truckload of any material can buy direct.

Some manufacturers also are selling directly to dealers, thus bypassing the mixer-distributor. One large Midwest interest which makes ammonium nitrate says it has been doing this in connection with its sales in Mississippi, Louisiana, and Arkansas. Its hand has been forced, it indicates, by competition from a Mississippi cooperative that is able to sell at low prices "because of its favorable tax position."

Effect on Market

Nitrogen manufacturers are by no means happy over this situation. Another ammonium nitrate interest in the South feels that bypassing of the mixer-distributor will tend to break down the prevailing marketing pattern for fertilizers. The mixer-distributor is not a parasite in this pattern, he contends. The mixer-distributor helps to promote the product, and also handles such details as credit collections.

The Midwest manufacturer's reply to this is that the mixer-distributor really doesn't perform much of a job in promoting a product like ammonium nitrate. He is primarily interested in selling mixed goods and not basic fertilizer materials.

Dealers evidently are bearing the brunt of the direct selling practice in fertilizers. Dealers are being bypassed not only by manufacturers but also by many mixers. A spokesman for a large eastern cooperative reports that probably as many as 75% of the growers who use 30 tons or more buy as "dealers" in this area.

Basic producers bypass mixers to sell directly to farmers less often, the same co-op states, because all materials are plentiful, and producers can't afford to sell their customers' customers. Dealers meanwhile have no way of counteracting the direct selling which bypasses them, and they are forced to spend their time and energy on some commodity other than fertilizer.

Small Companies Joining

The direct selling question draws varied comment from state officials and industry people in the South. One state director of agriculture fears this practice could progress to an alarming degree. Even smaller companies are taking up the idea, he says. And the manager of a cooperative estimates that as much as 50 to 60% of fertilizer in his area is sold direct.

On the other hand, one fertilizer mixer in Arkansas feels that direct selling by basic producers has been negligible in his territory. Only one major producer has attempted to sell direct there, he points out, and the efforts were so futile that the producer will not want to adopt this as a permanent policy.

Effects of direct selling are minimized in other parts of the South. One state official grants that there is some trend toward direct selling of fertilizer to farmers by manufacturers, but doubts that the practice is making important progress.

Dealer Reaction

Among certain large basic producers it is contended that the effect of direct selling on dealers is not too serious. Some dealers are concentrating efforts on specialty grades, it is said, and others on giving better service, such as soil testing. They are also extending credit more freely in some cases, and tieing in sales with other services. But dealers can do little else about the practice, because of their narrow profit margins.

Generally, complete fertilizers are chiefly involved, although some note a good measure of direct selling in ammonium sulfate, cyanamide, ammonium nitrate, sodium nitrate, and superphosphates.

If this practice develops into a major trend, what will be the ultimate effects on dealers, distributors, mixers, and basic producers? Answers to this question are varied.

"It will obviously tend to limit the amount of fertilizer sold through dealers and distributors," says one observer. "Dealers trying to compete with this trend will have to cut their prices even more than they have."

"It will increase the cost of distribution."

"It will mean elimination of the dealer."

"Lower profits, higher sales costs."

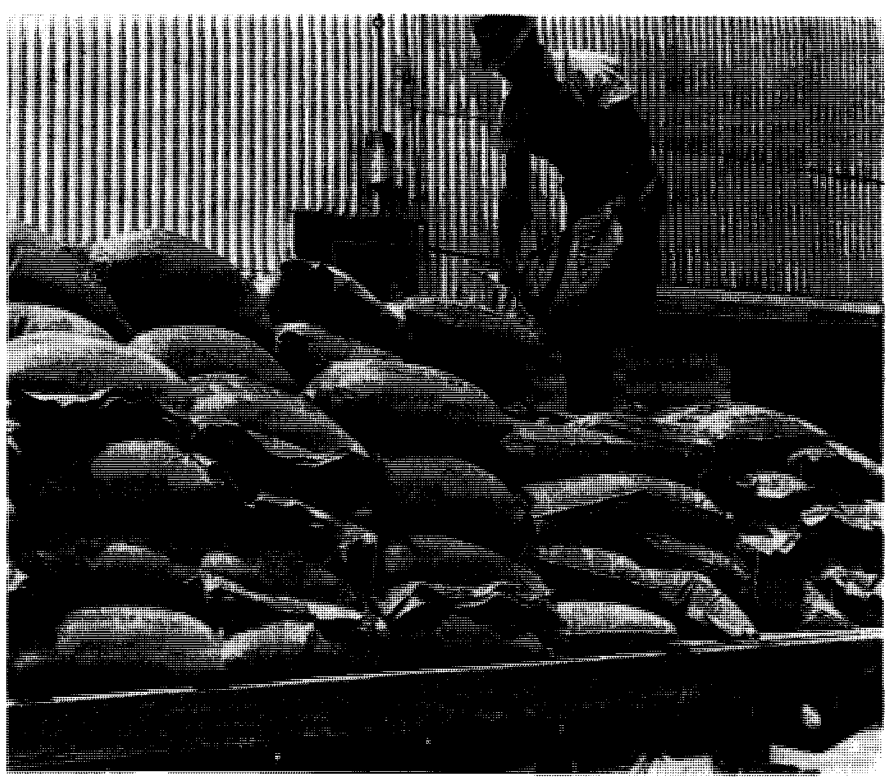
"More competition at the grower level."

Adverse Result Seen

"In general," says an eastern manufacturer, "the effects will be adverse. By the current set of standards dealers and distributors will lose business. Their functions will not be discontinued, but someone else will perform them. Mixers and basic producers will be better off only if the new marketing entity is more efficient than the current dealer and distributor.

"There appears to be one other per-

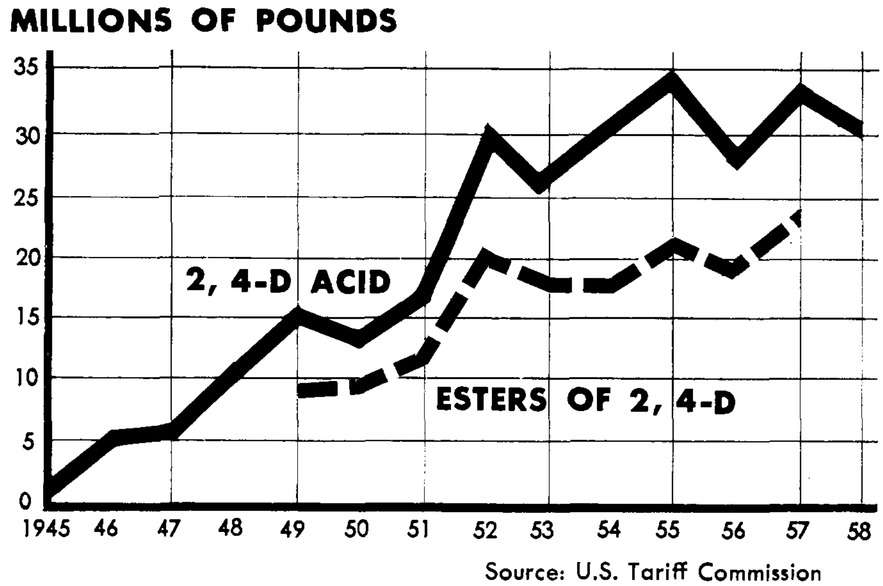
In many areas, farmer can get a truckload of fertilizer from a manufacturer as easily as he can get it from a dealer—and at considerable savings to himself



son worthy of consideration in this chain—the farmer. Over the long run he will benefit by any new efficiencies in production and distribution adopted by the fertilizer industry as a general practice."

Weed Killer 2,4-D

2,4-D, in the form of esters and amine salts, remains the nation's top-selling selective herbicide



Production of 2,4-D has had its ups and downs, but general trend is upward

ALTHOUGH PRODUCTION of 2,4-dichlorophenoxyacetic acid (2,4-D) didn't reach a record high last year, it was only about 3.5 million pounds short of the outputs for peak years 1955 and 1957. According to the U. S. Tariff Commission, production in 1958 totaled 30.9 million pounds.

2,4-D continues to be among the top-tonnage products of the pesticides industry. Its output is exceeded only by that of pesticides such as copper sulfate, sodium chlorate, and DDT. Obviously 2,4-D has come a long way since its herbicidal properties were first discovered in the early 1940's.

This discovery was an outgrowth of research on chemicals capable of altering plant growth. Chemists were seeking new compounds which, like indolebutyric acid, could accelerate or modify the growing process. In the forefront of this work were such organizations as Boyce Thompson Institute for Plant Research, in Yonkers, N. Y., and Imperial Chemical Industries, in Great Britain.

One of the earliest discoveries was that 2,4-D and related compounds, in concentrations of about 1 to 3 p.p.m., could stimulate plant growth. In 1943, Du Pont received U. S. Patent 2,322,760 covering a wide range of materials capable of controlling plant growth—among them 2,4-D.

Researchers at the New York Agricultural Experiment Station in Geneva, N. Y., at the USDA laboratories in Beltsville, Md., and in laboratories elsewhere in the U. S. and Great Britain found that, at higher concentrations (about 100 p.p.m.), 2,4-D and a number of its derivatives were capable of destroying many broad-leaved plants. Narrow-leaved plants, such as grasses and cereals, remained unharmed.

The first U. S. company to make 2,4-D commercially as a herbicide was Amchem Products (then known as American Chemical Paint). Its production began at Ambler, Pa., in 1943. Two years later, Amchem received U. S. Patent 2,390,941 covering a variety of halogenated phenoxyacetic acid compounds, including 2,4-D and derivatives, for use as weed killers.

Next company to enter the field was Thompson Chemicals, which began making 2,4-D as a herbicide in Los Angeles in 1944. Actually, this company had been producing 2,4-D as far back as 1933 for use as a plant hormone to promote the formation of fruit. Thompson Chemicals now makes 2,4-D in St. Louis, and expects to have a new plant on stream next month.

A number of companies launched commercial production of 2,4-D in 1945. Among these were Dow Chemical in Midland, Mich., and J. T. Baker Chemical in Phillipsburg, N. J. The following year, Monsanto started production in St. Louis.

Today the major producers include Dow, Monsanto, Diamond Alkali, Pittsburgh Coke & Chemical, Thompson Chemicals, Chipman Chemical, Thompson-Hayward Chemical, and Frontier Chemical. These companies make a wide range of 2,4-D derivatives, as do California Spray-Chemical and others.

Some Have Bowed Out

In recent years, several companies have discontinued producing 2,4-D. Sherwin-Williams, which began making it in Chicago in 1947, ceased production in 1949—partly because of legal problems resulting from improper handling of the compound by users. Some farmers and others applied 2,4-D carelessly, allowing it to drift to nearby areas, sometimes causing serious crop damage. After careful consideration, Sherwin-Williams decided it would be more profitable to concentrate on its well-established paint business.

Amchem also is no longer making 2,4-D. Its plant was in a residential area, where escaping fumes and dust caused difficulties.

Du Pont originally got into 2,4-D production because it wanted to offer a complete line of agricultural chemicals. Within a few years, however, Du Pont likewise decided to bow out. Because the company wasn't basic in the chemicals needed for 2,4-D production, it found that its operations were not economical.

J. T. Baker gives much the same reason for its own decision to stop making 2,4-D. The price of the compound dropped to such a point, says Baker, that it was no longer profitable to make 2,4-D without being basic in at least some of the raw materials. Furthermore, as Baker points out, a number of other producers had begun marketing 2,4-D directly to consumers. Having limited its selling strictly to industrial users and formulators, Baker felt it was in no position to plunge into the consumer field.

Derivatives Preferred

Today, 2,4-D is seldom used as the unmodified acid or even as the sodium salt. About half of all 2,4-D now used is in the form of amine salts; the other half is esters.

The most common amine salts consist of 2,4-D combined with dimethylamine, trimethylamine, triethylamine, or diethanolamine. Highly soluble in water, the amine salts are readily formulated into aqueous sprays.

The esters, on the other hand, are essentially insoluble in water. Hence they are used either as oil sprays or in oil-water emulsions, along with emulsifying agents. The esters include the methyl, ethyl, isopropyl, *n*-butyl, and amyl derivatives of 2,4-D. The low-volatility esters, which are finding increasing acceptance, are usually the butoxyethyl, butoxypropyl, or butoxyethoxypropyl derivatives. These have the advantage of being less hazardous when sprayed near susceptible crops.

Standard Synthesis

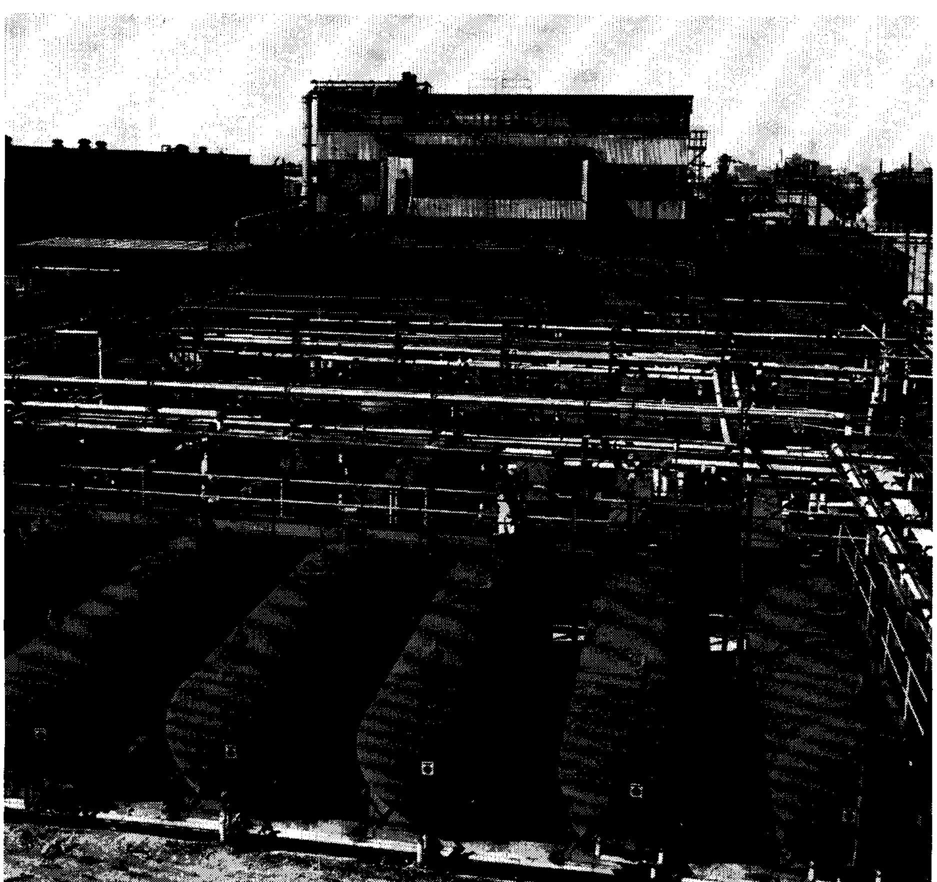
In broad outline, the process for making 2,4-D varies but little from one manufacturer to another. The September 1959 issue of *Industrial and Engineering Chemistry* (pages 974 to 980) carries a detailed account of how Dow Chemical makes 2,4-D at its Midland plant.

The process involves reaction of monochloroacetic acid with an excess of 2,4-dichlorophenol in the presence of aqueous sodium hydroxide. Main product is the sodium salt of 2,4-D. Once the reaction is complete, hydrochloric acid is added to lower the pH to 5. This converts the sodium salt of 2,4-dichlorophenol to the free dichlorophenol, and permits recovery of this excess material by distillation. The acidity of the residue is then increased still further to pH 1 to cause the 2,4-D to precipitate as fine white crystals.

The crystals are filtered, washed, and, if necessary, dried. The 2,4-D (either moist or dry) is later treated with an amine or alcohol to form the desired amine salt or ester. Dow says that last year it made 47 different products and formulations of 2,4-D and its derivatives. Many of these newer products have resulted from its own field research on the handling of specialized weed-control problems.

Most observers predict an expanding market for 2,4-D. Despite the introduction of newer weed killers such as 2,4,5-T, IPC, and CMU, highly effective 2,4-D continues to be the all-time favorite among selective weed killers.

Dow Chemical's 2,4-D plant is in the background. Tank farm has about 40 tanks



Nitrogen Losses

TVA finds some causes, recommends some preventive measures

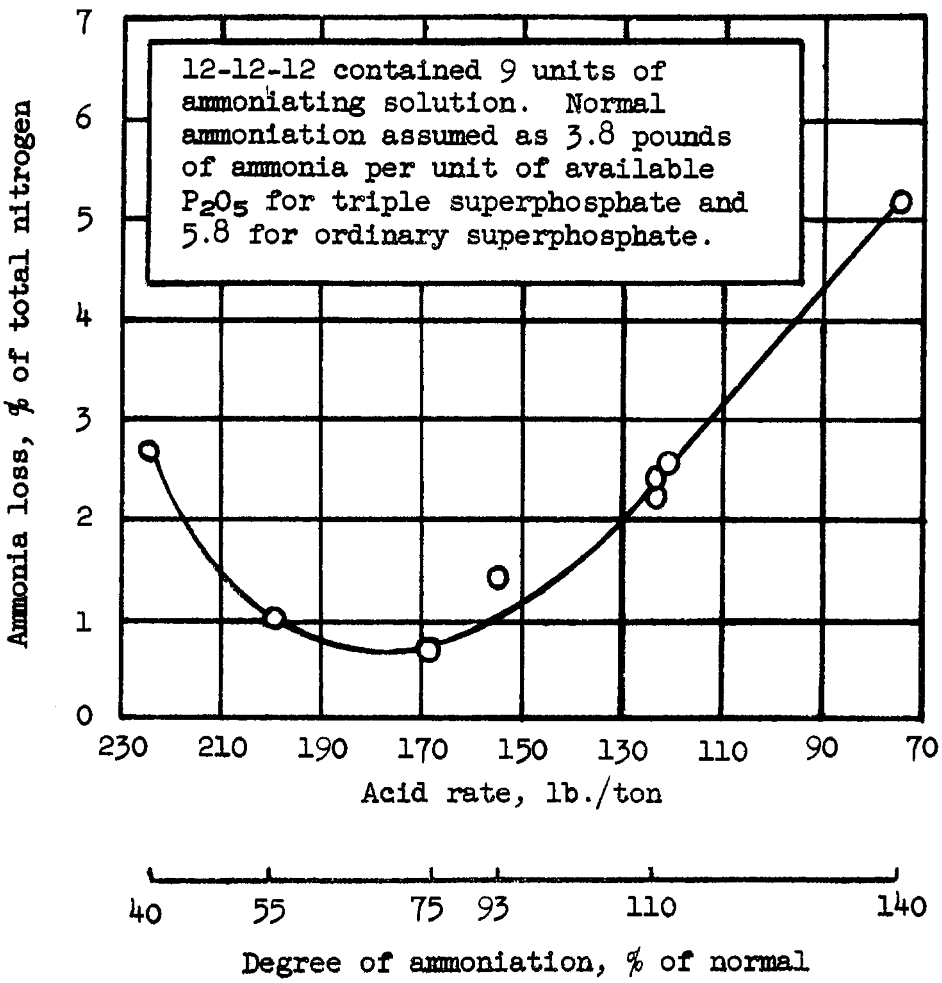
Fertilizer manufacturers have become increasingly concerned in recent years over losses of nitrogen in production of high-analysis fertilizers. Nitrogen losses have been the subject of numerous informal studies in industry, of a major discussion at the 1957 Fertilizer Industry Round Table, of more formal engineering studies at TVA, and most recently of intense scrutiny during TVA's June 1959 pilot plant demonstrations of the production of granular fertilizers.

TVA experts tackled the problem in force after several companies which had installed large-scale continuous ammoniators reported heavy fuming and high nitrogen losses. No such problem had been encountered in early development work on the ammoniator; evidently the difficulties had been introduced in scaling up pilot-plant data for the design of commercial sized equipment.

The problem is an important one. A limited survey reported in 1957 by T. P. Hignett of TVA showed that in Wisconsin, Indiana, and Kentucky, over half the samples of 10-10-10 and 12-12-12 tested were deficient in nitrogen to an extent that exceeded state tolerances. In Missouri, about 40% of those grades were deficient. Visitors at the TVA demonstrations in June were told that in a typical state the average analysis of 12-12-12 was 11.5-12.5-12.5.

Yet nitrogen input was at least equal to that guaranteed, and usually well above it. Calculation shows that if a manufacturer formulates 12-12-12 to contain the same amounts of nitrogen, P_2O_5, and K_2O, and comes out with 11.5-12.5-12.5, a full unit of nitrogen must have been lost. If the P_2O_5 and K_2O contents were formulated to be exactly 12%, then there must have been an unanticipated weight loss of about 80 pounds to account for the surplus percentages of these nutrients.

As TVA points out, heavy nitrogen losses are costly in several ways: through the actual value of the nitrogen; through shrinkage in weight of the product; through the resulting overage in P_2O_5 and K_2O, for which the manufacturer receives no credit; and through penalties and unfavorable publicity due to deficiencies found by state laboratories. These economic losses have been estimated at several million dollars per year.



Effect of acid rate on loss of ammonia in production of granular 12-12-12

In early pilot-plant work on continuous ammoniation, analysis of ammoniator exhaust gas had revealed slight losses of free ammonia. The heavy losses experienced with industrial units made it evident, however, that nitrogen was not being lost primarily as ammonia, since ammonia losses would not cause such great over-all losses in weight. TVA undertook a series of special tests to pin down the sources of trouble. A 12-12-12 grade was chosen for the work because among the more popular grades this was the one in which highest nitrogen losses had been reported.

As expected, no single practice or condition could be blamed for all losses. Several important influences were studied, resulting in a number of recommendations designed to improve over-all performance and cut over-all losses.

In one series of tests, the amount of sulfuric acid used was varied from 75 to 225 pounds per ton of product; as a result of the variation in acid feed rate, the degree of ammoniation of the superphosphates in the formulation was varied from about 40 to 140% of the normal value (3.8 and 5.8 pounds of ammonia per unit of available P_2O_5 for triple and ordinary superphosphate, respectively). As the graph shows, the lowest nitrogen loss (0.7%) occurred at about 75% of the normal degree of ammoniation (170 pounds sulfuric acid per ton). The loss increased at about equal rates as the degree of ammoniation increased or decreased from the 75% value. TVA cautions against attempting to apply these results directly to large-scale plants, but thinks it likely that in large units, too, ammonia loss will be increased by increased acid rates at some level of acid addition.

Study of the effects of varying production rate per unit length of ammonia distributor revealed that nitrogen loss, as per cent of input, rose rather sharply as production rate was increased.

The most plausible explanation for loss of nitrogen in a form that would not be detected by scrubbing exhaust gas samples (that is, any form other than ammonia) was decomposition of ammonium nitrate to nitrous oxide or elemental nitrogen. Laboratory studies on decomposition, using cold traps to collect insoluble effluent gases, gave evidence that a substantial portion of the nitrogen losses at high production

rates does involve decomposition of ammonium nitrate.

As a result of its work to date, TVA is convinced that nitrogen is lost from the continuous ammoniator both as free ammonia and as nitrate decomposition products. The decomposition products contain nitrous oxide and possibly elemental nitrogen, and cannot be detected by ordinary gas analysis. Conditions favoring serious loss of nitrogen by nitrate decomposition are likely to occur in many large-scale ammoniators, TVA says. Localized areas of high temperature or high acidity, or both, may result when distribution and mixing of liquids with solids are poor, or when too much reaction occurs per unit length of distributor.

To reduce losses of nitrogen through nitrate decomposition when making high-nitrogen grades such as 12-12-12, TVA suggests these precautions:

- Use distributors that extend throughout the full length of the ammoniator;
- Use distributors designed to give maximum distribution of liquids. Distributors should be slotted or should contain a large number of small holes, rather than a few large ones;
- Use distributors and supporting members of streamlined design, to minimize interference with the rolling action of the bed;
- Adjust formulations and operating conditions to avoid overgranulating to the extent that mixing is impaired;
- Inspect and clean distributors frequently. Replace them before openings are enlarged so much that the distribution pattern is changed. Give special attention to the acid distributor, since it is subject to the worst corrosion (Hastelloy C is a recommended material for acid distributors);
- Avoid formulations giving excess heat of reaction.

All these are measures that manufacturers can adopt with equipment already in use. Some of the existing ammoniators may be so short, TVA observes, that even with full-length distributors the concentration of heat of reaction is too great. In such cases, it may be profitable to install a second set of distributors to utilize the volume of the ammoniator effectively. Another trick that might reduce local overheating is separation of the solution and acid distributors a short distance, to permit mixing of the solution with the solids before it reacts with the acid.

For new installations, TVA is convinced that building longer ammoniators than are now in common use would represent money well spent.