Ag and Food Interprets . . .

- **Freight rates to have large say in future of superphosphoric acid**
- **Research may settle question of pesticides *vs.* wildlife**
- **Organic phosphate insecticides headed for bigger share of market**
- **Electrodialysis, freezing rival distillation in saline water conversion**

Superphosphoric Acid

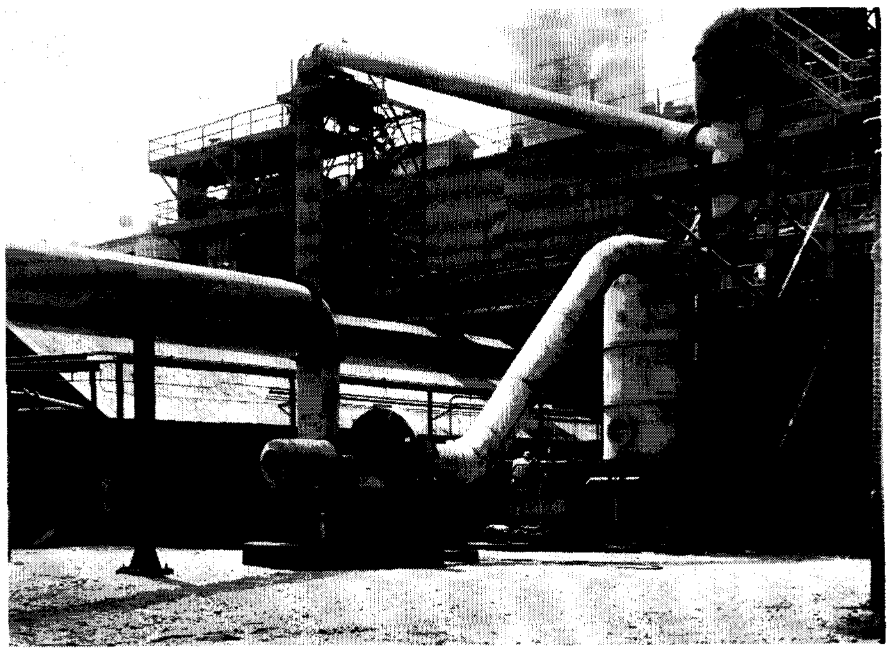
Superphosphoric must hurdle economics, especially in freight rates, to gain prominence in fertilizer markets

THIS YEAR the fertilizer industry is keeping a sharp eye on the progress of superphosphoric acid. Some observers foresee bright prospects for the material; others think such prospects appear only through rose-colored glasses. Upon one thing all agree, however: economics, especially freight rates, will largely dictate the super acid's future.

Superphosphoric acid, developed by the Tennessee Valley Authority, is not yet produced commercially in the U. S. Central Farmers Fertilizer, however, plans to make it at its Idaho phosphate works. In addition, among the host of companies which have obtained sample amounts of superphosphoric from TVA, several have indicated that they could make it if the market warranted. And several liquids formulators say they would be interested in using it—if the price were right.

One Canadian company, Electric Reduction Co. of Canada, Ltd., now produces superphosphoric acid commercially. The freight rate it has obtained is the same as that on food grade or fertilizer grade 75% acid. However, Canadian freight rates are substantially higher than those in the U. S., and the Canadian product will not be marketed in the U. S.

TVA's superphosphoric acid contains about 76% P_2O_5. By comparison, ordinary phosphoric acid sold as phosphatic fertilizer solution (made by either the wet or electric-furnace process) is only 54 to 58% P_2O_5. More highly concentrated phosphoric acids, except those in the 75 to 77% P_2O_5 range, solidify or are extremely viscous at ordinary temperatures. As a result, they find little use in the fertilizer industry because they are difficult to handle, ship, and store.



Companies may obtain from TVA, for study purposes, up to 500 tons of superphosphoric acid per fiscal year. TVA makes it in this plant at Wilson Dam

Handling

Superphosphoric acid with 76% P_2O_5 content, although somewhat viscous, can be handled. It is a complex material containing about 49% of its phosphate as ortho-, 42% as pyro-, 8% as tri-, and 1% as tetraphosphoric acid.

Two major potential outlets exist for superphosphoric. One is high-analysis liquid fertilizers and the other is concentrated superphosphate. TVA has developed ammoniating processes to produce more highly concentrated liquid solutions than are now being marketed. Base solutions are 11-33-0 or 12-36-0. Urea, urea-ammonium nitrate solution, and potassium chloride can be added to these bases to yield various mixed grades. Generally, these products have much lower salting-out temperatures than present highly concentrated mixes. However, when appreciable amounts of potash are present, the temperature differential is less significant.

Starting with its superphosphoric acid, TVA now also makes a concentrated superphosphate which contains

54% available P_2O_5, as compared with the usual 48% product. This new material, which TVA calls high-analysis triple superphosphate, is composed chiefly of anhydrous monocalcium phosphate. It is very porous and readily ammoniated. TVA has actually discontinued making 48% P_2O_5 phosphate and is focusing its efforts instead on high-analysis triple super.

Competition?

Superphosphoric acid plays a dual role in its relationship to the less expensive wet-process acid. In one sense, it is a competitor. On the other hand, it may give wet acid a boost because a combination of the two may be used to make liquid fertilizers. The pyrophosphate in superphosphoric sequesters impurities in wet acid so that they do not precipitate upon ammoniation. This may well allow wet acid to push strongly into the liquid-mix market. One southeastern company reports that this factor results in savings of 14 cents per unit of P_2O_5.

Varied Opinions

When as many companies as have checked TVA's superphosphoric acid investigate a potential product, there are certain to be differences of opinion. TVA and at least one industrial company find that the cost of making superphosphoric, per unit of P_2O_5, is no greater than that for ordinary furnace acid. Several companies emphatically disagree with this. They claim that for superphosphoric to be economically attractive, it must command a price premium over normal orthophosphoric acid.

Estimates of required plant investment vary, and for good reason. Some companies could produce superphosphoric with slight modifications to their existing plants. Others would need complete new units. In any event, additional cooling equipment is necessary to remove the increased heat involved. Estimates of costs for this cooling equipment run the gamut from negligible to great.

Several companies point to other considerations. The high viscosity of superphosphoric presents pumping and pump maintenance problems. Moisture picked up by the hygroscopic product, they say, raises the freezing point so that storage over several months is impractical. Another cited disadvantage: superphosphoric hydrolyzes on storage and reverts to orthophosphoric acid. This reversion causes some precipitation from high analysis liquid mixes produced from it.

Freight Rates Crucial

Still, the most important unanswered question about the super acid's commercial future is that of freight rates to be assigned. And upon this point all interested companies agree: rates should be no higher per ton than existing rates on ordinary acid. The result: a lower cost per unit of P_2O_5 for shipping superphosphoric.

Ordinary fertilizer-grade acid is shipped as "phosphatic fertilizer solution" with the provision that it must not contain over 58% P_2O_5. TVA and, of course, other potential makers and users of superphosphoric hope that this limitation will be removed.

Same Rates as Ordinary Acid in West

The Western Railroad Association has published freight rates for superphosphoric which are the same per ton as those for ordinary acid. This is the result of an application by Central Farmers Fertilizer. Whether or not this sets a precedent for other railroads throughout the country remains to be seen.

TVA has applied for similar rates with a southeastern railroad. No decision has yet been reached on its application, but should it be unfavorable, TVA can appeal to the ICC. Much of the economics of superphosphoric's future will depend on the rates assigned, although one company feels that even lower shipping costs per unit P_2O_5 will not offset its projected premium price.

Another potential outlet for superphosphoric, in which freight rates are favorable, is as the chemical grade acid. The freight rate on chemical grade acid is the same per ton regardless of its concentration. Consequently, shipping superphosphoric (105% ortho equivalent) rather than 75% H_3PO_4 would result in a definite saving. If a customer did not need the super acid, he would have only to dilute it. For some producers, out-put of chemical grade acid is almost equal to that of the fertilizer grade.

Price Will Determine The Market

Nobody is predicting how big will be the market for superphosphoric acid, if one develops at all. However, if the delivered cost per unit of P_2O_5 proves to be lower with superphosphoric, a market is almost sure to evolve. Time and experience will tell.

Pesticides and Wildlife

Expanding research on effects of pesticides on wildlife brings hope for end to a heated controversy

How does the ever greater use of chemical pesticides affect wildlife? And what is their effect on domestic animals and humans? Answers to these questions are plentiful and widely divergent. But at present relatively little is known about how pesticides affect wild or other life on a broad scale.

Even the importance of pesticides for crop and forest protection and for human comfort is questioned when the matter of effects on animal life comes in for debate. On one side are those who believe that the rapidly expanding use of pesticides will be the greatest detrimental influence on wildlife since the ice age. Others feel that pesticides will be no more important than other factors such as increased human population and its need for more living space, or general depletion of natural resources.

Most agree that pesticides in general have some good effects, some bad. But aside from their value in crop and forest production, pesticides' positive values to wildlife are much less well-known to the public than are their negative effects.

On the positive side, herbicides in particular are growing more important in wildlife management. Herbicides control marsh weeds to improve food supplies for ducks and other birds. Deer browse is improved through use of herbicides, which cause low shoots to grow from trees at levels deer can reach. Open areas created artificially with herbicides help to increase small animal populations.

In the insecticide field, the USDA's cattle screwworm control program is expected to have a pronounced beneficial effect on deer in the South. In fishery management, rotenone has been used extensively to eliminate trash fish and permit stocking of desirable game species. Animal repellents help, too, by protecting young pine trees and useful brush against damage from wildlife itself. However, these and similar uses of pesticides still remain a relatively small part of total consumption.

Most controversy on the effects of pesticides on wildlife concerns large-scale use of insecticides, although the

Spraying in woodland areas can produce both good and bad effects for wildlife. Direct kill of wildlife sometimes occurs, but spraying protects animals' food

term pesticides is often used. The gypsy moth control program in the Middle Atlantic states and the Northeast (AG AND FOOD, September, 1957, pages 635–36; July, 1958, pages 496–98), and the fire ant eradication program in several parts of the South (AG AND FOOD, November, 1957, pages 797–98), get a large amount of favorable and unfavorable criticism. Less well-known insect control programs also meet with local and sometimes national opposition.

The extent of large-scale control programs designed to protect man and his interests will be far greater within a decade if predictions are correct. And according to John L. George of the U. S. Fish and Wildlife Service, aerial application of insecticides has already included:

- 500,000 acres for imported fire ant eradication.
- 9 million acres for grasshopper control.
- 3 million acres for gypsy moth control.
- 1 million acres for spruce budworm control.

Approximately a fourth of U. S. crop land is treated annually to some extent with pesticides. Obviously, as George points out, wildlife cannot be excluded from treated areas. And ample evidence exists that wildlife has been killed by insecticides.

Equally important, though, is the need to avoid the implication that all insecticides as applied in various ways will harm wildlife. A conservationist thus should attempt to appraise the real or potential hazard to wildlife, and should aid in development and dissemination of information, and in adoption of methods and materials which will permit adequate pest control with minimum damage to other values, says George.

More Research

The U. S. Fish and Wildlife Service received additional money for research from Congress last July. Of the increased funds, about one third will go for initial studies on the effects of pesticides on fish, and the remainder for studies relating to birds and mammals.

The additional federal research money also provides for major projects to study effects of grasshopper and other range and forest pest control programs (headquartered at the Denver, Colo., Wildlife Research Laboratory), and continued studies on the effects of gypsy moth control efforts in the East and the fire ant eradication program in the South. In all cases efforts will be made to combine toxicological tests, chemical analysis, and more systematic field studies.

Current research by the Bureau of Sport Fisheries and Wildlife is directed toward study of chlorinated insecticides. Particular attention is being devoted to heptachlor and dieldrin, since they are being used in the fire ant program. Some of Fish and Wildlife's fire ant work will be contracted in the South, as will other work such as the study of effects on migratory birds of pesticides for control of Dutch elm disease in the Midwest. These contracts, like the fire ant control program, will be administered from the Patuxent Research Refuge near Beltsville, Md.

Generally less well-known are research programs of various manufacturers of pesticides, especially insecticides, on effects of their commercial and potentially commercial materials. Their wildlife studies often run simultaneously with studies of pesticidal effectiveness for new materials that show promise. One example of manufacturers' efforts is research undertaken by Carbide to compare the toxicity to fish and wildlife of its new carbamate insecticide, Sevin, with that of other insecticides now in use. Results indicate that goldfish, for instance, tolerate 200 times as much Sevin as DDT.

Probably more experimental work has been done with DDT formulations than with any other modern insecticide. Thus knowledge of DDT's effectiveness is more complete, its side effects are better understood, and its use can be more intelligent. Field studies show that within limited single application rates, little apparent damage occurs from use of this material. In the gypsy moth spray program, USDA field tests with DDT sprayed at a pound per gallon of light oil per acre—the usual rate—showed that DDT does little harm to honey bees. But other reliable data on insecticide effects and application rates are still limited.

Fire Ant Studies

Much attention from conservationists and control officials is now centered on imported fire ant eradication programs. The fire ant now is found in the South from eastern Texas to the Atlantic Coast.

In response to reports that pesticides such as dieldrin and heptachlor were killing wildlife when applied broadcast to control fire ants, tests were conducted by the Alabama experiment station, the Alabama departments of conservation and agriculture, USDA, and the U. S. Fish and Wildlife Service, near Camden, Ala., to establish a basis for judging possible wildlife kills. Animals of widely varied species found dead after application of these insecticides at 2 pounds per acre were autopsied, and found to contain enough of either of the materials to justify attributing death to the insecticides. One USDA observer of the tests notes that while initial losses were relatively high, there are no indications that the use of insecticides will have a long-range effect on the population of wildlife in the area.

Even more significant than reliable information on wildlife kills by insecticides are plans for research into several basic aspects of fire ant—and other pest—control. At a meeting held last fall, entomologists and others concerned with fire ant control set up a program to cover in detail such factors as:

- Biology of the fire ant.
- Economic and nuisance importance of the fire ant in old and newly infested areas.
- Ecology in relation to population of wildlife and arthropods.
- Control.
- Immediate and long-range effects of chemical control on wildlife, water resources, and arthropods.
- Insecticide contamination of food, feed, and water.

Cooperating are state experiment stations of Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas; state health departments of Alabama and Georgia; the U. S. Public Health Service; USDA (Agricultural Research Service); Alabama Department of Conservation; the Fish and Wildlife Service; and the Bureau of Sport Fisheries and Wildlife.

Biological Considerations

While in many cases wildlife may not succumb to use of pesticides in their habitat, some less obvious—perhaps chronic—effects may still be significant. Some of these are adversely affected reproduction, increased mortality of young, weakened physical condition causing susceptibility to disease and predation, and reduced supplies of food chain organisms.

A pressing research need, according to several experts, is determination of the manner in which wildlife obtains the pesticide. Once the mode of entry of such materials is understood, it may be possible to modify formulations to minimize adverse side effects, and protect wildlife in pest control areas.

Interest in biological pest control grows. This stems from such factors as apparent resistance to insecticides, and limitations on pesticide use posed by residue problems. While important, however, biological control agents must give economic control if they are to be accepted by growers in lieu of chemical pesticides or other methods. In some cases, they satisfactorily complement insecticides or other methods.

Even though controversy will continue, some generalizations may be made concerning pesticides and wildlife, says Harlow B. Mills of the Illinois Natural History Survey. For example, pest control chemicals have become increasingly a part of our environment, and this trend is not immediately or greatly reversible; these chemicals change the environment, and will continue to as people increase in numbers, demands, and fastidiousness; use of pesticides must be made as innocuous as possible, but it must be recognized that some injury to wildlife will occur; and the data available are not yet sufficient to permit intelligent recommendations for modifications in pest control activities—except negatively, which is not the most effective way to approach the problem.

Research of several kinds now under way will make possible a clearer understanding of how pesticides affect wildlife, and should solve many related problems. Also important are planned conferences to distribute data and bring together different factions for better understanding.

Organophosphates Progress

Organic phosphate insecticides seek bigger share of markets; new compounds, new uses, and new, lower prices add impetus

The outlook for organic phosphate insecticides once more is for greater use this year than last. Malathion and parathion will undoubtedly retain their sales leadership within the group, but newer materials such as trithion, diazinon, Trolene, ethion, and phosdrin should also gain.

Much of the growth this year is likely to come at the expense of chlorinated hydrocarbons, particularly where there are indications that insects have developed resistance to these materials. Relatively new outlets such as treating cattle with Co-Ral, using Korlan on farm buildings, and applying phosdrin to vegetables should stimulate larger sales.

New formulations, too, will be important. Of special interest here is Monsanto's new (announced March 23) stabilized methyl parathion, expected to whip that material's instability in dust formulations. Monsanto says formulations based on its new "stabilizing system" have endured storage for 12 weeks at 123° F.—estimated to be equivalent to over a year at normal ambient temperatures—with less than 10% loss in activity. Label approvals are now being sought, and the material should be available for use this season.

Greater use of organic phosphates will apparently be nationwide, with the South and Southwest probably accounting for the biggest consumption. Forecasts call for heavier use of organic phosphates to control boll weevils, thrips, and fleahoppers on cotton, mostly through methyl parathion and malathion.

Meanwhile, in the Northwest, Northeast, and Mid-Atlantic states, mites loom as a problem. Their control might mean more outlets for phosphates such as trithion, and possibly phosdrin and ethion. Codling moths in fruit areas should bring calls for organic phosphates, and in the South, tobacco lice should fall victim to methyl parathion and malathion, while Guthion battles cotton grubs.

Also stimulating demands for organic phosphates are price declines, notably in parathion and methyl parathion. High prices relative to those for chlorinated hydrocarbons still rate as a major deterrent to the over-all growth of the phosphates.

Toxicity also rates as a major problem, although in one sense it is not so severe today as it was a decade back. Education programs by manufacturers have been effective and have done much to convince growers and farm advisory groups that with proper precautions the phosphates can be handled safely. On the other hand, toxicity is in another sense a bigger problem for manufacturers now than it was before 1954, because of the requirements of the Miller Amendment.

This year, researchers will continue programs to make organic phosphates more toxic to insects but less toxic to mammals. This is one of the big needs in organic phosphates.

Meanwhile, systemic agents for use in both plants and animals continue to become popular. They reduce hazards to desirable predators, and are said to give longer lasting control than foliage-type organic phosphates. A big factor in favor of systemics is that

they reduce the number of applications a farmer must make.

But systemics have problems too, major among them being that in the case of systemics, each crop must be evaluated separately for residue problems, whereas crop groupings may be used to develop residue data for nonsystemic materials. This added work reduces the speed of development and increases the costs involved.

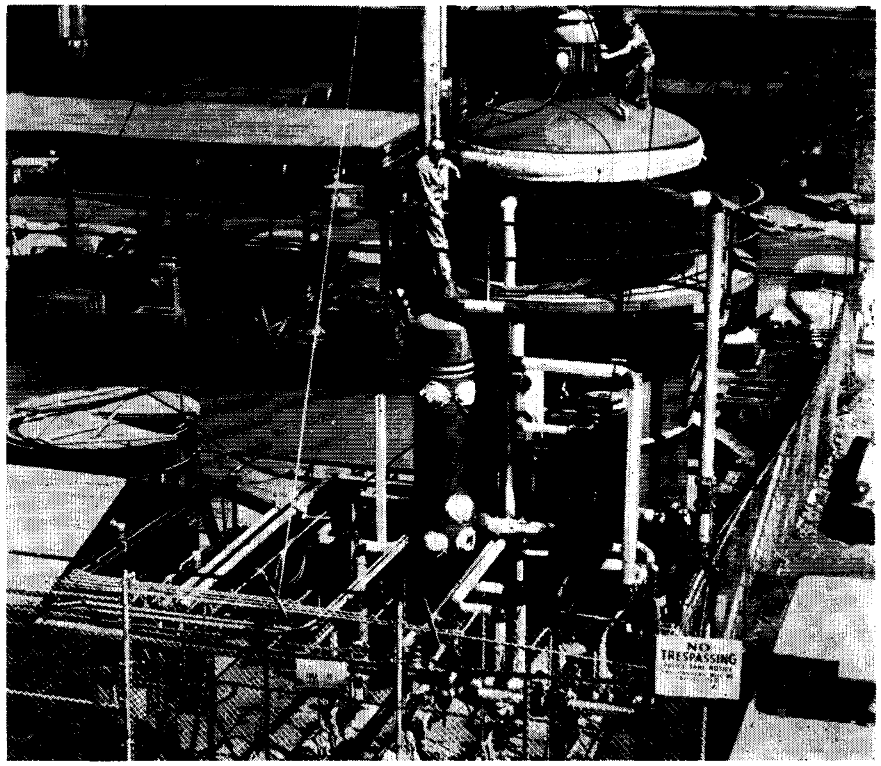
However, the industry sees a need for both systemic and nonsystemic organic phosphates. Over a dozen compounds, including both types, are under evaluation by various agricultural experiment stations. All signs indicate that still more new materials will enter evaluation this year.

Feeling is mixed this year over the desirability of tailoring specific phosphates for specific insects. On the one hand, the field is wide open for development, but on the other, it promises to be a costly area. From the commercial viewpoint, companies like to recover their research costs as rapidly as possible. Broad-spectrum products designed for general use offer a better chance to accomplish this end. Specifics, if many must be developed to handle the many troublesome insects, might not. But if a few specific toxicants were to be developed for major bugs such as the boll weevil, they might have a good chance of achieving commercial success.

Hence, it is expected that most organic phosphates which go to market in the near future will be broad-spectrum rather than specific types. As more information is obtained—for example, on insect physiology and the influence of specific chemicals on vital insect processes—there might be more interest in tailor-made materials.

Desalting Water

Get the salt out—that's the aim of those who work on saline water conversion. But relief for the farmer is still not in sight



Badger-Hickman centrifugal compression still produces 25,000 gallons of desalted water a day

CONSIDER THIS SCENE: A western farmer in dusty overalls pulls up to his favorite farm store in a battered pickup truck. He says to the dealer: "I'd like some feed, seed, fertilizer, insecticide, weed killer, hexadecanol, dimethylbutylamine, and a half dozen semipermeable membranes."

Such an event is improbable, but not completely out of the question. The farmer will use hexadecanol to reduce evaporation from his irrigation reservoir. The membranes are replacement items for the farm's electrodialysis system, which supplies pure water from brackish wastes. And the dimethylbutylamine goes into an experimental solvent extraction unit on the south 40.

Individual farmers may never need to go to these extremes to get water. But the next generation of farmers may see these methods, or others like them, used commercially to provide fresh water for crops.

Water has always been a problem for the farmer. Nature provides plenty of it, but not always in the right place, at the right time, or in the right form. Many of the sections of the country that have the most serious water problems are located over vast underground supplies of water—brackish water that is not usable because of its solids content. Only within the past half-dozen years has there emerged reasonable hope of finding an economical way to clean up these brackish water supplies.

Brackish means saltish; geologists use the term to describe water that runs from 1000 to 10,000 p.p.m. solids. Seawater, by comparison, has about 35,000 p.p.m. solids. Salt, of course, is toxic to plants; 0.3% in a soil inhibits most plant growth. Farmers can't use irrigation water having more than 500 p.p.m. solids without using special techniques to prevent salt build-up in the soil.

Desalting brackish water even for household use is still not economical except in special cases, as when water from other sources is unusually expensive. For irrigation, it's even further away, and at this point most agronomists have only an academic interest in saline water conversion. Nevertheless, they are watching new developments.

The OSW

Much of the research activity in water desalting is sparked by the federal government's Office of Saline Water. The OSW sponsors work at a number of schools and private companies. It has plans for five large demonstration plants—three for seawater conversion and two for brackish water. In addition, the OSW has mutual assistance agreements with New Mexico and California, and expects to develop such agreements with other water-conscious states.

Distillation is the oldest approach to purifying saline water. On the West Coast, the Pacific Gas and Electric Co. gets water for boiler feed make-up by distilling seawater in two triple-effect evaporators. Even though this costs PG&E nearly $82.00 per 1000 gallons, it is the best answer to the water prob-

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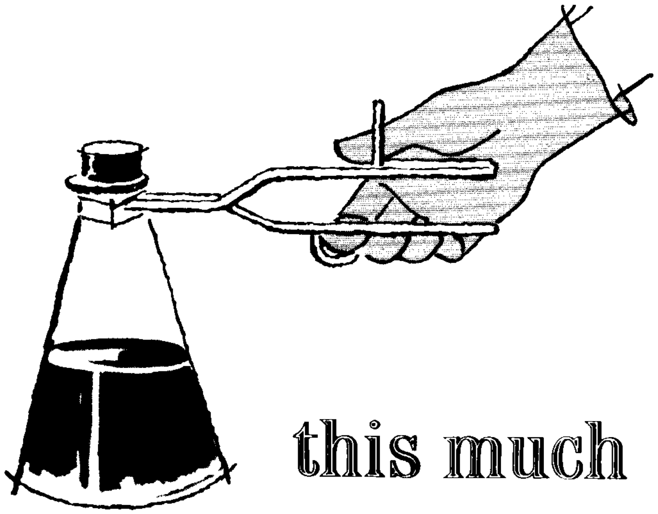

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lem in this spot. In most other places, where water costs from 5 to 25 cents per 1000 gallons, such a plant would be out of the question.

The PG&E facility is relatively small —144,000 gallons per day. Evaporator makers say that a large installation, to yield several million gallons per day or more, could turn out fresh water for under $1.00 per 1000 gallons. And if electricity can be produced as a by-product, water costs drop further—perhaps under 50 cents. These are only estimates, however; the next step is to put up a large plant from which firm cost figures can be obtained. Last month the Department of Interior announced plans to build a one-million-gallons-per-day demonstration plant which will use vertical, long tube multiple effect evaporators.

Conventional distillation has progressed further than other seawater desalting methods because it is the oldest. But other approaches are definitely in the running. Du Pont and Battelle Memorial Institute are experimenting with solar stills. Completion of Battelle's first experimental unit at Port Orange, Fla., was announced on March 24; two other units, developed jointly, will bring total capacity there to about 500 gallons of fresh water per day. The OSW is also considering nuclear power. Fluor Corp. estimates that a plant using nuclear energy could distill seawater for about 60 cents per 1000 gallons.

At the other end of water's liquid state, freezing is a candidate for desalting. It has several built-in advantages over distillation: fewer corrosion problems because of the low temperature; less scale build-up; lower energy needs since freezing takes only one-seventh as much energy as evaporation. Freezing, however, is a relatively new idea in this field, and has been tried only on a small scale. This year the OSW awarded Carrier Corp. a $150,000 contract to build a 15,000-gallons-per-day pilot unit. In the Carrier process, seawater is sprayed into a high-vacuum chamber, a mixture of ice crystals in brine forms, brine is washed from the ice in a countercurrent separation column, and the ice is melted to give relatively pure water. Carrier hopes to show in its pilot plant that such a process is commercially practical, and would be as cheap as or cheaper than distillation.

Electrodialysis

Distillation and freezing are the heavy artillery in saline water conversion. They are aimed at the tough problems presented by seawater. Brackish water does not necessarily present fewer problems, but because it is less salty than seawater, engineers can call on other, less drastic methods to get rid of solids. Most promising: electrodialysis.

Electrodialysis uses an electric current to push ions through semipermeable membranes. It works best on brackish waters up to 5000 p.p.m. solids. A by-product of the treatment is high-salt waste brine which amounts to 20 to 40% of the feed. Ionics, Inc., pioneer in electrodialysis, has its desalters in use from Montana to the Persian Gulf.

Treatment costs for electrodialysis depend on the solids concentration of the feed, and on local power costs. If both are favorable, Ionics says, a large plant can treat water for 40 cents per 1000 gallons. Ionics believes that membrane separation has a bright future, and deserves more attention.

The first municipal use of electrodialysis in this country began late in February at Coalinga, Calif. The circumstances here are ideal for electrodialysis. Well water in the Coalinga area contains about 2000 p.p.m. solids, and for the past 50 years the city has hauled in fresh water by tank car from a neighboring town 45 miles away. Freight charges alone cost $7.05 per 1000 gallons. The electrodialysis unit, built by Ionics, is expected to provide Coalinga with drinking water at less than $1.00 per 1000 gallons. At the dedication ceremony, William Berry of the California State Department of Water Resources said: "We think this may well set the pattern for the gradual application of a practical conversion process within the state."

Solvent extraction is one of the newest ideas to come along. Like electrodialysis, it is best able to handle brackish water. In OSW-supported research at Texas A&M, secondary and tertiary amines with five or six carbon atoms have proved the best solvents to date. Donald Hood, in charge of the project, says that solvent extraction seems competitive with other methods "on paper," but still is not much beyond the fundamental investigation stage.

As far as the farmer and his irrigation problems are concerned, saline water conversion is something for the future. When it begins to enjoy widespread use will be strictly a matter of cost. In most places irrigation water costs just a penny or two per 1000 gallons. Even in arid lands farmers can seldom afford to pay more than 10 cents. Thus, there is at least a 30-cent gap between the most that farmers can now afford and the best that science can now promise. Nobody can predict when the gap might be closed.

Still, wider use of irrigation is one of the definite trends in farming. And where to get irrigation water will become an increasingly vexing problem. Until such time as brackish water can be cleaned up at a reasonable cost, conservation remains the only economic answer.

"Flash" distilling apparatus requires relatively little power to produce fresh water from salty. This unit, with a capacity of 25,000 gallons per day, is installed aboard an oil drilling barge anchored in the Gulf of Mexico