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FILE

TRIP REPORT

9310832

Date submitted 7/31/79

NAME John L. Malcolm TITLE Soil & Fertilizer Specialist DIV./UNIT TSWM

PERIOD OF TRAVEL (including dates) July 24-27, 1979

ITINERARY Washington - Muscle Shoals, Alabama Washington

(Use attachment for details, including time schedule)

PURPOSE To review ongoing work at IFDC and TVA.

ORGANIZATIONS AND PERSONS CONTACTED:

(Use attachment for details.)

IFDC and TVA.

RESULTS/ACCOMPLISHMENTS:

1. Progress on both projects highly satisfactory.
2. New TVA activity relating valley experience to development promising
3 Pan granulator in operation at IFDC pilot plant for first time.

Etc.

FOLLOW-UP ACTION REQUIRED:

(indicate what, by whom, when.)

1. IFDC will need to submit full scale, five year proposal for funding in January/February, 1980. I will attend Board Meeting October 1-5.

OTHER REMARKS:

(May include other information, observations, and impressions of general interest.)

Attachments:

(List)

TVA "Pipe Cross Reactor"

Distribution:

(List)

DS/AGR Regional Bureau Tech Offices.

Trip Report

IFDC and TVA Progress Review

Both IFDC and TVA are providing excellent service and activities in support of AID's program.

TVA is developing a new training course and materials which can be used independently to relate TVA experience from the 1930s to date to problems of developing agriculture in other countries of the world. They are also preparing brief summaries of TVA developments which may be used to introduce U.S. technology to developing countries. An example, the "Pipe Cross Reactor" is attached.

IFDC is making substantial progress in both phosphate and nitrogen research. The wind tunnel work with Colorado has confirmed the gas lysimeter work on amonia losses and is leading to a simple equation for estimating these losses under field conditions.

The pan granulator in the pilot plant was being used to prepare granular urea for the first time. The product was of very good quality. Through-put was 500 kg per hour. The work on Senegal phosphate slimes is a turning point. The dilute acid process based on precipitation of ammoium phosphate has proven a technical success. The alternate process will be tested as soon as more material is received from Senegal. The sulfur oxidation experiments with African soils have shown satisfactory sulfate formation without inoculation. The degree of solubilization of phosphate rock added to the same soils has yet to be tested.

Returning to TVA, the international program division and the University of Tennessee are working together to capture the essence of the experience of extension agents and TVA officers who still remember when the Tennessee Valley was a major disaster area with soils washing into the Gulf of mexico. Many of the problems, physical, economic and human faced by farmers of the developing world have their parallel in the Valley drama. A meeting with these oldtimers, while I was at the Shoals, brought out many development principles and anecdotes to illustrate both success and failure. The UT team will write up a sample module, principle and example. If the sample successfully dramatizes the theme, a full series will be prepared and will eventually serve as a textbook on U.S. experience in agri-

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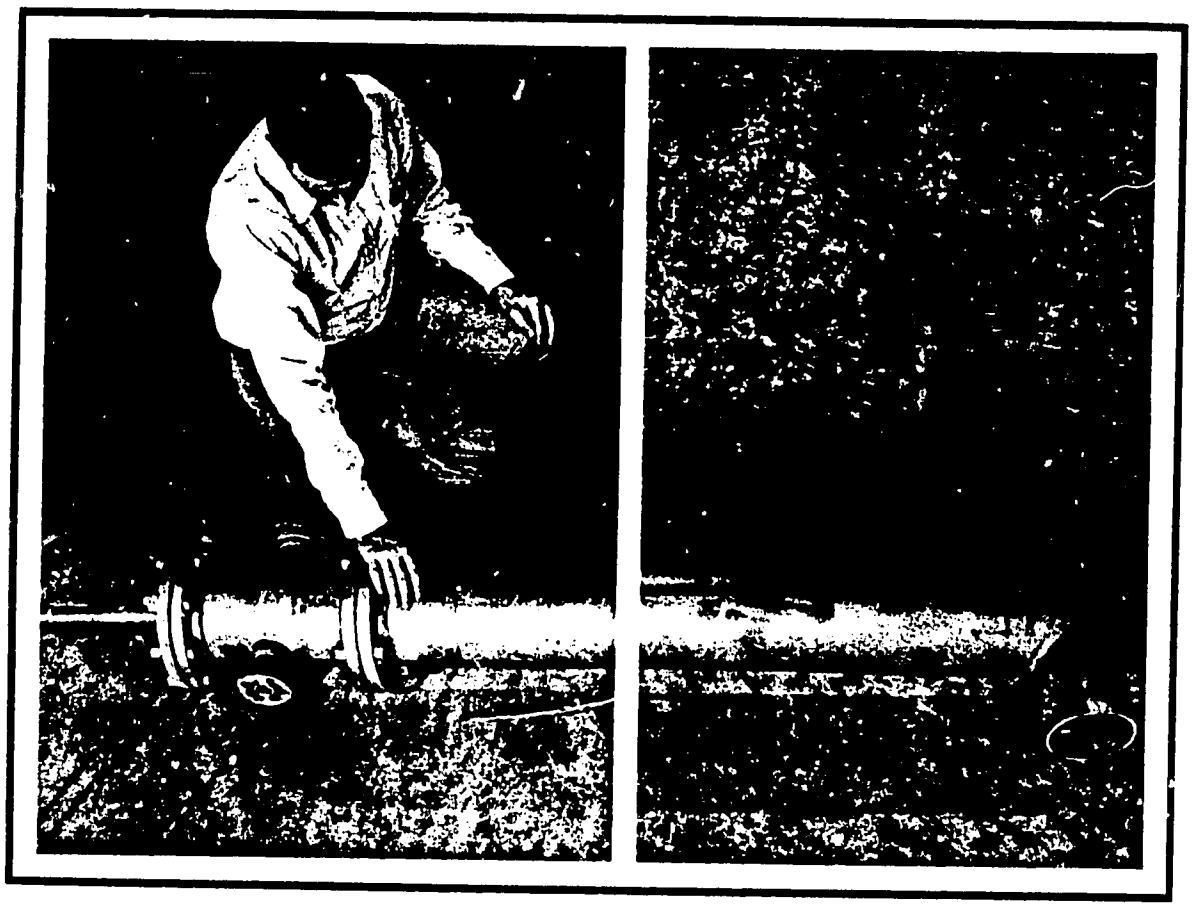
cultural development.

The pan granulator at IFDC also contains more of a story than is seen on the surface. Most urea in the world is shaped in a prilling tower which gives a good but rather small product size. Interest in larger particles comes from a need for materials compatible in bulk blends, for urea suitable for coating and for supergranules to replace mudballs in rice culture. The Indonesians were faced with replacing a deteriorating prilling tower in their first urea plant and opted instead to install a pan granulator, which is much less costly, on IFDC/TVA recommendation. The new pan granulator is now almost ready to put in service but none of the Indonesian engineers have had experience in operating this equipment. The flexible pilot plant at IFDC was modified in three days, replacing the drum granulator with a pan. Now after several practice runs by IFDC engineers it is ready for training 11 Indonesian engineers. They will have a chance to make a typical commercial product or rather products. The components and controls on the pilot plant are the same that will be available on the new production unit with 10 times the capacity. They can be shown not only how to produce a high quality product at efficient production rates but also test the results of variation in processing conditions and observe the consequences and where necessary corrective action. The pilot plant at IFDC was and is primarily for new product development, but this use as a training device was part of the original design concept.

Pipe-Cross Reactor



Technical Update

June /1979

TENNESSEE VALLEY AUTHORITY, NATIONAL FERTILIZER DEVELOPMENT CENTER, MUSCLE SHOALS, AL 35660

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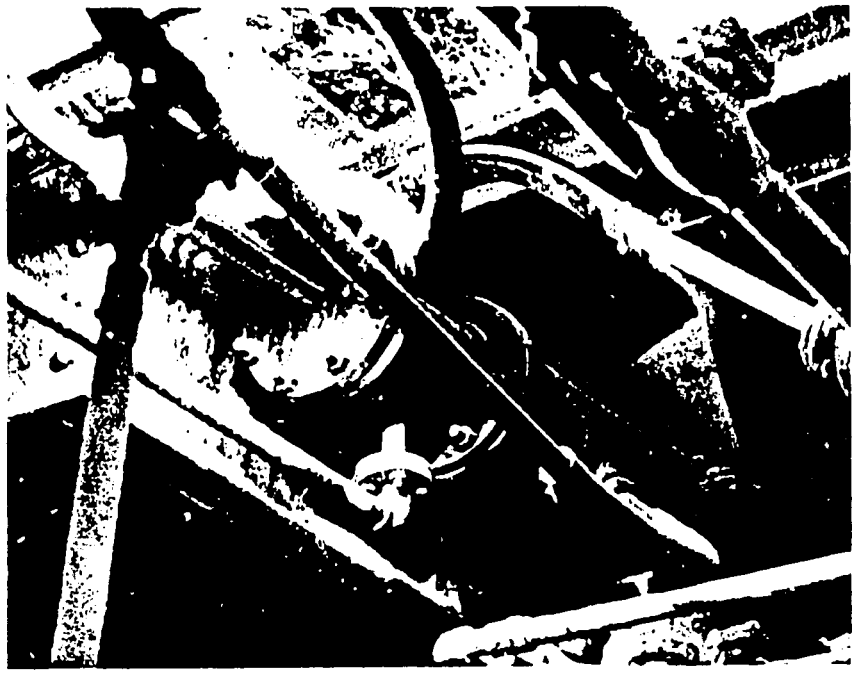
This is a pipe-cross reactor as installed in Landmark, Incorporated's granulating plant at Mt. Gilead, Ohio. The feedlines for water, anhydrous ammonia, and phosphoric acid can be seen.



Background

TVA first used a pipe reactor in the 1960's. It was used to produce a fluid fertilizer from ammonia and merchant-grade phosphoric acid. Later we tried wet-process superphosphoric acid in place of the merchant-grade acid. The heat of the chemical reaction between the ammonia and the super acid evaporated some of the water from the super acid. The product was a high quality ammonium polyphosphate liquid fertilizer. This development was quickly adopted by the U.S. and world fertilizer industry. This simple reactor is regarded as a major technological advance and it is now used in more than 135 plants to produce liquid fertilizers.

Continued pilot-plant studies proved the versatility of the pipe reactor. We found that we could produce granular ammonium phosphate fertilizers with it. A pipe reactor—spray reactor-scrubber—pugmill granulation system (12-20 tons per hour) then was installed in a TVA demonstration plant. About 325,000 tons of 11-55-0 ammonium phosphate and 28-28-0 and 35-17-0 grades of urea ammonium phosphate has been produced in this plant. A few commercial plants of this type also are in operation.

In 1974 TVA started plant tests with a new reactor, a pipe-cross reactor (PCR), to solve a problem in a commerical plant. The Missouri Farmers Association wanted to include byproduct sodium nitrate with other materials in its ammoniation-granulation plant at Palmyra, Missouri. The sodium nitrate was an economical source of nitrogen, but it affected the chemical reactions.

A large volume of fumes was produced when sulfuric acid was reacted with ammonia in the presence of the sodium nitrate. We found that this violent reaction could be avoided by partially ammoniating the sulfuric and phosphoric acids before they entered the granulator. This could be done in a conventional preneutralizer, but a less complicated device was desired. This led to the development of the pipe-cross reactor wherein two acids are ammoniated simultaneously. The PCR eliminated the problems at the Palmyra plant and has proved to be very effective in other granular fertilizer plants that use both phosphoric and sulfuric acids. It is an improvement over the old TVA pipe-reactor process in that a preneutralizer is not required to partially neutralize the acids before their introduction to the reactor.

Techniques

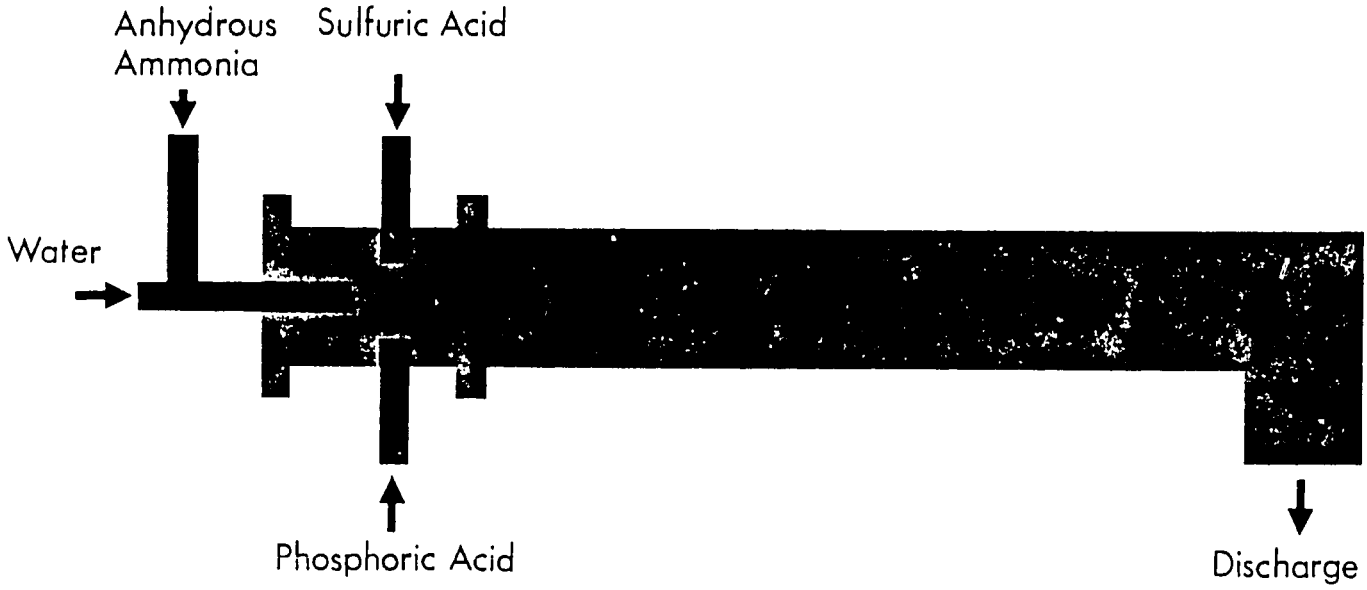
The reactor consists of a 5-inch Hastelloy C-276 reaction tube (about 9½ feet in length) to which sulfuric and phosphoric acids are added through two cross pipes. A mixture of about four parts anhydrous ammonia and one part water is added through a third pipe. The hot aqua ammonia gives a smooth reaction. (Using liquid anhydrous ammonia without water causes a violent reaction.)

The hot melt discharges from the tube into a TVA-type rotary ammoniator-granulator. Steam pressure generated in the PCR provides good distribution. The dryer in the granulation plant acts as a cooler, and no heat is required for drying most of the grades.

Advantages

The most important reasons for substituting the PCR for a preneutralizer in a conventional ammoniator-granulator plant are:

1. Large proportions of phosphoric and sulfuric acid can be used in the formulations.
2. No dryer is required for most



grades. This saves energy and can lower plant investment costs.

3. Less ammonium chloride fume is produced. This minimized difficult removal of the fume exit gases.
4. Cost of the PCR is much lower than that of a preneutralizer.
5. Easier operation and more precise control are possible because no pumps, lines, and meters are needed for controlling slurry discharge rate and transport.
6. Moisture content of the melt from the PCR (about 1% to 4%) is much lower than that from a preneutralizer (10%-25%). Fuel needed for drying is greatly decreased or eliminated.
7. The reactor provides a convenient means of producing a granular monoammonium phosphate. This is an excellent product for blending because a wider range of grades can be blended with it (12-48-0 or 11-55-0) than with 18-46-0.

Limitations

Like all new developments, the PCR presents potential problems. These are being evaluated in TVA pilot-plant testing and in commercial operation.

1. To take full advantage of energy savings, only those grades that don't require fuel for drying should be produced.
2. Confining a rapid chemical reaction such as NH_3 with H_3PO_4 and H_2SO_4 creates a potential hazard. More research is needed to establish proper operating procedures and the best types of pressure relief devices.
3. Hastelloy C-276 has given good corrosion resistance in the PCR. But, in any situation where sulfuric acid can become diluted without concurrent ammoniation, spot corrosion can become severe. Good design details and orderly startup and shutdown minimize the problem.

Commercial Application & Experiences

By early 1979, the PCR had been installed in at least 15 plants by commercial U.S. fertilizer companies and has been successfully used to produce such granular grades as 12-48-0, 12-12-12, 6-24-24, 8-22-11, 10-40-10, 20-10-10, 17-17-17, 33-11-0, and 18-46-0. PCR units are being used in Brazil, Spain, Australia, Columbia, and Japan. Some experiences with these plants are described below.

Swift Agricultural Chemicals, East St. Louis, Illinois——A PCR was installed in early 1977. A main grade of 6-24-24 is produced at the rate of 20 tons per hour. Acid feed rates are modest. Advantages of using the PCR at this plant have included easier startup, less cycling in process control, improved scrubber performance, lower fuel requirements, and less fuming.

Missouri Farmers Association, Palmyra, Missouri——This was the first PCR installed in a commercial plant. The main grade produced was a 6-24-24. Capacity of the burner for the dryer in the plant is 30 million Btu's but the burner has not been turned on since the PCR was installed in 1975. Fuel savings have been about $2 per ton of product. The PCR is easier to operate than a preneutralizer or adding acids directly to the granulator through a regular sparger. It is safer and fume problems have almost been eliminated. A blowout of the PCR occurred soon after a startup in April 1978. The acid and ammonia pipes broke and the 5-inch reactor was distorted. Some potential causes were: (1) the sulfuric acid rate—12 gpm—may have been

high compared with the ammonia rate—4 gpm. (2) The skin temperature of the reactor was greater than 300°F instead of the usual 240° to 280°F. (3) The startup procedure probably was too rapid. A new 4-inch PCR was installed and a pressure-relief valve was placed on the reactor tube at the discharge of the ammonia pipe.

Gold Kist, Hanceville, Alabama—One of the company's three granulation plants has a PCR. The TVA-type plant has an ammoniator-granulator, dryer, and cooler. Main grades made with the PCR include 13-13-13, 8-24-24, and 7-14-21. Production ranges from 18 to 30 tons per hour, depending on the grade being produced. Fuming is greatly decreased because most of the acid is neutralized in the PCR before it comes in contact with potassium chloride. Although fuel savings have been greatest with production of 13-13-13, Gold Kist expects even greater fuel savings and will probably install PCR's in other plants. Cost of the PCR installation and improvement of the granulation system was about $60,000. This included $24,000 for instrumentation and $4,500 for a small control laboratory.

Smith-Douglass, Division of Borden Chemical, Streater, Illinois—A 6-inch PCR was installed in early 1978 and has successfully produced more than 60,000 tons of NPK fertilizers. Production rate is higher with the PCR—25 to 30 tons per hour on 6-24-24 and 20 to 25 tons per hour on other grades. Fumes have been greatly decreased. Two more PCR's will be installed by the company.

International Minerals and Chemicals, Florence, Alabama—A PCR was installed at this plant in late 1976. Results have been better than expected. The most important advantages have been fuel savings, greatly decreased fume problems, and increased production rates for some grades.

Research Progress

Tests are being continued by TVA to further develop the PCR process and to determine its application to producing improved and more economical fertilizers. Special emphasis is on refining operational variables and conditions for different fertilizer grades. Monitoring of experience in commercial plants is continuing. Pilot-plant work is emphasizing use of the PCR to produce granular diammonium phosphate.

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TVA Research Contacts

Charles H. Davis, Director of Chemical Development, concerning TVA development work; and Frank P. Achorn, Head, Process and Product Improvement Section, Division of Agricultural Development, concerning industry experience.

References

More detailed information on pipe reactors is available from the Technical Library at Muscle Shoals. Library reference numbers are X-98, X-222, X-275, X-306, X-136, Z-70 and Z-84.

Circular Z-95
June 1979