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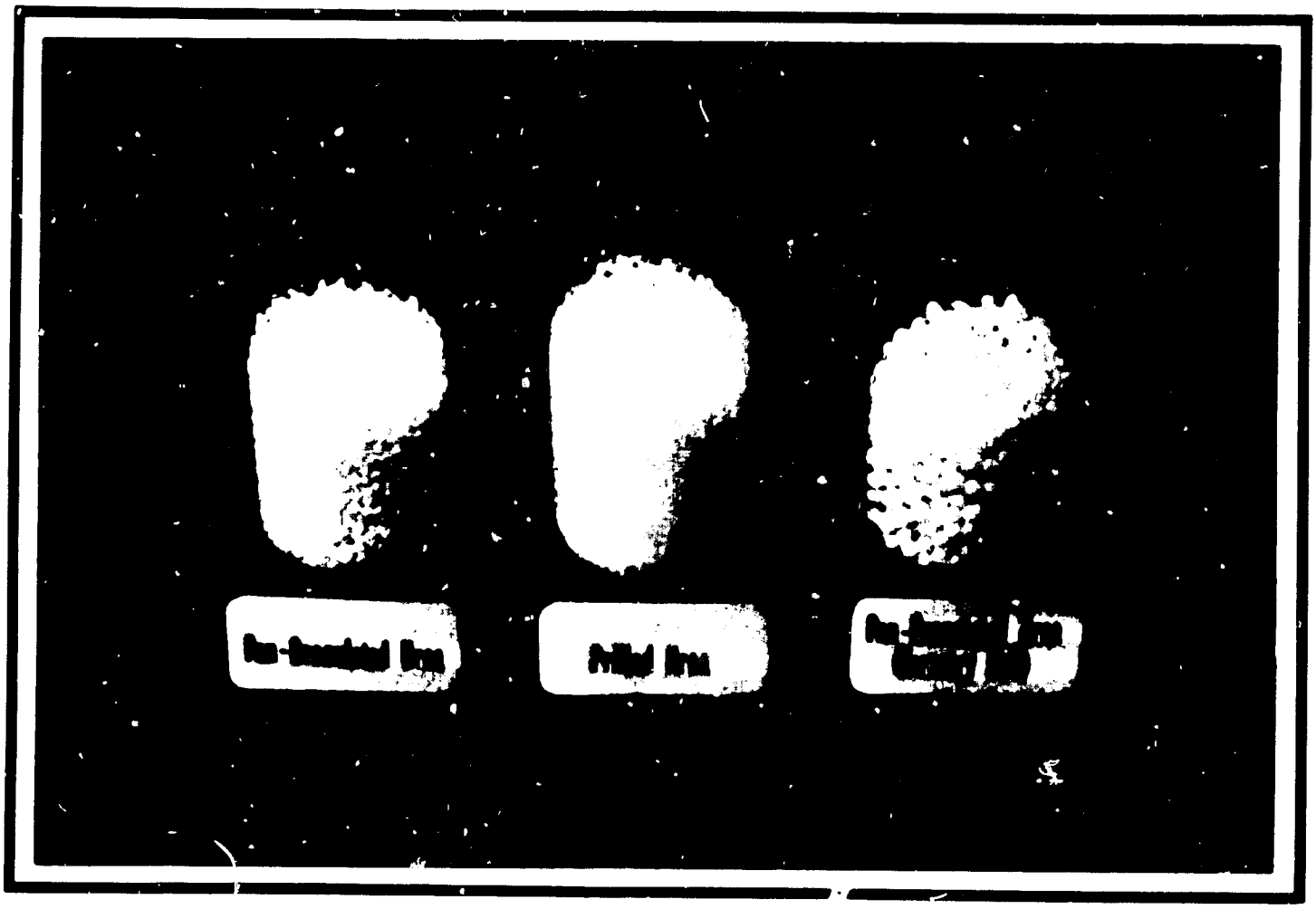
Pan Granulation of Urea

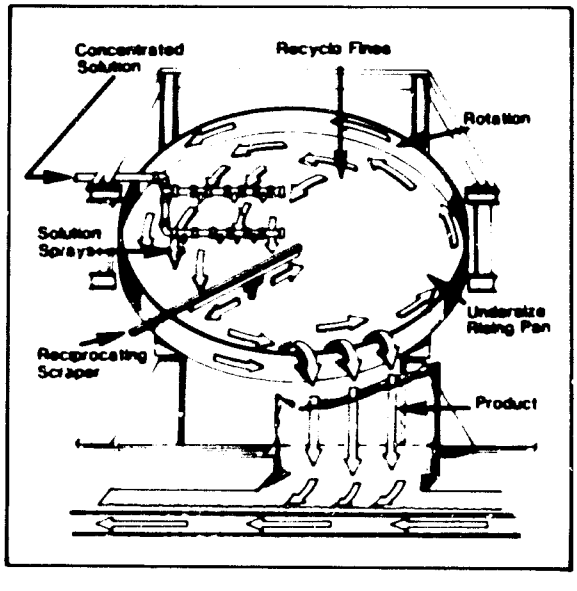


Technical Update

January 1981

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

Right: Pan granulation in action;
Below: Diagram of urea granulation



Background

Urea has become the world's leading nitrogen fertilizer and is steadily becoming more popular than ammonium nitrate in the United States.

Most solid urea is produced as small, fragile prills formed by cooling and solidifying droplets of concentrated solution or melt as they fall through cool air in a prill tower. However, bulk blending, which quickly became popular during the 1950's and 1960's, required larger urea granules. Responding to that need, researchers at TVA's National Fertilizer Development Center began conducting studies with the goal of producing urea with a pan granulator.

TVA pioneered granulation studies in the 1950's. The popular TVA rotary drum ammoniator-granulator process for making most granular NP and NPK fertilizers was the result. When ammonium nitrate in granular form was needed, the familiar rotary drum system was the first to be tested. However, sensitivity of material to melting in the granulator and the forming of irregular granules were serious problems. Only recycle and varying solution temperature could be used to control granulation. At this point, TVA began to look for better granulation equipment and processes.

TVA's first pilot plant studies of urea granulation began in the

1960's. By 1973, a demonstration plant for producing about 10 tons per hour began operating. This plant can readily produce granules within a specified size range with greatly increased crushing strength.

Another important objective was the production of granular sulfur-coated urea, a controlled release fertilizer developed by TVA. Urea granules to be coated must have surface smoothness and a low specific surface. Pan granulated urea readily met these requirements.

Techniques

Pelletizing discs (inclined pans) had long been used for forming large pellets from iron ore fines and for pelletizing recycled fines for manufacturing glass and ceramics. The excellent classifying action of this equipment that allowed spraying of solutions or melts precisely on the area where undersize material was distributed in the pan seemed to offer a big plus for granulating highly soluble ammonium nitrate or grades of fertilizer based on this intermediate. The main question was whether this type of equipment could produce fertilizer-size granules instead of the larger (3/8- to 3/4-inch) pellets. Early tests were promising and led to increases in both angle of inclination of the pan (to about 65 degrees) and rotational speed.

Pilot-Plant Test

When the pan is used for pelletizing ore or ceramic fines, it agglomerates fines with the use of binding agents and rolls the pellets until they are round and firm. The process is slightly different in manufacturing granular nitrogen fertilizers; successive layers of concentrated urea solution are deposited on fines and recycle. To produce fertilizer-size granules of excellent quality, the important factors are angle of inclination, rotational speed, location of sprays, concentration and temperature of solution, temperature of material in the pan, and size and temperature of recycle.

The first tests of urea granulation in the pan involved urea solutions of 96 to 98 percent concentration. While granulation was good, drying was needed to lower the moisture content for product storage. A solution of 99.3 to 99.8 percent concentration was tested later in the pan with the result of good granulation and well-rounded granules. No drying was required. Other equipment needs included a rotary cooler, sizing screens, crusher, and dust collectors. This resulted in a much simpler process. Best results were obtained with urea solution of 99+ percent concentration at a temperature of 295 to 305 degrees F.

The simple and dependable TVA pan granulation process uses a conventional solution or melt-preparation system, pan granulator, and conventional equipment for cooling and sizing the product. No dryer is needed. Concentrated solution or melt (99+ percent) is sprayed onto a cascading bed of recycle material in the pan granulator where the undersize particles receive a thin layer of melt each time they pass underneath the sprays. The natural classifying action in the pan results in the larger particles being discharged as product while the smaller ones remain in the granulator and become larger. Very little oversize is formed.

Product from the pan is cooled and screened and the onsize fraction is stored. The oversize may be crushed and returned with the undersize fraction as recycle material to the granulator, or dissolved and returned to the solution system if it isn't needed as recycle material.

During pilot-plant studies, adding formaldehyde to the concentrated urea solution increased crushing strength of the granules by about 2 or 3 to 1. The formaldehyde was fed in proportion of 0.4 percent (by weight) as an aqueous solution, inhibited with methanol to ensure fluidity without heating. The solution contained 37 percent formaldehyde, 12 percent methanol, and 51 percent water. The additive was much more effective when fed into the urea solution between the evaporator and pan granulator than when added before or in the evaporator. The treatment with 0.4 percent of formaldehyde has another advantage. No further conditioning of granules is required for good storage and bagging properties. Omitting any surface conditioner decreases dust and easily ensures a grade of 46 percent N.

Demonstration Plant

Successful pilot-plant studies led to the retrofitting of a pan granulation system in a demonstration urea granulation facility. The resulting product has good size, shape, crushing strength, and storage characteristics. With a few minor operating changes, the pan has also been used to produce products with specific particle size and other physical requirements for use not only in bulk blending, but also for forest fertilization and as a substrate material for sulfur coating. Although production costs for pan granulated urea might be slightly higher than for prills, product quality is improved, granule size can be varied, and collection and recovery of fumes and dust is easier.

Commercial Application

Commercial pan granulation facilities of the TVA-type for urea are being built. One with very large capacity in Pakistan will use multiple pans; a smaller one in Indonesia should be operational by mid-1981. Interest in this process in the U.S. is high.

Research Progress

The TVA pan granulation process for urea has been proved in 6 years of demonstration plant operation. Changes have been made to collect a large part of the dust in a bag filter and dissolve it and oversize granules in scrubber solution for return to the process. This should relieve the present tight water balance, since a 75 percent solution will be fed back to process instead of the present 50 percent. Experience the next few years from large commercial units, designed specifically for urea, will provide more helpful information.

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References

More detailed information on pan granulation of urea is available from the Technical Library, TVA, Muscle Shoals, Alabama 35660. Library reference numbers are CD-451, CD-478, X-342, Y-92, Y-133,, Z-86 and New Developments in Fertilizer Technology, 1976, (pages 79-81).

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