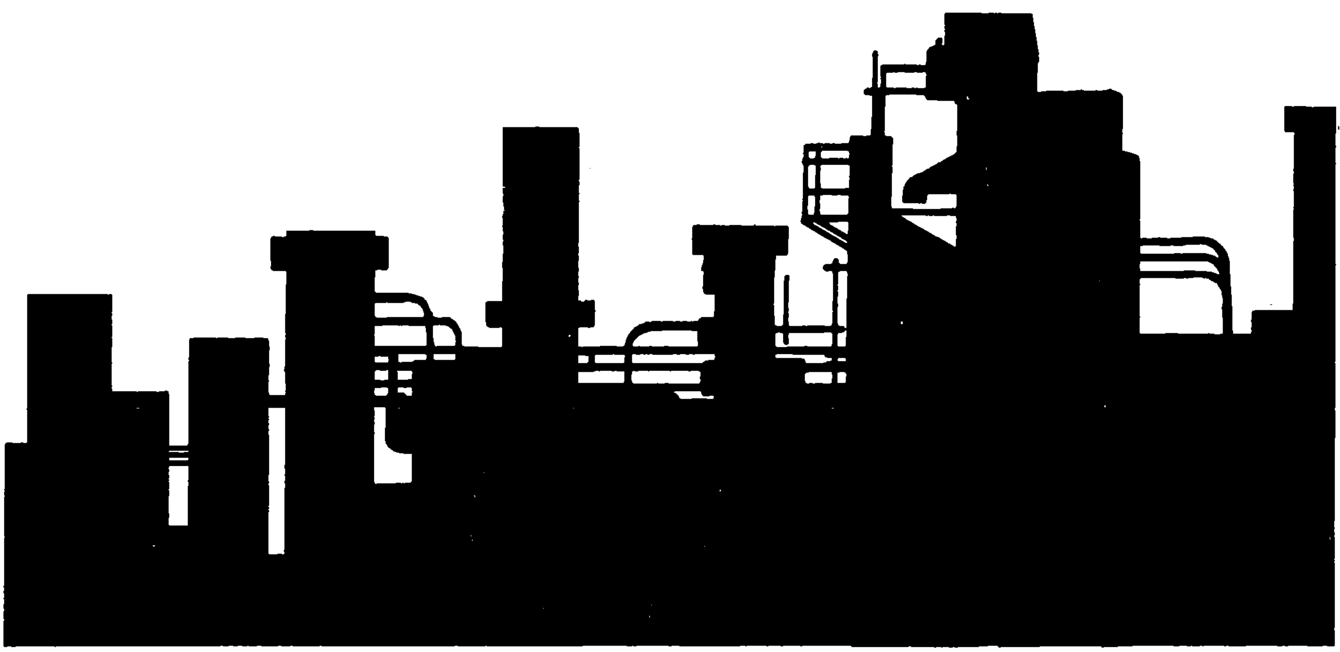
Phosphate Fertilizer Technology



Phosphate Fertilizer Technology

A slide set assembled by Division S-8, Fertilizer Technology and Use, of the Soil Science Society of America, Inc. in cooperation with the Fertilizer Industry, Potash and Phosphate Institute, and the National Fertilizer Development Center of the Tennessee Valley Authority.

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FOREWORD

This slide set, titled "Phosphate Fertilizer Technology," and the written comments about each slide, were prepared by a special subcommittee in Division S-8, Fertilizer Technology and Use, of the Soil Science Society of America, Inc. Reproduction of the slides and of the accompanying booklet was undertaken by the Headquarters Office in behalf of the Society, specifically for classroom use. The slides and booklet provide background material which can be used to supplement or complement other sources of information.

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Matthias Stelly
Executive Vice President

November 1980

PHOSPHATE FERTILIZER TECHNOLOGY

Soil Science Society of America
677 South Segoe Road
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Visual	Text
1. Art: Phosphate Fertilizer Technology	
2. Photo: General crop scene	2. Phosphorus is vital for plant growth. Without it, we would find it impossible to maintain high yields of quality crops.
3. Photo: Bottle containing phosphate rock	3. Our source of phosphorus is phosphate rock, a mineral found in the Earth's crust. This presentation shows how phosphate rock is mined and processed into phosphate fertilizer.
4. Art: World map showing phosphate rock deposits	4. The world's most important deposits of phosphate rock are in Morocco, the United States, and Russia, but deposits also are found in many other countries.
5. Art: Table of worldwide phosphate rock reserves	5. The estimated amount of phosphate rock reserves in the world was about 45 billion metric tons in 1975, but was over 100 billion tons in 1980. Reserves are those deposits which can be economically used with current technology, while resources are those which could be used at a greater cost or with improved technology. The amounts of reserves and resources change with further discoveries, improved technology, and a changing economic situation.
6. Art: Table of U.S. phosphate rock reserves	6. The largest deposits in the United States are in Florida. Other deposits are found in Utah, Idaho, North Carolina, Georgia, Montana, Wyoming, and Tennessee. The U.S. is the world's largest phosphate producer, and exports much of the material to other countries. The reserves listed are mineable rock by current technology as of 1975. These amounts have increased since that time, especially in Florida.

Visual	Text
7. Art: Phosphate mine profile showing surface, overburden, and ore layers	7. Phosphate rock, also called apatite, is a mineral deposited millions of years ago in sediments at the bottom of a prehistoric sea. These sediments also include impurities such as sand and clay.
8. Art: Flowsheet of phosphate rock operations	8. Today's phosphate industry begins with the mining of the rock. This flowsheet shows the general steps in handling phosphate rock. After mining, the rock is washed to remove impurities, prepared for further cleaning in the table and flotation plants, and then stored for future processing.
9. Photo: Dragline in operation	9. Because most of these deposits are near the Earth's surface, the open-pit method of mining is the most practical. Huge draglines remove the overburden and dig out the phosphate rock and clay mixture.
10. Photo: Slurry pits	10. The mixture is slurried by hydraulic action in a slurry pit, then pumped through a movable pipeline to the washers.
11. Photo: Washers section	11. At the washers, coarse rock is separated from the slurry by screening.
12. Art: Feed preparation operation	12. The next step is to remove and discard the slime which contains very fine particles of clay, sand, and phosphate. This is done by passing the slurry through a classifier and several vibrating screens. The coarse material after screening is called classified product and needs no further beneficiation or upgrading of the ore. The medium-sized materials are pumped to the table plant and the fine-sized materials are pumped to the flotation plant.
13. Art: Table plant	13. In the table plant, water is removed from the slurry which contains medium-sized phosphate and sand particles in the classifier. Chemicals are added which coat the phosphate but not the sand particles. The mixture is separated by gravity on vibrating tables.
14. Art: Flotation plant	14. In the flotation plant, fine clay is first floated away from the phosphate. In the second phase, the fine phosphate particles are floated away from the sand particles remaining in the slurry.

Visual	Text
15. Photo: Wet pile storage of phosphate rock	15. Cleaned phosphate rock material is stored in wet piles. This saves drying costs and reduces air pollution due to wind blowing the dry phosphate dust from the piles.
16. Photo: Calcination furnace	16. Most phosphate rock deposits, especially those in Florida, do not contain organic matter as a contaminant. Organic matter must be removed by calcination if it is contained in the ore. Contaminating organic matter is burned by passing the phosphate through a high-temperature chamber. Then the phosphate is finely ground for further processing.
17. Art: Phosphate rock conversion into phosphoric acid electric process (thermal) wet acid process (chemical)	17. The two main methods which convert phosphate rock into chemicals are the electric or thermal process, and the wet acid or chemical process.
18. Photo: Electric furnace plant	18. The electric furnace method produces high-quality phosphoric acid but is very costly. Phosphates produced by this method are used mostly for food-grade phosphates and detergents.
19. Photo: Wet process plant	19. This is a modern wet process phosphoric acid plant. Most of the phosphorus used by the U.S. fertilizer industry is produced in plants such as this.
20. Art: Schematic of wet process method featuring the acid treatment step	20. In the wet process, beneficiated phosphate rock is treated or reacted with strong acids to convert water-insoluble phosphate into soluble phosphates.
21. Photo: Sulfuric acid plant	21. The most common acid used by the phosphate industry is concentrated sulfuric acid. Most phosphate producers make their own sulfuric acid at the plant site.
22. Art: Schematic of wet process method featuring the filtration and concentration steps	22. After the phosphates have been dissolved by the acid, they are filtered to remove impurities, then made into various concentrations of phosphoric acid.

Visual	Text
23. Art: Environmental considerations: gypsum disposal uranium recovery	23. There are environmental problems which must be considered during phosphate processing. Gypsum, a byproduct produced in large quantities, must be disposed of. Also, phosphates contain valuable fluorine and uranium. Fluorine is recoved by wet scrubbing the gases from the reactors. Chemical processes have been developed to remove uranium so it can serve as a source of fuel for nuclear plants after further processing.
24. Photo: Reclaimed mine site	24. After the phosphate ore is removed, the land is reclaimed, often to a higher use than it was before mining. The mined areas are filled with overburden dug from nearby sites. The reclaimed land is used for farming, housing, and recreation.
25. Photo: Bottles with TSP, MAP, DAP, 10-34-0, and 6-18-18 suspension	25. So far, we have discussed where phosphate deposits are and how phosphate rock is mined and processed into phosphoric acid. Now, let's see how phosphate fertilizers are manufactured.
26. Art: Main manufacturing processes: superphosphates ammoniated phosphates fluid phosphates	26. The main processes to convert phosphoric acid into phosphate fertilizers are the superphosphate and the ammoniated phosphate process to make solid fertilizers, and several methods to make fluid phosphates.
27. Art: Ordinary superphosphate (OSP) 0-20-0; triple superphosphate (TSP) 0-45-0	27. Ordinary superphosphate was the most common phosphate fertilizer for many years. It is made by reacting sulfuric acid with phosphate rock to form a mixture of monocalcium phosphate and gypsum. Because it contains only 20 percent P_2O_5, shipping costs per unit of phosphate are high. As a result, higher analysis phosphates are now more popular. Triple (or treble) superphosphate has an analysis of about 45 percent P_2O_5, and has largely replaced ordinary superphosphate because of lower freight costs.
28. Art: Schematic of run-of-pile triple superphosphate process	28. Run-of-pile triple superphosphate is made by treating ground phosphate rock with 54 percent phosphoric acid in a cone mixer, allowing it to react, then crushing and storing it in piles. Most of the calcium is retained as monocalcium phosphate.

Visual	Text
29. Art: Schematic of granular triple superphosphate process	29. Granular triple superphosphate is produced by granulating the slurry after reacting phosphate rock with phosphoric acid. The granular product is dried, screened to size, then stored.
30. Art: Diammonium phosphate (DAP) 18-46-0; monoammonium phosphate (MAP) 11-52-0	30. When ammonia is reacted with phosphoric acid in a certain ratio, the resulting product is diammonium phosphate with a typical grade of 18-46-0. If less ammonia is used in the reaction, monoammonium phosphate is produced. A typical grade is 11-52-0.
31. Art: Ammoniated mixed fertilizers: 6-24-12, 8-24-24, 12-13-13	31. Potash also may be combined with ammonium phosphates during the ammoniation-granulation process to form mixed fertilizers with different grades and ratios of N, P_2O_5, and K_2O.
32. Photo: Bulk-blending plant	32. It's also possible to prepare fertilizer grades by dry blending granular fertilizers such as diammonium phosphate, potash, and urea. This is a big advantage to a dealer because it allows him to store fewer fertilizers and still mix many grades to meet fertilizer recommendations.
33. Art: Schematic of a bulk-blending plant	33. In a bulk-blending plant the desired amounts of fertilizer from each bin are weighed into a mixer. After the batch is properly mixed, the blend is emptied into a holding bin or directly into the spreader truck. Bulk blends are rarely bagged for storage.
34. Photo: Fluid fertilizer applicator	34. The development of fluid fertilizers is more recent than that of solid fertilizers. The use of fluids has spread to most regions of the U.S.
35. Photo: Bottles of a clear liquid and a suspension	35. Fluid fertilizers can either be suspensions or clear solutions. Suspensions generally contain higher concentrations of plant foods, especially potassium.
36. Art: Conversion of orthophosphates to polyphosphate	36. Two kinds of phosphates are used in the fluid fertilizer industry—polyphosphates and orthophosphates. Polyphosphates contain two or more orthophosphates linked together through an oxygen atom by removal of water. Most polyphosphate fertilizers also contain at least part of their phosphorus in the orthophosphate form.

Visual	Text
37. Photo: A pipe reactor	37. Polyphosphates can be made in a pipe reactor. In the reactor, ammonia is reacted with phosphoric acid under high temperature and pressure. Water is driven off, which condenses orthophosphoric acid to product ammonium polyphosphate.
38. Photo: Pipe reactor installation	38. Plants equipped with these reactors require less energy than plants using older processes.
39. Photo: Suspension plant	39. When high potash fluid grades are needed the potash must be suspended because it will not completely dissolve. The suspending agent is usually clay gelled in water.
40. Art: Schematic of a suspension plant	40. Suspensions are made by pumping the desired amounts of phosphate base solution, urea-ammonium nitrate solution, and water to a mix tank. Gelled clay is mixed in the tank, and then the required amount of potash is suspended. The prepared suspension is then pumped to applicators or to storage tanks.
41. Photo: Liquid mix plant for orthophosphate suspensions	41. Orthophosphate suspensions are made by fluidizing granular monoammonium or diammonium phosphate in water and adjusting the pH with ammonia in a mix tank. Heat from ammoniation is used to help dissolve the solid phosphates. Potash and micronutrients also can be added in the process. While their storage properties may not be as good as those made from polyphosphates, they generally are less expensive to manufacture.
42. Photo: Direct application of phosphate rock to soil	42. Phosphate rock can be used directly on acid soils for some crops and for trees grown for pulpwood. However, it must be finely ground and mixed well with soil to be effective. Some sources of phosphate rock are not as effective as others for direct application because of differences in composition. Less than one percent of the phosphate rock used in the United States is applied directly to soil.

Visual	Text
43. Art: Under development— urea phosphate, potassium polyphosphate	43. Two other phosphate fertilizers being developed are urea phosphate and potassium polyphosphate. They could become popular if production costs are competitive.
44. Photo: Bottles of phosphate rock and phosphate products	44. This has been the story of processing phosphate rock into usable phosphate fertilizers. But research continues to reach for new goals of increased phosphate production efficiency and better phosphate fertilizers for greater crop response.

45. Art:

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