8.5.1 Normal Superphosphates

8.5.1.1 General[1-3]

Normal superphosphate refers to fertilizer material containing 15 to 21 percent phosphorus as phosphorus pentoxide (P_2O_5). As defined by the Census Bureau, normal superphosphate contains not more than 22 percent of available P_2O_5. There are currently about 8 fertilizer facilities producing normal superphosphates in the U. S. with an estimated total production of about 273,000 megagrams (Mg) (300,000 tons) per year.

8.5.1.2 Process Description[1]

Normal superphosphates are prepared by reacting ground phosphate rock with 65 to 75 percent sulfuric acid. An important factor in the production of normal superphosphates is the amount of iron and aluminum in the phosphate rock. Aluminum (as Al_2O_3) and iron (as Fe_2O_3) above 5 percent imparts an extreme stickiness to the superphosphate and makes it difficult to handle.

The 2 general types of sulfuric acid used in superphosphate manufacture are virgin and spent acid. Virgin acid is produced from elemental sulfur, pyrites, and industrial gases and is relatively pure. Spent acid is a recycled waste product from various industries that use large quantities of sulfuric acid. Problems encountered with using spent acid include unusual color, unfamiliar odor, and toxicity.

A generalized flow diagram of normal superphosphate production is shown in Figure 8.5.1-1. Ground phosphate rock and acid are mixed in a reaction vessel, held in an enclosed area for about 30 minutes until the reaction is partially completed, and then transferred, using an enclosed conveyer known as the den, to a storage pile for curing (the completion of the reaction). Following curing, the product is most often used as a high-phosphate additive in the production of granular fertilizers. It can also be granulated for sale as granulated superphosphate or granular mixed fertilizer. To produce granulated normal superphosphate, cured superphosphate is fed through a clod breaker and sent to a rotary drum granulator where steam, water, and acid may be added to aid in granulation. Material is processed through a rotary drum granulator, a rotary dryer, and a rotary cooler, and is then screened to specification. Finally, it is stored in bagged or bulk form prior to being sold.

8.5.1.3 Emissions And Controls[1-6]

Sources of emissions at a normal superphosphate plant include rock unloading and feeding, mixing operations (in the reactor), storage (in the curing building), and fertilizer handling operations. Rock unloading, handling, and feeding generate particulate emissions of phosphate rock dust. The mixer, den, and curing building emit gases in the form of silicon tetrafluoride (SiF_4), hydrogen fluoride (HF), and particulates composed of fluoride and phosphate material. Fertilizer handling operations release fertilizer dust. Emission factors for the production of normal superphosphate are presented in Table 8.5.1-1. Units are expressed in terms of kilograms per megagram (kg/Mg) and pounds per ton (lb/ton).

At a typical normal superphosphate plant, emissions from the rock unloading, handling, and feeding operations are controlled by a baghouse. Baghouse cloth filters have reported efficiencies of den are controlled by a wet scrubber. The curing building and fertilizer handling operations over

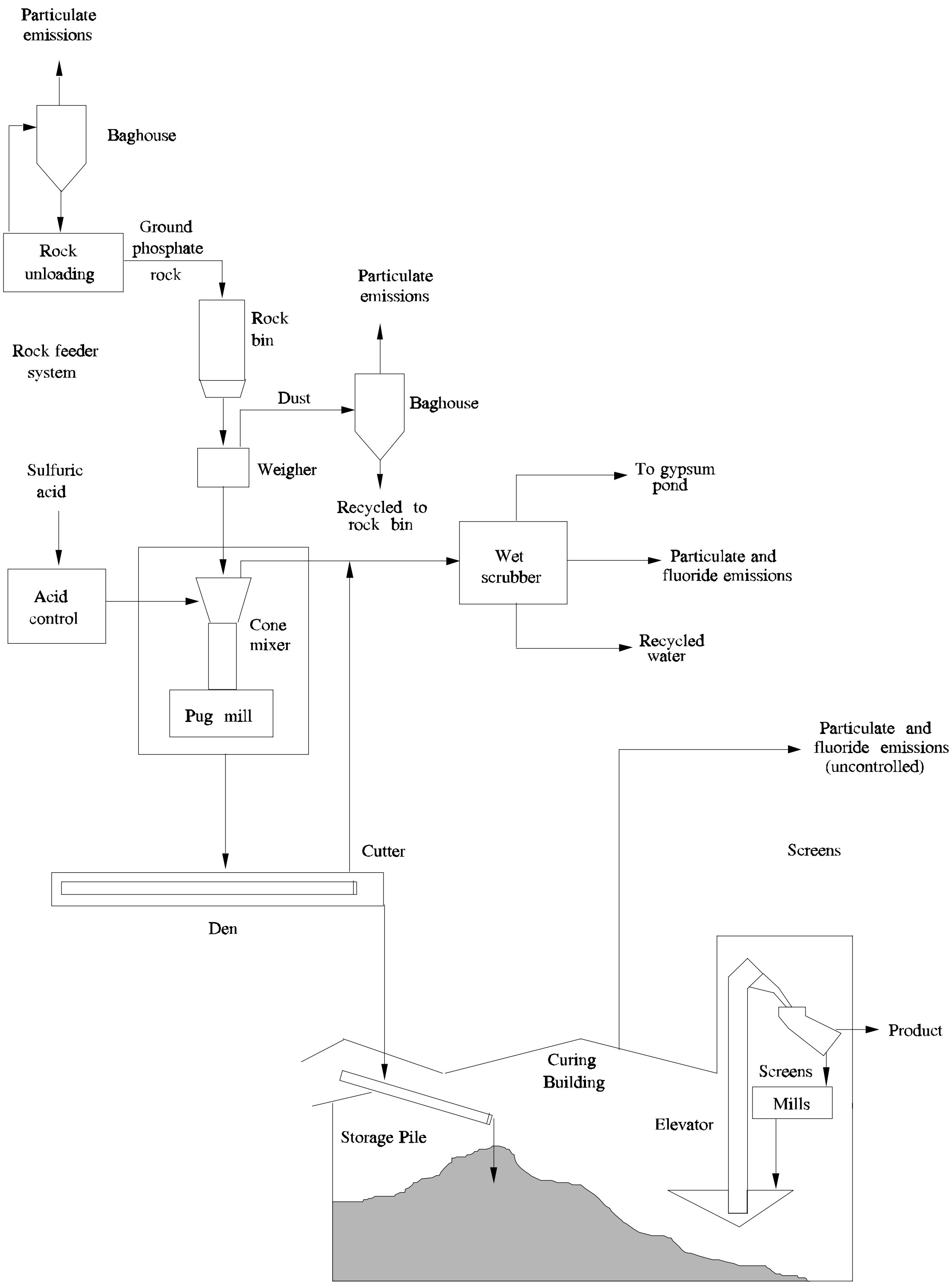

Figure 8.5.1-1. Normal superphosphate process flow diagram.[1]

Table 8.5.1-1 (Metric And English Units). EMISSION FACTORS FOR THE PRODUCTION OF NORMAL SUPERPHOSPHATE

EMISSION FACTOR RATING: E

Emission Point	Pollutant	Emission Factor	
		kg/Mg Of P_2O_5 Produced	lb/ton Of P_2O_5 Produced
Rock unloading[a]	Particulate[b]	0.28	0.56
	PM-10[c]	0.15	0.29
Rock feeding[a]	Particulate[b]	0.06	0.11
	PM-10[c]	0.03	0.06
Mixer and den[d]	Particulate[b]	0.26	0.52
	Fluoride[b]	0.10	0.2
	PM-10[c]	0.22	0.44
Curing building[e]	Particulate[b]	3.60	7.20
	Fluoride[b]	1.90	3.80
	PM-10[c]	3.0	6.1

[a] Factors are for emissions from baghouse with an estimated collection efficiency of 99%. PM-10 = particulate matter no greater than 10 micrometers.
[b] Reference 1, pp. 74-77, 169.
[c] Taken from Aerometric Information Retrieval System (AIRS) Listing for Criteria Air Pollutants.
[d] Factors are for emissions from wet scrubbers with a reported 97% control efficiency.
[e] Uncontrolled.

99 percent under ideal conditions. Collected dust is recycled. Emissions from the mixer and den are controlled by a wet scrubber. The curing building and fertilizer handling operations normally are not controlled.

SiF_4 and HF emissions, and particulate from the mixer, den, and curing building are controlled by scrubbing the offgases with recycled water. Gaseous SiF_4 in the presence of moisture reacts to form gelatinous silica, which has a tendency to plug scrubber packings. The use of conventional packed-countercurrent scrubbers and other contacting devices with small gas passages for emissions control is therefore limited. Scrubbers that can be used are cyclones, venturi, impingement, jet ejector, and spray-crossflow packed scrubbers. Spray towers are also used as precontactors for fluorine removal at relatively high concentration levels of greater than 4.67 grams per cubic meter (3000 parts per million).

Air pollution control techniques vary with particular plant designs. The effectiveness of abatement systems in removing fluoride and particulate also varies from plant to plant, depending on a number of factors. The effectiveness of fluorine abatement is determined by the inlet fluorine concentration, outlet or saturated gas temperature, composition and temperature of the scrubbing liquid, scrubber type and transfer units, and the effectiveness of entrainment separation. Control efficiency is enhanced by increasing the number of scrubbing stages in series and by using a fresh water scrub in the final stage. Reported efficiencies for fluoride control range from less than 90 percent to over 99 percent, depending on inlet fluoride concentrations and the system employed. An efficiency of 98 percent for particulate control is achievable.

The emission factors have not been adjusted by this revision, but they have been downgraded to an "E" quality rating based on the absence of supporting source tests. The PM-10 (particulate matter with a diameter of less than 10 micrometers) emission factors have been added to the table, but were taken from the AIRS Listing for Criteria Air Pollutants, which is also rated "E". No additional or recent data were found concerning fluoride emissions from gypsum ponds. A number of hazardous air pollutants (HAPs) have been identified by SPECIATE as being present in the phosphate manufacturing process. Some HAPs identified include hexane, methyl alcohol, formaldehyde, methyl ethyl ketone, benzene, toluene, and styrene. Heavy metals such as lead and mercury are present in the phosphate rock. The phosphate rock is mildly radioactive due to the presence of some radionuclides. No emission factors are included for these HAPs, heavy metals, or radionuclides due to the lack of sufficient data.

References For Section 8.5.1

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