8.4 Ammonium Sulfate

8.4.1 General[1-2]

Ammonium sulfate ($[NH_4]_2SO_4$) is commonly used as a fertilizer. In 1991, U. S. facilities produced about 2.7 million megagrams (Mg) (3 million tons) of ammonium sulfate in about 35 plants. Production rates at these plants range from 1.8 to 360 Mg (2 to 400 tons) per year.

8.4.2 Process Description[1]

About 90 percent of ammonium sulfate is produced by 3 different processes: (1) as a byproduct of caprolactam [$(CH_2)_5COHN$] production, (2) from synthetic manufacture, and (3) as a coke oven byproduct. The remainder is produced as a byproduct of either nickel or methyl methacrylate manufacture, or from ammonia (NH_3) scrubbing of tailgas at sulfuric acid (H_2SO_4) plants. These minor sources are not discussed here.

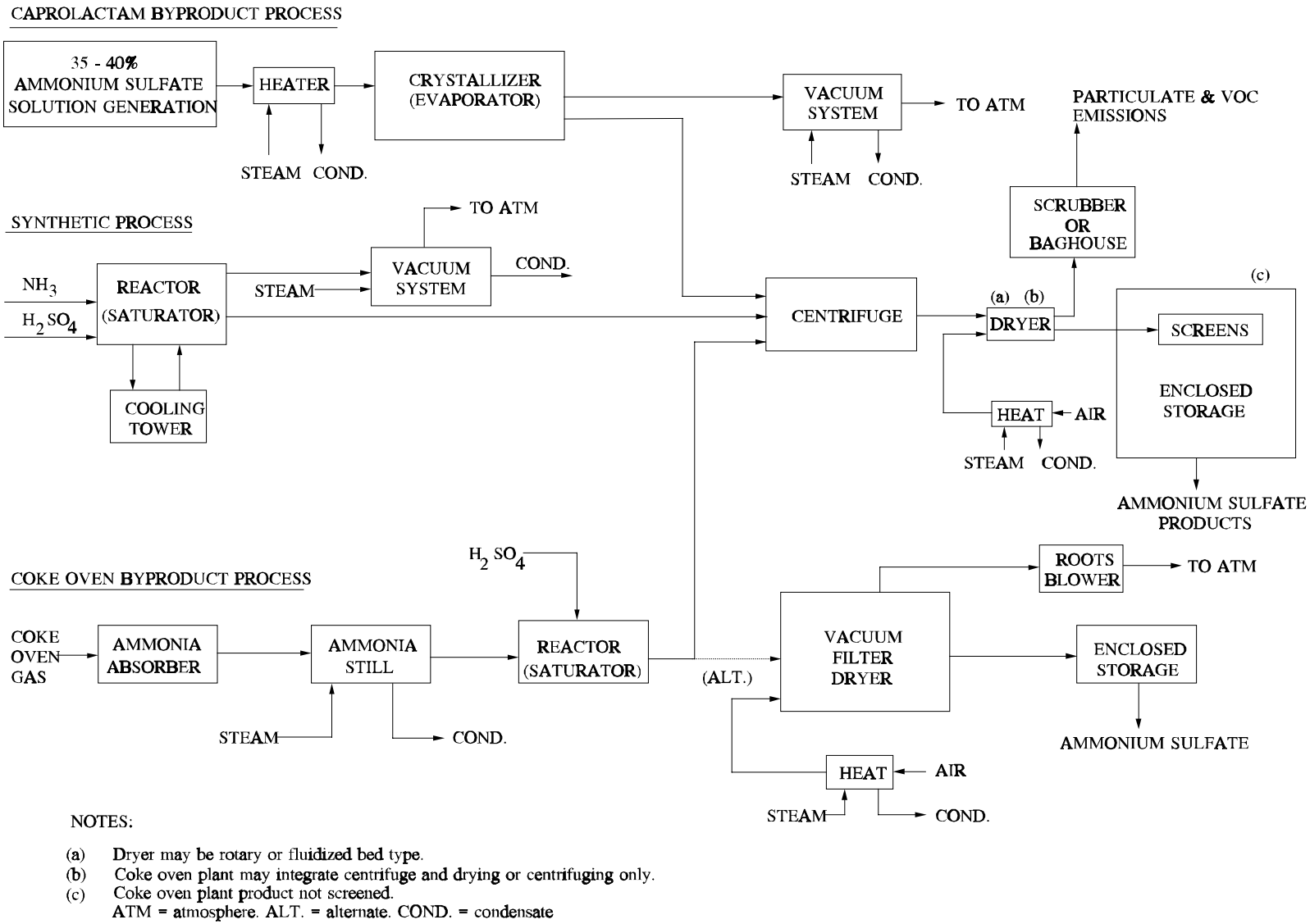
Ammonium sulfate is produced as a byproduct from the caprolactam oxidation process stream and the rearrangement reaction stream. Synthetic ammonium sulfate is produced by combining anhydrous ammonia and sulfuric acid in a reactor. Coke oven byproduct ammonium sulfate is produced by reacting the ammonia recovered from coke oven offgas with sulfuric acid. Figure 8.4-1 is a diagram of typical ammonium sulfate manufacturing for each of the 3 primary commercial processes.

After formation of the ammonium sulfate solution, manufacturing operations of each process are similar. Ammonium sulfate crystals are formed by circulating the ammonium sulfate liquor through a water evaporator, which thickens the solution. Ammonium sulfate crystals are separated from the liquor in a centrifuge. In the caprolactam byproduct process, the product is first transferred to a settling tank to reduce the liquid load on the centrifuge. The saturated liquor is returned to the dilute ammonium sulfate brine of the evaporator. The crystals, which contain about 1 to 2.5 percent moisture by weight after the centrifuge, are fed to either a fluidized-bed or a rotary drum dryer. Fluidized-bed dryers are continuously steam heated, while the rotary dryers are fired directly with either oil or natural gas or may use steam-heated air.

At coke oven byproduct plants, rotary vacuum filters may be used in place of a centrifuge and dryer. The crystal layer is deposited on the filter and is removed as product. These crystals are generally not screened, although they contain a wide range of particle sizes. They are then carried by conveyors to bulk storage.

At synthetic plants, a small quantity (about 0.05 percent) of a heavy organic (i. e., high molecular weight organic) is added to the product after drying to reduce caking.

Dryer exhaust gases pass through a particulate collection device, such as a wet scrubber. This collection controls emissions and reclaims residual product. After being dried, the ammonium sulfate crystals are screened into coarse and fine crystals. This screening is done in an enclosed area to restrict fugitive dust in the building.



NOTES:

(a) Dryer may be rotary or fluidized bed type.
(b) Coke oven plant may integrate centrifuge and drying or centrifuging only.
(c) Coke oven plant product not screened.
ATM = atmosphere. ALT. = alternate. COND. = condensate

Figure 8.4-1. Typical diagram of ammonium sulfate processes.

8.4.3 Emissions And Controls[1]

Ammonium sulfate particulate is the principal emission from ammonium sulfate manufacturing plants. The gaseous exhaust of the dryers contains nearly all the emitted ammonium sulfate. Other plant processes, such as evaporation, screening and materials handling, are not significant sources of emissions.

The particulate emission rate of a dryer is dependent on gas velocity and particle size distribution. Gas velocity, and thus emission rates, varies according to the dryer type. Generally, the gas velocity of fluidized-bed dryers is higher than for most rotary drum dryers. Therefore, the particulate emission rates are higher for fluidized-bed dryers. At caprolactam byproduct plants, relatively small amounts of volatile organic compounds (VOC) are emitted from the dryers.

Some plants use baghouses for emission control, but wet scrubbers, such as venturi and centrifugal scrubbers, are more suitable for reducing particulate emissions from the dryers. Wet scrubbers use the process streams as the scrubbing liquid so that the collected particulate can be easily recycled to the production system.

Table 8.4-1 shows uncontrolled and controlled particulate and VOC emission factors for various dryer types. Emission factors are in units of kilograms per megagram (kg/Mg) and pounds per ton (lb/ton). The VOC emissions shown apply only to caprolactam byproduct plants.

Table 8.4-1 (Metric And English Units). EMISSION FACTORS FOR AMMONIUM SULFATE MANUFACTURE[a]

EMISSION FACTOR RATING: C (except as noted)

Dryer Type	Particulate		VOC[b]	
	kg/Mg	lb/ton	kg/Mg	lb/ton
Rotary dryers				
Uncontrolled	23	46	0.74	1.48
Wet scrubber	0.02[c]	0.04[c]	0.11	0.22
Fluidized-bed dryers				
Uncontrolled	109	218	0.74	1.48
Wet scrubber	0.14	0.28	0.11	0.22

[a] Reference 3. Units are kg of pollutant/Mg of ammonium sulfate produced (lb of pollutant/ton of ammonium sulfate produced).
[b] VOC emissions occur only at caprolactam plants. The emissions are caprolactam vapor.
[c] Reference 4. EMISSION FACTOR RATING: A.

References For Section 8.4

1. *Ammonium Sulfate Manufacture: Background Information For Proposed Emission Standards*, EPA-450/3-79-034a, U. S. Environmental Protection Agency, Research Triangle Park, NC, December 1979.

2. *North American Fertilizer Capacity Data*, Tennessee Valley Authority, Muscle Shoals, AL, December 1991.

3. *Emission Factor Documentation For Section 8.4, Ammonium Sulfate Manufacture*, Pacific Environmental Services, Inc., Research Triangle Park, NC, March 1981.

4. *Compliance Test Report: J. R. Simplot Company*, Pocatello, ID, February, 1990.