PHOSPHATE PART II

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Reference: Shreve's Book Ch. 10, pp. 244-261

Phosphoric Acid Production

- Metallic acid with the chemical formula of (H_3PO_4), also called Orthophosphoric Acid.
- Orthophosphoric acid used in fertilizers industry.
- Diluted phosphoric acid of (28% P_2O_5) concentration are produced daily, depending on the type.
- By acidulation with Sulfuric Acid, Phosphate rock is converted to Phosphoric Acid and Gypsum is a by product.
- The phosphoric acid plant produces the following by – products:

  25% hexa fluorosilicic acid (H_2SiF_6)

  Gypsum, 25-30% free water.

Phosphoric Acid Production

Production

- Phosphate is moved by conveyor belts to Phosphate Crusher, where all particles are having the size of less than 500 micron.
- Powdered phosphate reacts with sulfuric acid in a reactor which produced diluted phosphoric acid and gypsum.

$$3Ca_3(PO_4)_2CaF_2+10H_2SO_4+20H_2O \longrightarrow 6H_3PO_4+10CaSO_4.2H_2O+2HF$$

- The mixture is, then pumped to three incubators, in order to enlarge the gypsum crystals.

Phosphoric Acid

- The resulting solution is filtered, and the diluted phosphoric acid is sent to the acid storage, to be concentrated later.
- The resulting gases from the reaction, which include multiple fluoride compounds, water vapor, and acids, are washed by absorption towers before they are released to the atmosphere.

Phosphoric Acid

- Diluted phosphoric acid is concentrated in heat- exchangers from 28% to 52% in three concentration lines, using vacuum evaporation.
- During this concentration process HF reacts with silica (which is present in the rock in sufficient amounts) producing fluorosilicic acid (H_2SiF_6) in 22% concentration and water vapor.

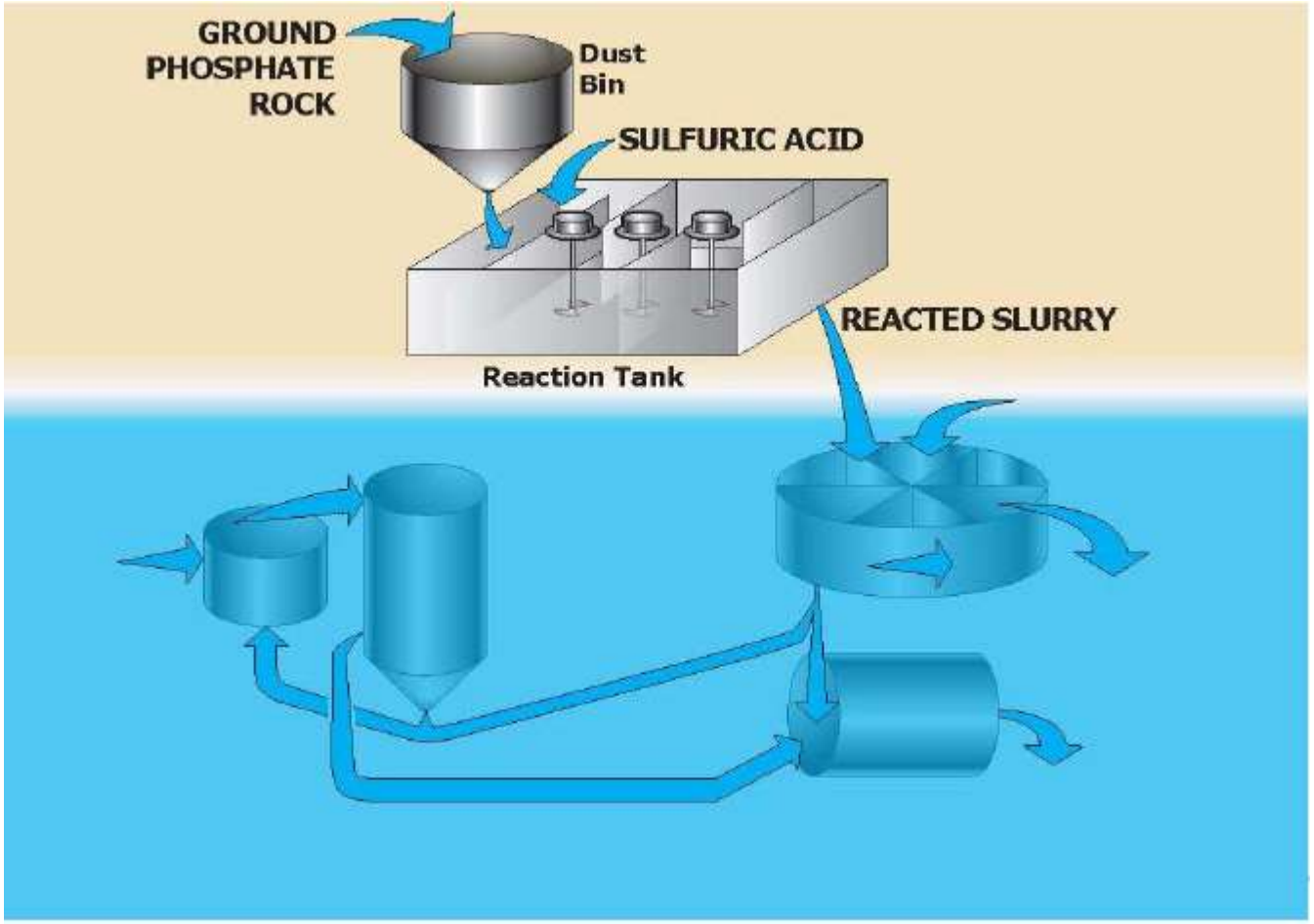
$$6HF + SiO_2 \longrightarrow H_2SiF_6 + 2H_2O$$

- Purification to part of the acid is applied to have part of the final product for exporting as a final product; a minor part is sent to the local market.

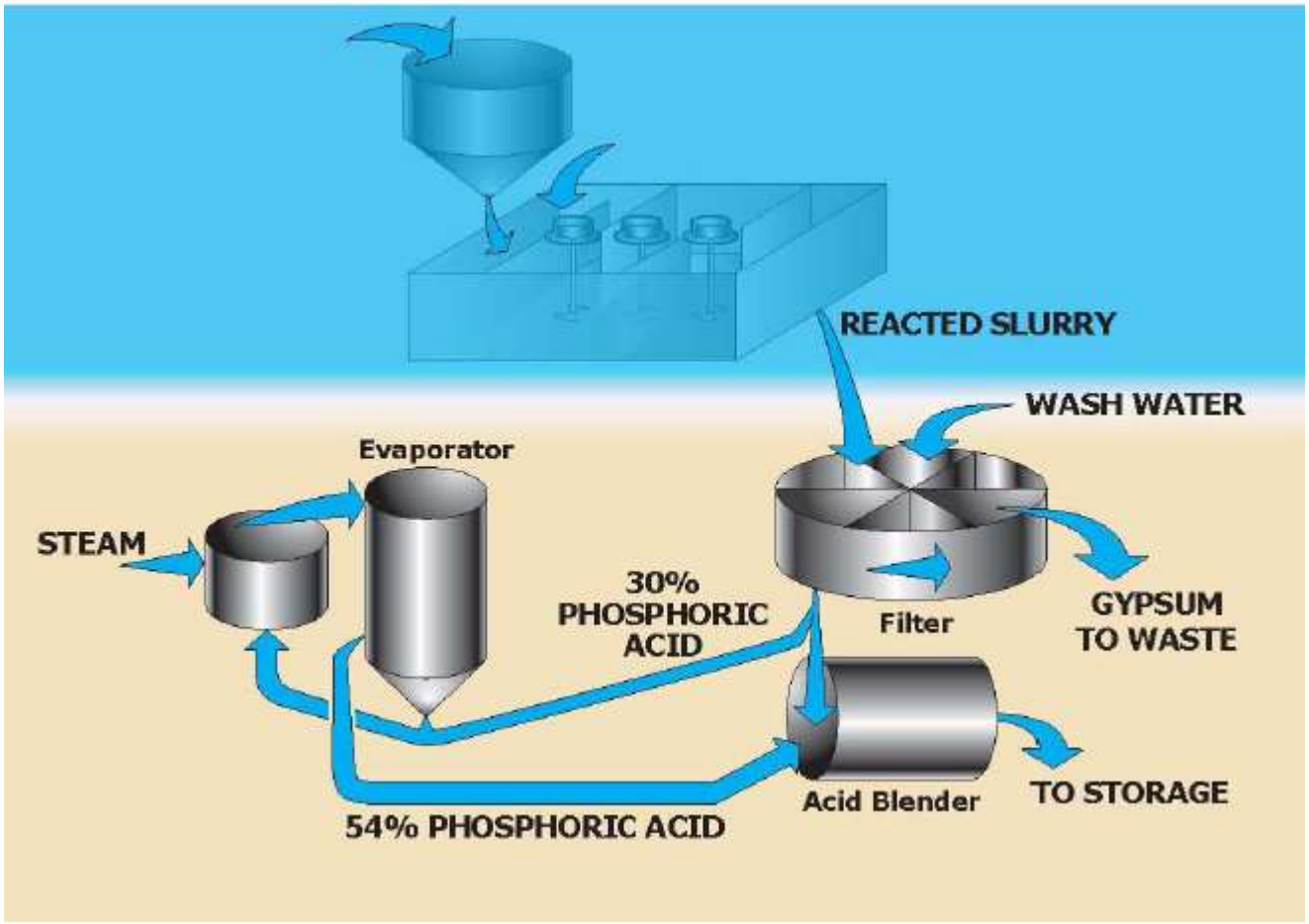
Usages:

Phosphoric acid is an intermediate product for multiple industries such as fertilizers, animal feed, detergents, and some food industries.

Phosphoric Acid



Phosphoric Acid



Environmental Hazards of H_3PO_4 Production

1. Solid waste

- Phosphogypsum (PG) is a waste byproduct produced by phosphoric acid, about 5 tones of PG are generated for every tone of phosphoric acid (H_3PO_4) produced.
- Some impurities naturally present in the phosphate rock become concentrated in (PG), including fluoride compounds, heavy metals such as lead and cadmium, radioactive elements and residual acidity.
- The continued accumulation of (PG) has created urgent pressures to find useful applications for this by-product.

Environmental Hazards of H_3PO_4 Production

2. Liquid waste

- The flouroslisic acid shall be supplied to produce aluminum fluoride.
- Off- grade flouroslisic acid shall be recycled to H_3PO_4 plant.
- Any remaining amount of off- grade flouroslisic acid will be neutralized with limestone to produce calcium silicate.

Environmental Hazards of H_3PO_4 Production

3. Emissions

a. Major emissions from H_3PO_4 production include SiF4, HF, fluorine gas.

- These gases will be collected by ventilation system and the sent to scrubber.

b. The secondary emission is dust originated from handling, grinding of phosphate rock.

- Dust collecting equipment will be installed.

Sulphuric Acid Production

- It is a strong metallic soluble acid at all concentrations, has a chemical formula H_2SO_4.
- Sulfuric acid is produced in two units with 98.5% concentration, and a designed daily capacity of 2,500 tons for each unit.
- Sulfur used in producing sulfuric acid is imported from Arab neighboring countries, Iraq and Saudi Arabia, and from some foreign countries as Russia and Iran.
- Sulfur is stored in a storage facility of a capacity of 35,000 tons.

Sulphuric Acid Production

Production

- Sulfur is dragged from the stores by loaders and fed onto conveyor belts, where it gets melted in special pools by medium-pressure vapor, and adding some materials for purification.
- Lime was used to neutralize sulfur acidity before melting.
- Liquid sulfur is stored in a heat-insulated storage at a temperature of 135 °C.
- Liquid sulfur is pumped into a kiln at a temperature of 1000 °C, where it is burnt with the presence of dry atmospheric air to be transformed into sulfur dioxide in the state of gas.
- As that chemical reaction is an exothermal one, the released temperature is then used in producing high pressure steam (at 46 atm), which conveyed to the Facilities Unit.

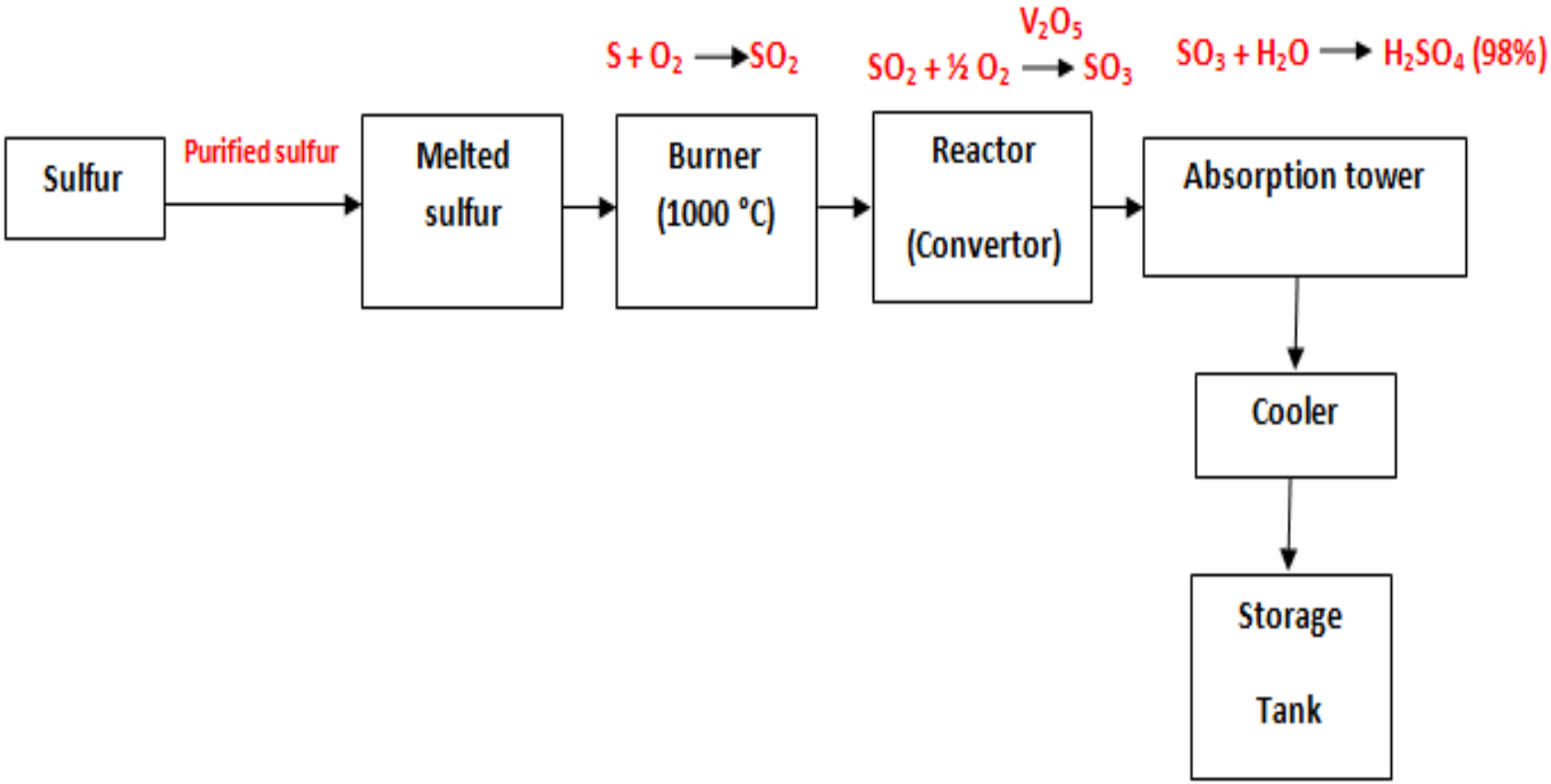
Sulphuric Acid Production

- Sulfur dioxide, cooled to (425°C) and passed in the state of gas into a four-stage reactor containing Vanadium oxide (V_2O_5) as a catalyst, where it is transformed into sulfur trioxide (SO_3).
- That gas is then directed to absorption towers where it reacts with water producing sulfuric acid at a concentration of 98.5%, then, cooled down and stored in two tanks.

Usages:

- Sulfuric acid is used in various industries such as water treatment, batteries, and as a solvent in various industries. It is also used in producing phosphoric acid.

Sulphuric Acid Production



Sulfuric acid production process

Environmental Hazards of H_2SO_4 Production

1. Solid waste

A. Spent V_2O_5 should be carefully dealt since is considered as hazardous material.

- The spent catalyst is sealed in steel or plastic containers and stocked in old mines.

B. Sulfur generated from filtration process(filter cake).

- This waste will be mixed with gypsum and disposed in the gypsum disposal area.

Environmental Hazards of H_2SO_4 Production

2. Emissions

- SO_2 emissions may be originate from bad conversion of SO_2 to SO_3.
- SO_3 emissions may be originate from bad absorption efficiency.
- H_2SO_4 emissions may be originate from mist formation.

Aluminum Fluoride Production

Production

- Aluminum fluoride is produced from fluorosilicic acid coming as waste product from the phosphoric acid plant and Aluminum hydroxide, which is imported from abroad.
- The unit includes the follow steps: $Al(OH)_3$ handling and drying, fluorosilicic acid (H_2SiF_6) heating, reaction, silica filtration, AlF_3 crystallization, filtration, drying, and bagging.

Aluminum Fluoride Production

- By the completion of the reaction, the resulting mixture would be consisting of the solvent aluminum fluoride, and silica sand.
- Sand is then removed by a filtration belt, and disposed onto the belt carrying gypsum from the Phosphoric Acid Unit.
- Aluminum fluoride solution is then sent to 16 crystallizers to be separated by a filtration belt, dried through roasting in special equipment using burnt diesel, and packed according to demand in 25 kg, 50 kg, or 75 kg bags as demanded.
- **Usages:**
- Aluminum fluoride is used in extracting Aluminum from its ores by lowering the melting point in the electrical cells during the manufacturing process.

Environmental Hazards of Aluminum fluoride Production

- Environmental features were installed in most important areas to minimize dust emissions and recycle product (like cyclone and bag filters, and scrubbers).