Phosphoric Acid

Thermal Process and Wet Process are two common methods to produce phosphoric acid in commercial scale. The produced phosphoric acid from phosphor element, by thermal method, is very expensive in comparison with wet method. The produced phosphoric acid by wet method, is proper to use for phosphate fertilizer and animal feed. Also it is possible to make it ready for technical grade and food grade by refining.

A) thermal method

In phosphoric acid producing by thermal method, the phosphor element is burned in contact of extra air, then produced phosphor oxide be hydrated and then after adsorption, hydration and combustion latent heat and produced phosphoric acid dusts are accumulated. Produced phosphoric acid concentration is function of water consumption amount and system cooling power. High temperature in combustion zone, high activity of hot phosphor oxide, high corrosion of hot phosphoric acid and accumulating phosphoric acid particles are common problems of various methods of thermal process.

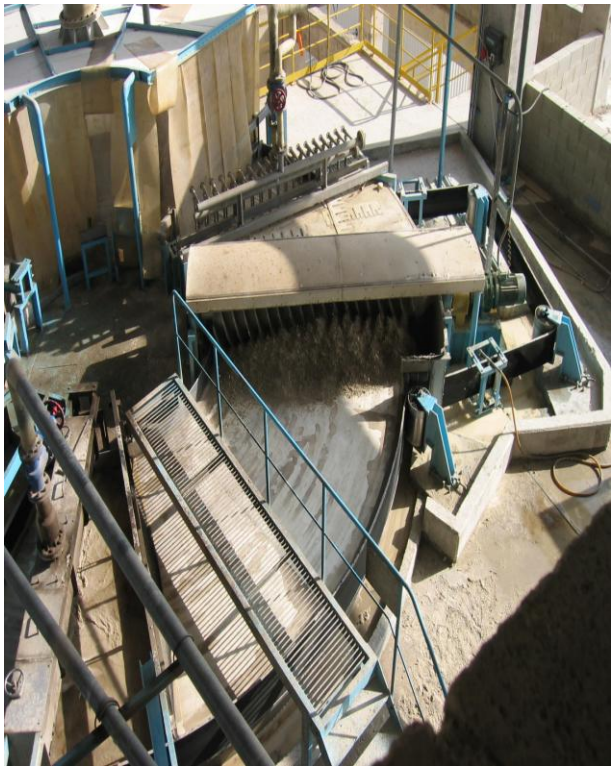
The main processes in thermal method based on the kind of combustion zone cooling are following:

1- Wetted Wall

2- Water Cooled

3- Air Cooled

At the units with wetted wall that have long cylinder shape combustion zone, there is a cooled acid stream down to which causes wall be protected. Phosphor is atomized by compressed air and after spraying in the top of combustion zone, is burned by extra air that is prepared by a fan. In these kind of units, the amount of extra air is about 22% to 25% , to keep volume of produced gases in combustion zone in a certain amount at higher temperature of 2000 (C). The combustion zone is made by refractory material of SS316. The phosphor absorption process is very quick, this is why about 95% is absorbed by reflux stream. Phosphor should be well atomized in the process and required extra air for burning and input phosphor should be controlled to prevent producing of phosphor oxides with less oxidation. The feature of cooling by air unit, is major combustion ceramic refractor zones which causes heat transfers out by radiation and convection method. Used refractory is made by graphite or alumina that because of less heat transfer of alumina, it is used at lower temperatures. There won't be any corrosion until the input gases and used refractory temperatures are more than phosphoric acid dew point. Excess air percent is usually between 1% to 200%, and flame temperature is about 1000 (c) to 1700 (c). Produced hot gases from combustion, be cold and solved by water spraying inside of a chamber which is called hydrator An absorbing layer of carbon or graphite ring which is at top of hydrator to maximum absorption occurs and cool gases to 100 (c). Produced diluted acid from dusts are sprayed on the bed and 75% to 85% phosphoric acid exits from hydrator. As the concentrated acid solubility is much faster than water, in the first step in hydrator, output gases are touched by concentrated acid and then in next steps, are washed by dilute acid and water.



B) Wet method

Gypsum and phosphoric acid are produced by the effect of sulfuric cid on phosphate stone in this method that after filtration and oncentration, are achieved. The most important chemical reaction in wet method which is expressed as follows, can be considered by phosphate stone with fluorine and apatite form.

$$Ca10F2(PO4)6 + 10H2SO4 + 10nH2O \rightarrow 10CaSO4nH2O + 6H3PO4 + 2HF$$

The n depends on hydration in calcium sulfate crystals which could be zero, one, and half. Indeed the illustrated reaction is the sum of two separate reactions. First step, phosphoric acid reacts with patite and as the result phosphate mono calcium is produced.

The next step, phosphate mono calcium reacts with sulfuric acid and as the result phosphoric acid and calcium sulfate are produced.

These two reactions don't need two separate reactors and are able to be done by one. Phosphate stone contains various impurities in structure of apatite and other minerals. The impurities cause different adverse reactions. The most of phosphate stones have a greater ratio of CaO : P2O5 than fluorine and pure apatite, so it causes more sulfuric acid used and more gypsum produced. The produced HF in reaction with other impurities such as Al, Mg, K and Na are compound and create complex compounds from fluorosilicates. Some amounts of fluorine evaporate from system as HF or SiF4. Resulted standard released heat of apatite from the mentioned reaction, which is able to be done by dehydrate method if it be assumed n is 2, is about 240 Kcal/gmol . If the raw materials enter to system at 25 (c) and productions be removed at 82 (c), the energy is used to heat some materials and as the assumption, if there is 100% sulfuric acid, 400 calories are taken for each gram of P2O5 from system.

In the wet process, after extracting of phosphate stone from mine and crushing it to proper size, gypsum and phosphoric acid are produced by effect of sulfuric acid on it and then phosphoric acid is prepared by filtration and concentration. After concentration and filtration, concentration of phosphoric acid gets more from 35% to 54%. At the process, concentration step is not needed. The produced acid in this method, because of the impurities of mine stone is black, so this is why it is used in compounds such as chemical fertilizers that purity is not important.

The required raw material to produce phosphoric acid in this method is equal one tone P2O5, that contains 3.3559 tonns of 74% to 75% phosphate soil and 2.6978 tonns of sulfuric acid.

Based on amount of calcium sulfate hydration, the different processes of wet method follows:

1- Anhydride

2- Hemi-Hydrate

3- Di-hydrate