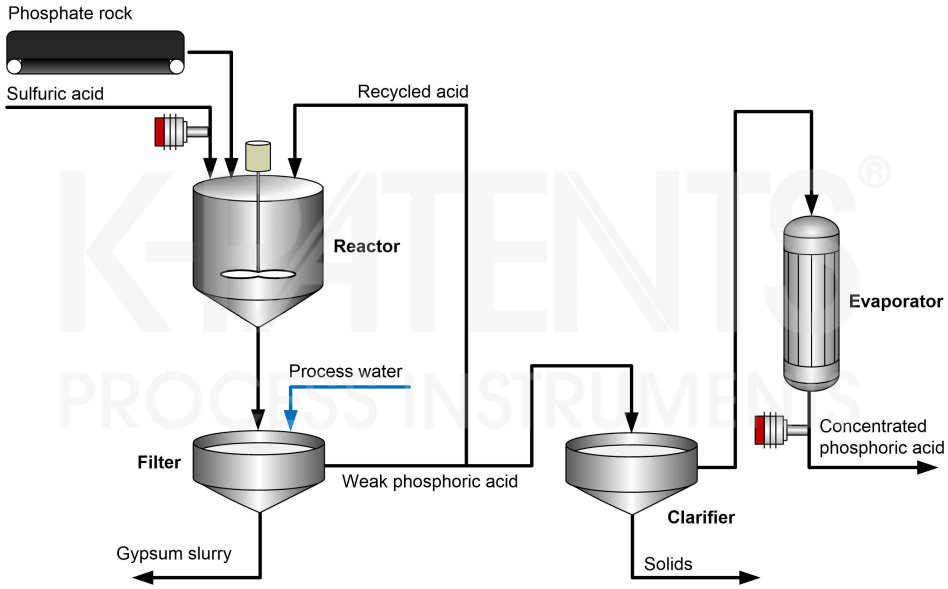
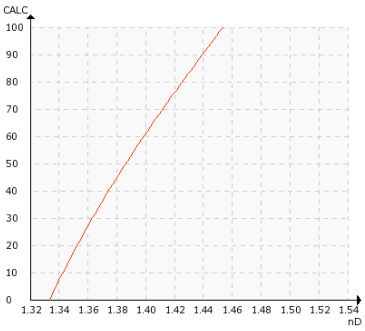


PHOSPHORIC ACID H_3PO_4, SULFURIC ACID H_2SO_4

Typical end products

Phosphoric acid for different industrial applications such as the manufacture of agricultural phosphate fertilizers, detergents, pesticides, metal coating, etc.

Chemical curve: R.I. vs. Phosphoric Acid % b.w. at Ref. Temp. of 20˚C



Introduction

Phosphoric acid (H_3PO_4) is the second most produced inorganic acid in volume, after sulfuric acid (H_2SO_4). It is an important acid used industrially mainly in the production of phosphate agricultural fertilizers. Due to its non-toxic and mildly acidic nature, phosphoric acid is also used in other applications including food flavoring, soft drinks, pharmaceuticals, dental products, cosmetics, and skin care products.

Phosphoric acid is produced by mining the naturally occurring phosphate rock and processing it via a *wet process* or a *thermal process*. The wet process is by far the most common method, as the resulting phosphoric acid is of adequate quality to produce fertilizers. About 80 % of the world's phosphoric acid is obtained by the wet process.

The concentration of phosphoric acid is normally expressed as percent of phosphoric anhydride (% P_2O_5) rather than % H_3PO_4. Phosphoric acid is available as a commercial or merchant grade acid (40-54 % P_2O_5), and high grade acid (75-85 % P_2O_5).

Application

The wet process consists of three main steps: reaction, filtration and concentration. The phosphate rock is first ground and fed to a reactor vessel for an acidulation reaction with sulfuric acid. In the reaction, the tricalcium phosphate in the phosphate rock is converted to phosphoric acid and to the insoluble salt calcium sulfate ($CaSO_4$), also known as *gypsum*.

The concentration of sulfuric acid is carefully monitored and maintained to 93-98 %. Keeping the concentration at the specified level is important as it affects the acidulation reaction rate and crystallization of gypsum. In addition, control of the sulfuric acid concentration ensures the production of the strongest possible acid which reduces the energy requirement at the evaporators.

The next step is filtration. The thick slurry from the reactor contains approximately 30 % of solids particles, mainly gypsum and unreacted phosphate rock. The solids are separated and washed from the phosphoric acid by filtration, and the result is a phosphoric acid of 32 % P_2O_5 (about 50 % H_3PO_4).

Finally, the acid concentration is increased by evaporation to obtain a commercial grade acid of 54 % P_2O_5 (70 % H_3PO_4). Some facilities may perform further purification to obtain a higher-grade phosphoric acid which is suitable for other applications, for example in the food, pharmaceutical and cosmetics industries.

Instrumentation and installation

The concentration of the acids during the wet process can be measured in-line with the K-Patents Process Refractometer PR-43-GP. The refractometer is installed directly in the process line to provide real-time measurement of the sulfuric and phosphoric acid concentrations, eliminating the need for sampling and laboratory titration tests.

At the reactor step, the refractometer is used to monitor the concentration and quality of the sulfuric acid feed. By using the correct sulfuric acid concentration (93-98 %), the factories ensure that only phosphoric acid of high strength is produced and less energy at the evaporators is consumed. Moreover, control of sulfuric acid concentration is necessary to regulate the heat load in the reactor vessel, as well as to control gypsum crystallization. Good crystal shape and size distribution optimize the efficiency of the filtration step, which has impact to the overall productivity of the process.

Another refractometer at the evaporation step helps to reduce operation costs by monitoring the final phosphoric acid concentration. The refractometer's Ethernet and mA output signals can be used for automatic control of the evaporator, ensuring the specified concentration is always obtained, while optimum energy consumption is maintained.

The output of the refractometer can be configured to indicate the preferred concentration unit by the operators, for example percent of sulfuric acid, phosphoric acid, phosphoric anhydride or simply the refractive index value.

Due to its unique digital sensing technology, the measurement of the K-Patents refractometer is not affected by bubbles or suspended solids, and the measurement is selective to the liquid phase. This makes the K-Patents refractometer ideal for measuring acid concentrations also at other points of the process if required, for instance in mid-points between reaction and filtration, or filtration and concentration.

Instrumentation	Description
	K-Patents Process Refractometer PR-43-GP is a general industrial refractometer for pipes and vessel installations. The PR-43-GP can be installed with 2, 3 and 4 inch flange and 3 inch Sandvik L coupling process connections and a variety of flow cells for pipe sizes of 1 inch and larger.
User Interface	Selectable multichannel MI, compact CI or a web-based WI user interface options allow the user to select the most preferred way to access and use the refractometer measurement and diagnostics data.
Measurement range	Refractive Index (nD) 1.3200 – 1.5300, corresponding to 0-100 % by weight.