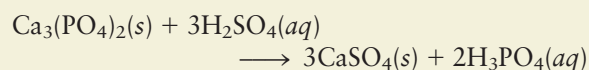


## Sulfuric Acid: The Most Important Chemical

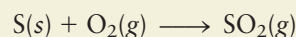
More sulfuric acid ( $\text{H}_2\text{SO}_4$ ) is produced in the world than any other chemical. Over 40 million tons ( $4 \times 10^{10}$  kilograms) of sulfuric acid is manufactured annually in the United States (see photo). Sulfuric acid is used in the production of fertilizers, explosives, petroleum products, detergents, dyes, insecticides, drugs, plastics, steel, storage batteries, and many other materials. The largest amount of sulfuric acid is used in the production of phosphate fertilizers. In this process calcium phosphate,  $\text{Ca}_3(\text{PO}_4)_2$ , in phosphate rock, which cannot be used by plants because of its insolubility in ground-water, is converted to forms that will dissolve in water, thus making the phosphate available to plants. This reaction can be represented as



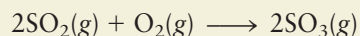
The mixture of  $\text{CaSO}_4$  and  $\text{H}_3\text{PO}_4$  (phosphoric acid) is dried, pulverized, and spread on fields, where the phosphate is dissolved by rainfall.

Sulfuric acid is produced by a sequence of three simple reactions.

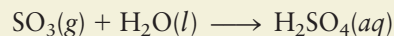
1. The combustion of sulfur to form sulfur dioxide:



2. The conversion of sulfur dioxide to sulfur trioxide:



3. The combination of sulfur trioxide with water:



Over 90% of sulfuric acid is produced commercially by the *contact process*. This term was coined because the sulfur dioxide and oxygen molecules react in *contact* with the surface of solid vanadium(V) oxide ( $\text{V}_2\text{O}_5$ ).

Because gaseous sulfur trioxide reacts so violently with water, it is absorbed during the production process by a sulfuric acid solution rather than by pure water. The sulfur trioxide is added to a flowing solution of sulfuric acid to which water is constantly added to keep the concentration at 98%

sulfuric acid by mass. This is the substance sold as *concentrated sulfuric acid*.

One remarkable property of sulfuric acid is its great affinity for water. For example, when it is mixed with sugar, it dehydrates the sugar (takes the water out) and forms a column of black carbon (see Fig. 19.22). Because of this high affinity for water, sulfuric acid is often used as a drying agent in the production of explosives, dyes, detergents, and various anhydrous (water-free) materials.

The violence with which sulfuric acid and water combine makes the dilution of concentrated sulfuric acid potentially hazardous. The addition of water to the concentrated acid produces a vigorous reaction, which often causes acid droplets to spew in all directions. For obvious reasons, this must be avoided. *Always add the acid to water when diluting* so that any accidental splattering will involve dilute acid rather than concentrated acid. ■



A sulfuric acid plant in Wilmington, North Carolina.