

PERP Program

October 2000

Chem Systems' Process Evaluation/Research Planning program has published a new report, ***Titanium Dioxide (99/00S14)***.

Nature does not yield titanium dioxide (TiO₂) in a form that is usable. Commercially viable titaniferous materials contain as little as 10 percent titanium dioxide and in excess of 95 percent. Most often the titanium is associated with other mineral types and the titaniferous portion is usually bound with an iron compound. Examples of titaniferous materials include ilmenite, leucoxene, rutile, anatase, titaniferous magnetite, vanadiferous magnetite, certain slags and synthetic rutilites obtained by reduction and leaching of ilmenite sands. The term thus generally includes other titanium bearing sands, ores, concentrates, slags, by-products and the like. Raw titanium dioxide can be found in Australia, Brazil, China, Canada, Sierra Leone, India and Sri Lanka, Norway, South Africa and the United States (Georgia).

The most commonly mined forms of titanium as oxide are ilmenite and rutile. Ilmenite beach sand concentrates typically contain titanium dioxide in the range of 40-60 percent along with ferrous oxide, ferric oxide, and residual silica. Ilmenite rock concentrates are generally of lower titanium dioxide yield than sand concentrates. Australian rutile contains upward of 94-95 percent titanium dioxide with the balance chiefly as iron oxides.

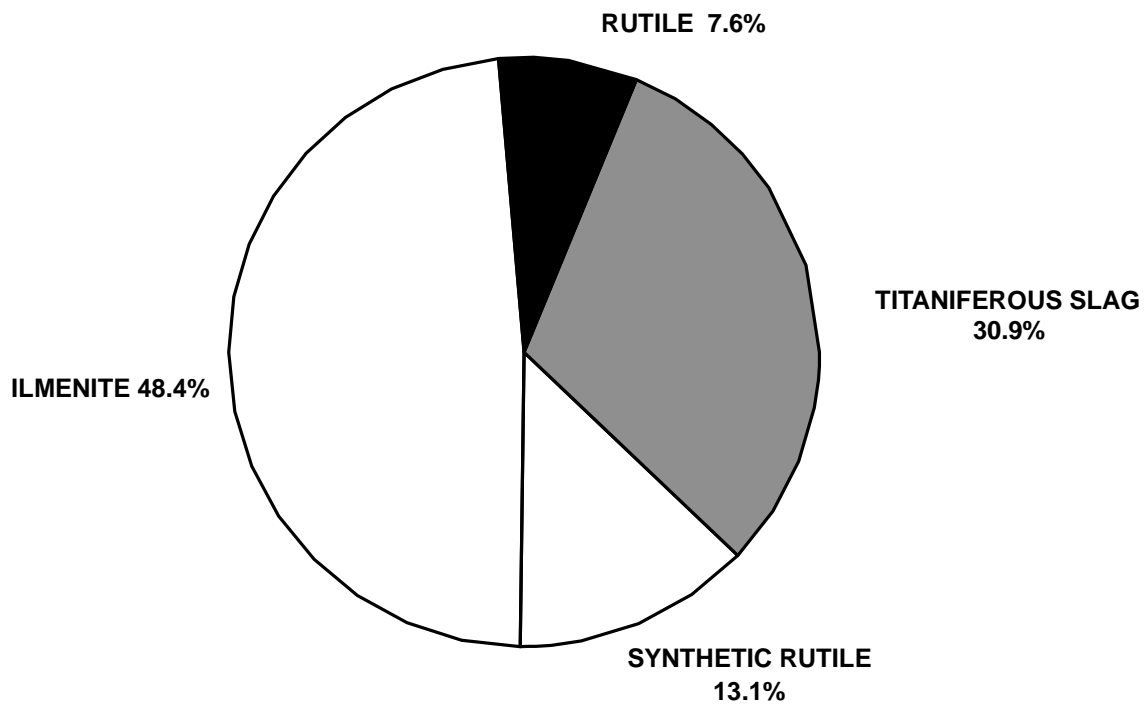
The production of titanium dioxide pigments is a two step process. The first step is to purify the ore, and is basically a refinement step. This may be achieved by either one of two processes – the sulfate process, which uses sulfuric acid as the liberating agent, or the chloride process, which uses chlorine as the liberating agent. In the former, the ore is dissolved in sulfuric acid, the solution is hydrolyzed to precipitate a microcrystalline titanium dioxide, which in turn is grown by a process of calcination at temperatures of 900-1,000°C. In the chloride process, titanium tetrachloride, formed by chlorinating the ore, is purified by distillation and then oxidized at 1,400-1,600°C to form crystals of the required size.

In general both processes provide high quality products having good color (chemical purity) and opacity (mean particle size and narrow size distribution). Rutile and anatase products obtained by the sulfate process generally satisfy extremely high purity applications only after additional purification stages. On the other hand, the commercial chloride process is not capable of providing titanium dioxide in the anatase form. It is this form, however, which is preferred for the production of papers, catalysts and cosmetics.

Once refined, and developed to the appropriate particle size, the pigment may be finished by coating with inorganic oxides or an organic material to give each grade its unique characteristics, that is, to control such properties as dispersion, dispersion stability, gloss and durability.

The choice of ore depends on the production process. The figure on the following page shows that ilmenite is the most widely produced titanium ore and almost 30 percent of the ilmenite is produced in Australia. Ilmenites can be attacked by sulfuric acid and although ilmenites and leucoxenes can be used in the chloride process, ores having higher titanium dioxide contents (rutile) are preferred in order to minimize loss of chlorine in the iron chloride by-product. This is not to say that ilmenite ores cannot be used with the chloride process – it may just require a larger investment. About 20 percent of titanium oxide is from rutile.

BREAKDOWN OF TITANIUM ORE PRODUCTION, 1999



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This report presents process descriptions, flow sheets and economics for TiO_2 production. In addition, regional supply/demand forecasts out to 2010 are given.