SYNTHETIC RUTILE FROM ILMENITE

<table>
<thead>
<tr>
<th>Capacity</th>
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<tbody>
<tr>
<td>Plant and machinery cost:</td>
<td>0.00 Lakh</td>
</tr>
<tr>
<td>Working Capital:</td>
<td>0.00 Lakh</td>
</tr>
<tr>
<td>Rate of return(ROR):</td>
<td>1.00 %</td>
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<tr>
<td>Break Even Point (BEP):</td>
<td>0.00 %</td>
</tr>
<tr>
<td>TCI:</td>
<td>0.00 Lakh</td>
</tr>
<tr>
<td>Cost of Project:</td>
<td>0.00 Lakh</td>
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</table>
Titanium is relatively abundant in the earth’s crust, which is usually found in igneous and metamorphic rocks as ilmenite (FeTiO₃), rutile (TiO₂) and titanomagnetite (Fe₂TiO₄–Fe₂O₄). Ilmenite is a lustrous black to brownish titanium ore, essentially FeTiO₃. Iron-black, heavy, metallic oxide mineral, composed of iron and titanium oxide (FeTiO), which is the major source of titanium. Thus ilmenite has enough titanium in their composition to be considered titanium ore when found in large enough deposits. Ilmenite contains iron, hence can be an iron ore while rutile does not contain iron, and is not an iron ore. Ilmenite forms as a primary mineral in igneous rocks and is concentrated into layers by a process called magmatic segregation. It crystallizes out of a magma relatively early before most of the other minerals. As a result, the heavier crystals of ilmenite fall to the bottom of the magma chamber and collect in layers. It is these layers that constitute a rich ore body for titanium miners. Ilmenite also occurs in pegmatite™s and some metamorphic rocks as well as in the sedimentary rocks that are formed from the weathering and erosion of them. Rutile is an interesting, varied and important mineral. Rutile is also unwittingly of major importance to the gemstone markets. Titanium dioxide or rutile also has high potential applications in environmental purification, gas sensors, and in photovoltaic cells due to its unique characteristics. Natural rutile, owing to its high titanium content and low levels of impurities, has traditionally been preferred as a feed stock for the production of titanium dioxide pigment. Natural rutile is becoming scarcer and consequently more costly and alternative methods that use ilmenite are being favored. Ilmenite concentrates have relatively low titanium content (usually about 50% titanium dioxide compared to about 96% in the case of rutile) but have Fe as their major impurity and thus pose problems for pigment production. Nevertheless, ilmenite has been used as an alternate feed material for production of pigment through chemical routes. Synthetic rutile was first produced in 1948 and is sold under a variety of names while very pure synthetic rutile is transparent and almost colorless (slightly yellow) in large pieces. Synthetic rutile can be made in a variety of colors. They can be made by doping, although the purest material is almost colorless. The high refractive index gives an adamantine luster and strong refraction that leads to a diamond-like appearance. The near-colorless diamond substitute is sold as Titania, which is the old-fashioned chemical name for this oxide. The process of converting ilmenite to synthetic rutile generates 0.7 tons of waste per ton of product, and the chloride process generates about 0.2 tons of waste per ton of TiO₂ product using rutile as a feedstock. In comparison, direct chlorination of ilmenite generates approximately 1.2 tons of waste (primarily ferric chloride) per ton of TiO₂ Synthetic rutile (TiO₂) can also manufacture through the upgrading of ilmenite ore to remove impurities (mostly iron) and yield a feedstock for production of titanium tetrachloride through the chloride process. The chemical composition of synthetic rutile is similar to that of natural rutile, but differs in physical form. Synthetic rutile concentrates are composed of very fine crystals and are porous, whereas natural rutile grains are composed of single crystals. Benelite Cyclic Process to produce synthetic rutile In the Benelite Cyclic process developed by the Benelite Corporation of America, raw ilmenite sand containing 54 to 65% TiO₂ is roasted with heavy fuel oil in a rotary kiln at 870° C. The fuel oil functions as a reducing agent, converting ferric iron (Fe³⁺) in the ilmenite to the ferrous (Fe²⁺) state. The fuel oil is burned at the discharge end of the kiln, and the resulting gases are passed through a cyclone and an incinerator to remove solids and unreacted hydrocarbons. The reduced ilmenite is then batch-digested in rotary-ball digesters with 18-20% HCl at 140° C. Ferrous oxide in the ilmenite is converted to soluble ferrous chloride, and the TiO₂ portion of the ilmenite is left as a solid. Spent acid liquor, which contains excess HCl and ferrous chloride, is sent to an acid regeneration circuit. The TiO₂ solids are washed with water and filtered and calcined at 870° C, yielding synthetic rutile with approximately 94% TiO₂. Exhaust gases from the calciner are treated to remove solids and acidic gases before they are released to the atmosphere. In the acid regeneration circuit, the spent acid liquor is sent to a preconcentrator where one-fourth of the water in the liquor is evaporated. The concentrated liquor is sprayed through atomizers, causing the droplets to dry out, yielding HCl gas and
ferric oxide powder. The gas is cycloned and then sent to an absorber to remove HCl for reuse. The ferric oxide powder is slurried with water to create the waste stream iron oxide slurry. Synthetic rutile (TiO2) is manufactured through the upgrading of ilmenite ore to remove impurities (mostly iron) and yield a feedstock for production of titanium tetrachloride through the chloride process. The chemical composition of synthetic rutile is similar to that of natural rutile, but differs in physical form. Synthetic rutile concentrates are composed of very fine crystals and are porous, whereas natural rutile grains are composed of single crystals.  

**SYNTHETIC RUTILE PROPERTIES**

**Chemical Composition:** Titanium Dioxide - TiO2  
**Classification / Type:** The material is found abundant as inclusions (silk, needles, crystals, etc.) in number of gemstones preferably in quartz, tourmaline, ruby and sapphire but large facet table crystals are quite rare therefore gemological importance lies in the synthetic counterpart produced by flame fusion method. Colors / Varieties: All colors, generally colorless with a yellow tinge. Crystal System / Forms: Tetragonal System.  
**Geological Occurrence:** Natural rutile as inclusions in quartz, tourmaline and corundum. Cuts & Uses: Facetted cuts, etc. USES Synthetic rutile is the preferred feedstocks for production of titanium tetrachloride which is used for sponge and metal production. Because it is relatively free of impurities, fewer wastes are generated using rutile and synthetic rutile to produce titanium tetrachloride and titanium dioxide pigment than with ilmenite. Rutile is a major ore of titanium, a metal used for high tech alloys because of its light weight, high strength and resistance to corrosion. Rutile is seldom used in jewellery because of its less hardened property. Rutile has minor uses in porcelain and glass manufacture as a coloring agent and in making some steels and copper alloys. Rutile is also used as a gem, but artificial rutile produced by the flame-fusion (Verneuil) process is superior to natural crystals for gem use. The artificial material has a yellow tinge, a very high index of refraction, and high dispersion; hence it shows fire and brilliance like that of diamond. Synthetic gems can be produced in various colours by the addition of appropriate metal oxides before fusion. Synthetic rutile is used for coating welding electrodes and for manufacture of titanium tetrachloride which in turn is used in making titanium sponge.  

**MARKET SURVEY** Iluka is the world’s largest producer of synthetic rutile, accounting for approximately 66% of global production in past years. Synthetic rutile prices have risen more strongly, up by around 12%, and ilmenite prices have increased by around 8%. Indian Synthetic Rutile Plants are based on reduction roasting followed by acid leaching with or without generation of hydrochloric acid. The continuing objective of Austpac is participation in a large scale synthetic rutile plant based on India’s large, high grade heavy mineral resources. TiO2 market analysts predict an increased demand for high grade feedstock for TiO2 pigment manufacture in past years. Austpac and Ticor are therefore now examining alternatives for the initial plant that will allow a large scale facility to meet the predicted market window for synthetic rutile. CMRL (Cochin Mineral and Rutile Ltd.) is manufacturing the best quality Synthetic Rutile across the World. CMRL is India’s largest manufacturer of Aqua Ferric Chloride which conforms to all major International Standards.
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