OAKDENE HOLLINS
RESEARCH & CONSULTING

REPORT SUMMARY

April 2008

Sustainable Innovation, Waste Economics, Low Carbon Technologies

Titanium Production Cost Analysis for a New Technology

Oakdene Hollins investigates the cost of producing Titanium sponge from Kroll and $FFC_{CAMBRIDGE}$ processes for a possible competing technology based on alkali metal oxide.

A comparison of cost analysis for the production of sponge Titanium via the well-established Kroll process and upcoming new technology on the basis of molten salt electrolysis (the $FFC_{CAMBRIDGE}$ process) were conducted on the basis of electricity, materials, consumables, equipment, labour and environment. The project was commissioned to help asses the economics of a novel reduction process, called alkali metal oxide (AMO) process, for Titanium sponge production.

The Kroll process cost is $15.38/kg Ti versus $10.13/kg Ti for $FFC_{CAMBRIDGE}$ process (Figure A). This analysis does not take the quality of the final sponge product into account when costing the process.

For a 10,000t capacity plant, the profit margin for the $FFC_{CAMBRIDGE}$ process is $5.87 per kg Ti sponge produced compared with $0.62 for Kroll process with the current sponge prices of $16.0 per kg (April 2008). This large profit margin can cushion any fluctuations on the cost of process variables especially the materials costs, mainly the purchase price of TiO2. On the other hand, energy is the major cost for the Kroll process and the baseline cost can be reduced if low cost energy is secured for any investment.

However it should be borne in mind that $FFC_{CAMBRIDGE}$ process has not been scaled up to the levels analyzed here and there was no commercial plant in operation yet at the time of writing this report. Therefore a reasonable uncertainty factor should be given to any investment decision. The Kroll process is still the major production method for sponge production and there has been plenty of investment utilizing this technology. It is a well established technology so the cost reduction is very limited. Increase in the annual production volume seems to be the only way to have any leverage on the profit margins. That is why most of the new investment projects are not less that 10,000t per year as was the case for our cost model.

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Background to this report:

Titanium is the ninth most abundant element, making up about 0.6% of the earth's crust. The majority of processes for the recovery of titanium dioxide from ores involve digestion of the ore in a mineral acid such as hydrochloric acid or sulphuric acid to remove the titanium values from the ore. Approximately 95% of titanium is consumed in the form of titanium dioxide concentrate, primarily as a white pigment in paints, paper, and plastics. The remaining 5% of the world's titanium is used as the metal, due to its exceptional properties.

Commercial production of titanium metal involves the chlorination of titanium-containing mineral concentrates to produce titanium tetrachloride ($TiCl_4$), which is reduced with magnesium (Kroll process) or sodium (Hunter process) to form a commercially pure form of titanium metal. As the metal is formed, it has a porous appearance and is referred to as sponge. Existing thermo-chemical processes require handling of large volumes of magnesium and chlorine and hold little potential for significant cost reductions and environmental beneficiation beyond current technology.

To overcome the cost limitations, various alternative production processes have been developed. These processes reduced the stages involved to three compared to four of the established Kroll process: Direct purification of Titanium dioxide via the chloride process, reduction and vacuum arc melting. Currently, the electrolytic reduction route is being exploited by the FFCCAMBRIDGE process where medium temperature de-oxidation in molten salt of TiO_2 to Titanium metal takes place.

About Oakdene Hollins:

Oakdene Hollins is a research and consulting company working to support change toward more sustainable and less carbon-intensive products, processes, services and supply chains. The business sectors we work with include Food & Drink, Textiles & Clothing, Metals & Mining, Construction, Wastes Management, Nanotechnology and European & UK Policy. We have built a strong reputation for integrity, reliability and excellence with public sector and private industry clients alike. We operate at a European scale and manage the Ecolabel scheme in the UK in collaboration with TUV/NEL.

Oakdene Hollins employs people with science, economics, business administration and manufacturing disciplines, so that within each industry sector we can offer the following core services:

- Market appraisal
- Technology appraisal
- Protocol and standards development
- Economic modelling
- Lean manufacturing projects
- Financial impact assessment
- Management of research projects
- Ecolabelling advice
- Carbon footprinting
- Critical review of life cycle assessments.

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