EXTENDED ABSTRACT - 17

ESTAÑO, Xi AND TIN
43 YEARS (AND COUNTING) OF TSL SMELTING

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Top Submerged Lance (TSL) technology was invented in the early 1970’s at CSIRO in Clayton, by a team led by Dr John Floyd. It was initially developed for reduction of tin reverberatory furnace slags and the first commercial furnace at Associated Tin Smelters in Sydney was installed for this purpose in 1978. This plant was also used to develop tin concentrate smelting at commercial scale before closing due to the collapse of the tin price in the late 1980’s. The technology was then adapted and used in a wide variety of non-ferrous applications but has still managed to maintain contact with its origins in tin. To date some 65 commercial TSL plants have been built by Outotec/Ausmelt, which excludes the Isasmelt contribution to TSL plants. In 1989 HMIB constructed and operated a small TSL tin smelter in Arnhem, Holland. This plant had a relatively short lifespan as local regulations forced the closure of the complex which included a lead smelter. Funsur constructed a greenfield TSL tin concentrate smelter in 1996 in Peru which was followed by YTCL in China in 2000. Following a lull of a few years, China Tin commissioned a TSL tin smelter in 2013 which will be followed by Vinto, Bolivia in 2014.

China Tin Project Background

Guangxi China Tin Group Co., Ltd (China Tin) commissioned Outotec in early 2010 to establish an Ausmelt tin smelter to replace the existing three reverberatory furnaces and expand the production as well as address the environmental situation, within its existing operation at Laibin, Guangxi Zhuang Autonomous Region in the People’s Republic of China.

China Tin Design

The TSL furnace system was designed to treat sufficient tin concentrates (roasted cassiterite) to produce 17,500 tonnes per annum of tin contained in crude bullion (~96% Sn), excluding the contribution to the tin production from all recycled and revert materials, and a slag with low levels of contained tin (3% Sn) in a single TSL furnace. The process route used was the typical two stage batch process, shown schematically in Figure 1. The slag is further processed in existing box fuming furnaces to maximise tin recovery. Fume from both the TSL furnace and box fumer was recycled to the TSL furnace along with typical refinery revert materials.

China Tin Hot Commissioning

The plant was commissioned in February-April 2013 and reached its design capacity within six (6) days after the commencement of concentrate smelting. The remainder of the hot commissioning time was spent on process optimisation and operator training. The Acceptance Certificate was signed on site in six (6) weeks acknowledging successful commissioning of the tin smelter and completion of the project. The commissioning of the
China Tin smelter went very well and is a reflection of the maturity of the technology, the well rounded knowledge of the process and engineering solutions to known issues. After the commissioning the plant has continued to operate well with the only real problem being a shortage of concentrates.

![China Tin Process Flowsheet](image)

**Figure 1:** China Tin Process Flowsheet

**Vinto Project**

Empressa Metalurgica Vinto (Vinto) commissioned Ausmelt to design a TSL furnace to process local concentrates to produce 38,000 tonnes of tin a year. The project is a modernisation of the plant to replace an existing reverberatory furnace. The proposed process is the conventional two stage process represented in Figure 1, with the addition of oxygen enrichment to increase the smelting intensity. The process fuel for this plant is natural gas. For this project, the reduction stage is increased in duration and intensity to produce a low tin slag suitable for discard without the need of separate treatment in a fuming furnace. The local concentrates contain a significant level of sulphur which will be a challenge to manage as this increases the fuming of tin. The plant is expected to be commissioned in 2014.

**Tin Market**

Tin, like copper, was one of the first metals mined and its many qualities such as its shiny finish made it a highly sought after commodity. Today, its main uses include the production of solder and the tin plating of iron and steel products. Tin is also used in the production of bronze, pewter and die-casting alloys and in modern engineering to make tungsten more machineable. 383,500 tonnes of tin was produced in 2011 [www.lme.com]. The combined annual production of the Ausmelt TSL tin furnaces will be 125,500 tonnes when Vinto starts production next year, which is 33% of the world’s production. The tin concentrates fed to all the TSL tin furnaces are all classed as medium grade, containing typically 40-60% tin. These
concentrates make a significant quantity of slag which is easily handled in the TSL system. Higher grade alluvial concentrates are typically smelted in electric or reverberatory furnaces the slag make is small. Tin containing materials with less than 40% tin are less suited to direct smelting due to the large volumes of slag generated. These materials are typically smelted with a source of sulphur and the tin fumed, producing an oxide fume which is subsequently remelted to metal.

A TSL furnace is suited to both the concentrate fuming and resmelting of the fume to metal. Several projects based on tin fuming have progressed to pilot plant and demonstration plant testwork however none have proceeded to commercial scale at this time. It is expected that as the supply of supply of high and medium grade gets tighter the lower grade materials will become economic.