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ISASMELT™ TSL – Applications for nickel

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ABSTRACT

The ISASMELT™ process is a top submerged lance (TSL) bath smelting technology which has been developed and optimised over the last 25 years. By the end of 2011, the total installed capacity of the ISASMELT™ technology will exceed 9,000,000 tonnes per year of feed materials in copper and lead smelters around the world. The technology is equally effective for smelting nickel sulfide concentrates, converting nickel mattes, and producing ferronickel from lateritic ores. This paper demonstrates how the features that make ISASMELT™ attractive for copper and lead smelting may be applied equally to nickel smelting and converting operations. Conceptual flowsheets are presented, supported by results from recent pilot plant and bench-scale testwork.

1. Introduction

The introduction of lance technology has enabled the use of stationary furnaces of simple design and very high reaction rates. The prior art involved the injection of gases into liquid slags or mattes predominantly through tuyeres, with inherent design complications and refractory problems. The top submerged lance (TSL) bath smelting technology was developed to commercial success at the Mount Isa smelting complex in Australia in the early 1990s, and subsequently called "ISASMELT™". Development of the process has focussed on smelting of lead and copper concentrates or secondaries over the last 30 years and commercial ISASMELT™ furnaces operated by Xstrata and external licensees currently have a combined annual smelting capacity exceeding 9,000,000 tonnes of feed.

2. The ISASMELT™ process

ISASMELT™ technology is based on a furnace design which is readily enclosed to eliminate emissions to the surrounding environment. It uses submerged lance injection technology to provide highly efficient mixing and reaction of feed materials in a molten slag bath. The use of advanced process control systems results in the furnace operation being largely automated. Being a vertical furnace, a very small footprint of floor space is required to accommodate the plant and so it can generally be easily retro-fitted into existing smelters to either augment or replace existing technology. The process concept is shown in Fig. 1.

During 30 years developing and operating submerged lance technology on large scale plants, significant technical improvements have occurred in areas such as furnace design, feed preparation systems, off-gas handling, operating and process control strategies, refractory management and operator training. The combined experience led to what is well recognised by the marketplace today as the "ISASMELT™ technology package", a technology package licensed to external clients – Burford (2009). Many of the improvements implemented by plant operators have been passed onto, and adopted by, other licensees. Exchange of ideas and technical improvements occurs through ad hoc visits to fellow licensee sites and through regular licensee workshops arranged by Xstrata Technology. Fig. 2 shows the location of the commercial plants that have been licensed to date.

3. Agip nickel ISASMELT™ plant

It is less well known that the ISASMELT™ process was also adapted for the treatment of nickel bearing feeds at a very early stage of its development. A large amount of pilot-scale testwork was completed during the 1980s on nickel deposits owned by Mount Isa Mines Ltd. Testwork was also performed for AGIP Australia Pty Ltd., who owned the Radio Hill deposit in Western Australia – Bakker et al. (2009). In 1991, AGIP decided to construct a semi-commercial ISASMELT™ plant to produce nickel–copper matte from concentrate feed. This was the first ISASMELT™ plant built and commissioned for an external client. Earlier in 1991, the first commercial-scale ISASMELT™ plant had been commissioned to produce lead bullion from concentrates in Mount Isa. A year later, two commercial-scale ISASMELT™ plants were commissioned to produce copper matte from concentrates; one in Mount Isa and the other in Miami, Arizona.

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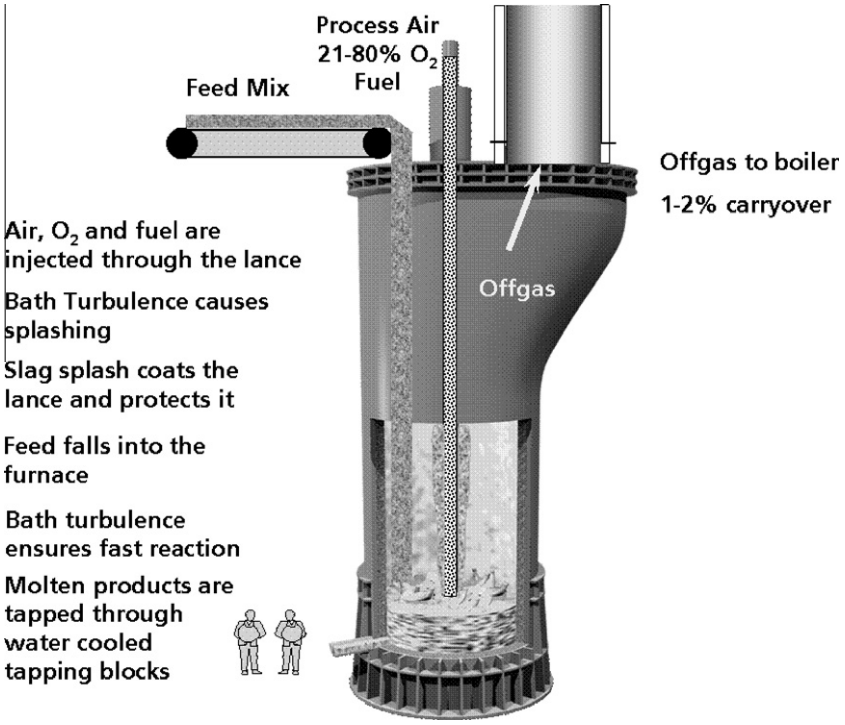

Fig. 1. The ISASMELT™ concept.

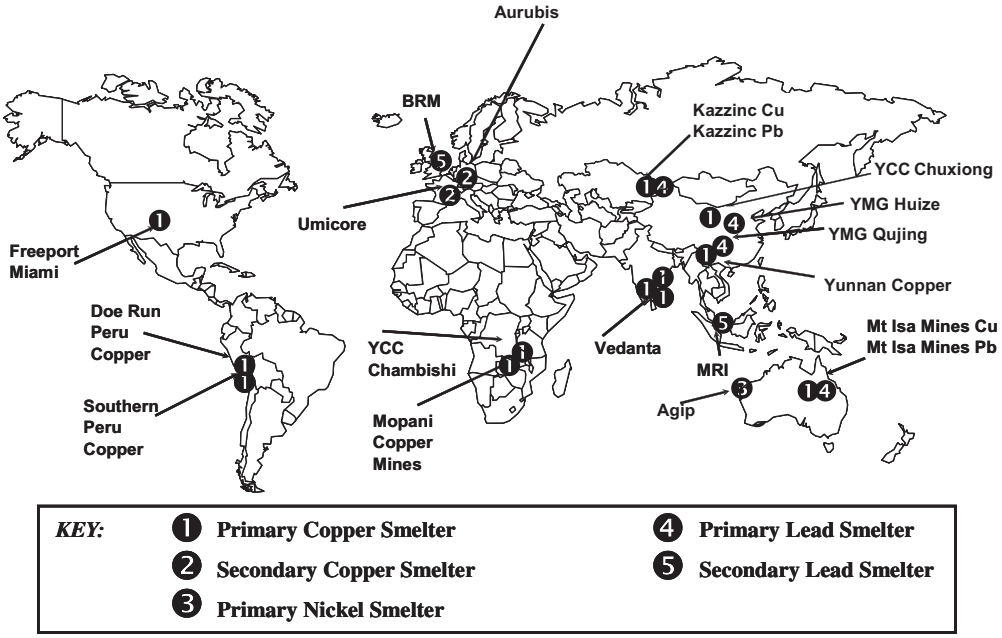

Fig. 2. ISASMELT™ plant locations.

The AGIP nickel ISASMELT™ commercial-scale plant was commissioned in September 1991 and within 3 months was running at design capacity of 7.5 t/h concentrate – Arthur and Hunt (2005). It produced 45 wt% nickel/copper matte from a concentrate containing approximately 7 wt% nickel and 3.5 wt% copper. Photographs of the plant are shown in Fig. 3 – Bakker et al. (2009). At the time, the plant was deemed a technical and operational success, however due to a large drop in nickel price, the facility was forced to close near the end of 1991; the plant has since been demolished.

4. The ISACONVERT™ process

A combination of pilot plant copper and nickel–copper continuous converting trials and the commercial batch copper converting operations show the ISASMELT™ furnace to be well suited to the duty of continuous converting – the ISACONVERT™ furnace – Edwards and Alvear (2007).

The ISACONVERT™ technology is based on the same design as the ISASMELT™ furnace which allows it to be readily enclosed to eliminate emissions to the surrounding environment. It uses the