



Aerial view of the NZAS smelter in New Zealand.

New Zealand Smelter Achieves Record Productivity While Undertaking Energy Efficiency Programs

The primary aluminum industry has been facing tough market conditions in recent years, due to low London Metal Exchange (LME) prices and high power costs. Faced with these challenges, many primary aluminum smelters are hunkering down in order to survive, focusing on cost reductions and cutting off investments.

New Zealand's Aluminium Smelter (NZAS) on the Tiwai Peninsula in New Zealand is no stranger to these challenges. "Ongoing low aluminum prices combined with a resolutely high New Zealand dollar continue to make commercial conditions difficult for NZAS," explained Gretta Stephens (Figure 1), chief executive and general manager, NZAS. "Over the course of the 2015 financial and calendar year, the cash price for aluminum on the LME was an average of 12% lower than the previous year."

Despite this, NZAS is taking a proactive approach to industry challenges by investing in new technologies, aimed at improving their operations and differentiating themselves from competitors. This includes the implementation of a large number of energy-saving projects across the entire site, as well as the installation of new stirring technology.



Figure 1. Gretta Stephens.

Company Profile

NZAS is New Zealand's only aluminum smelter and has been in operation for 45 years. The smelter is 79.36% owned by Pacific Aluminium (a wholly owned subsidiary of Rio Tinto) and 20.64% owned by Sumitomo Chemical Company, based in Japan. The facility has four reduction lines, with lines 1-3 each containing 208 individual cells and line 4 containing 48. Line 4 has been idled since April 2012 due to the continued deterioration of market

conditions, although restart options will be considered when economically viable. The plant operates two ingot casting machines and two VDC casting pits, and it employs close to 800 permanent personnel and contractors.

Energy for the facility is sourced from Manapouri Power Station, a hydro power plant that is part of the country's national electricity grid; and alumina is sourced from Queensland and Western Australia. Due in part to its reliance on hydro power, the NZAS smelter is able to achieve a low carbon footprint.

"The company's vision is to be recognized as the premium supplier of pure, hydro-powered aluminum to the world, with its core objective to be a sustainable business that benefits our people, community, and New Zealand for the long term," said Stephens. "We produce a wide range of value-added products, representing around 87% of production, including specialty billet, high purity ingot, and foundry alloys that are cast from low carbon footprint aluminum." NZAS is one of the few smelters in the world capable of producing ultra high purity aluminum in grades >99.97% Al (see article on page 38).

NZAS produced 335,292 tonnes of saleable primary aluminum in 2015 in the form of ingot, billet (Figure 2), rolling block, and T-bar products. Approximately 90% of the aluminum produced at NZAS is exported, with 56%



Figure 2. Aluminum billet produced at NZAS.

exported to Japan in 2015. Other regions included Europe, Asia, South America, and Canada.

Although the smelter's original technology dates from the late 1960s, the company has been continually adapting and innovating to ensure the smelter retains its high level of efficiency. The energy improvement programs undertaken at the facility culminated in an efficiency improvement of 0.17 MWh/t Al 2015 compared to the previous year—a considerable improvement in power efficiency for NZAS.

Energy is key, since power cost is an ongoing challenge for the smelter. "A challenge we can't fix on-site is the relatively high price NZAS pays for electricity and transmission, which is well above the international industry standard and one of the highest faced by a smelter anywhere in the world outside of China," said Stephens, who noted that New Zealand government's electricity system regulator is currently reviewing how transmission costs are charged to customers. "We believe this reform is more important than ever, with our transmission costs projected to hit \$70 million in 2017. Most smelters, especially those located close to their source of power, pay considerably less."

New Stirring Technology

In 2011, NZAS began looking at magnetic stirring to improve the performance of one of its Furnace Engineering holding furnaces dedicated to heavily alloyed products. "Stirring provides a tool that can lower direct costs, increase productivity, and therefore increase profits," said Don Faulkner, project engineer, NZAS. "In an industry that has maximized efficiencies in most other areas, stirring is one of the remaining areas where opportunities for improved productivity are still available."

The company considered a number of stirring options, including electromagnetics and permanent magnetic circuit based technologies developed by Zmag in Japan and distributed by Zmag America in the U.S. After due diligence was carried out, along with cost estimations, NZAS selected the MagStir stirrer with Zmag permanent magnetic circuit (zPMC) for its furnace. In 2011, when the new MagStir system from Zmag was installed, NZAS was the first smelter in the world to use this type of stirrer.

MagStir is a noncontact stirring technology that creates a current within the melt via a proprietary zPMC permanent magnetic circuit, which produces an eddy current and force field to stir the molten aluminum. Since a permanent magnetic circuit is used, no energy is required to create the magnetic field and no water or large air cooling system is required as with electromagnetic systems. "This system has all the benefits of an electromagnetic stirrer without the associated ongoing costs," said Faulkner, who noted that maintenance of the system is minimal. He also said that the stirrer reduced dross in the furnace by approximately 25% when using heavily alloyed products (the smelter has around 30 different product mixes, so data varies depending on how the furnace is prepared).

With this first stirrer, homogenization of the bath in the furnace (hearth and surface temperatures becoming the same) occurs within minutes of initiation of metal fill, which saves on furnace preparation time. Temperature homogeneity from the top-to-bottom of the melt (900 mm/35.4 inch metal depth within the furnace) is maintained within a differential of $\pm 1^\circ\text{C}$ from its set-point. Other benefits noted by Faulkner included a reduction in heavy fuel oil usage due to temperature homogenization and a reduction in manual skimming time.

The results obtained from the installation of the first stirrer prompted NZAS to install two additional MagStir



Figure 3. Standing in front of the two furnaces recently upgraded with new stirring technology (L-R): Eishin Takahashi, Zmag, and Don Faulkner, NZAS.

stirrers on their 50 ton and 65 ton tilting melting/holding furnaces in 2016 (Figure 3). The two new stirrers (Figure 4), which have 22 kW electric motors to run the unit (actual consumption is only 15 kW/h), are slightly smaller than the first one, and also rotate the zPMC differently (on a horizontal plane). The new stirrers will be able to provide higher speed rates, as well as improve productivity (similar to the 2011 stirrer, which increased production from 6 to 7 casts in a 24 hour day, a 16.7% increase).



Figure 4. One of the two newly installed MagStir permanent magnet stirrers. Because the stirrer is non-contact, it was installed underneath the furnace.

"The results are excellent and will change our process significantly," said Faulkner. For example, NZAS is currently working on being able to alloy the furnaces without tooling as part of a Six Sigma greenbelt project, which would enable the company to use the MagStir to stir in alloying elements without the use of a separate stirring tool. NZAS is also working to optimize burner control to limit their usage during certain processes.

Energy and Environment

Despite the challenges faced by the primary aluminum industry, NZAS has continued to strive for operational efficiency and even achieved a hot metal tonnage record of 333,292 tonnes from its three pot lines in 2015 (5,897 more than its previous record). Prudent strategic capital investment in energy improvements, such as a new stirring technology, are key to the smelter's long term survival.

These improvements also contribute to important environmental benefits, which enable NZAS to have its products marketed under Rio Tinto's RenewAl brand (through which metal is externally certified to have smelting emissions of less than 4 tonnes of CO₂ per tonne of aluminum). The brand is designed to guarantee that the aluminum products are produced with electricity from low carbon sources and using world-class smelting processes—NZAS is one of a few smelters that can market under this brand. "NZAS has one of the lowest carbon footprints of a smelter anywhere in the world," said Stephens. "As the world moves towards a lower carbon future, the RenewAl brand can help NZAS take advantage of growing demand for high quality aluminum to be used in more sustainable low carbon products."