New Platform for Aerospace Aluminum in India

Figure 1. Attendees from around the world at HAAL's open house.

An open house for the Hindalco-Almex Aerospace Limited (HAAL) greenfield casthouse took place at the new facility in Aurangabad, India on March 4, 2010 (Figure 1). The state-of–the-art facility is designed to manufacture aluminum billet for aerospace, defense, and other specialized applications. The construction of such a facility in particular is recognition of the growing importance of the Indian market to the global aerospace industry.

The celebratory event numbered delegates from twenty companies, including various downstream and end customers of HAAL from the aerospace sector (Figure 2). The impressive mix of attendees represented the forging, extrusion, and machining sectors, as well as representation from system integrators and OEMs. Attendees from overseas and various parts of India made their way to this Western India town, (approximately 200 miles from Mumbai) in the state of Maharashtra. Aurangabad, already an important tourist hub and key manufacturing base for the automotive and pharmaceutical sectors, now has an additional tag of being a vital center for aerospace grade aluminum production in India.

The day started with a presentation by HAAL executives, followed by a tour of the facility. The delegates were taken through all the critical details, physically witnessed the casting process, and were briefed about the stringent quality control measures in place at HAAL. The second half of the day was devoted to a gala luncheon, where executives from Boeing, Northrop Grumman, United Technologies, Goodrich Aerospace, and Weber Metals had the opportunity for one-on-one meetings (Figure 3).

Figure 2. HAAL welcomed a few U.S. visitors to the plant: (L-R) Gracewil D'Souza, HAAL; Eileen Gendron, Northrop Grumman Corporation; and Dr. Enrique (Rick) Sampson Jr., The Boeing Company.

Figure 3. Discussion during lunch: (L-R) Shashi Maudgal, executive president-marketing, Hindalco; Abhey Agarwal, ceo, HAAL; Gracewil D'Souza, head sales and marketing, HAAL; and Rick Creed, president, Weber Metals.

Background and Scope of Project

HAAL is a joint venture (JV) between Hindalco Industries Limited (70%) and Almex USA Inc. (30%) specially designed to manufacture 2xxx and 7xxx series aluminum alloys. Hindalco is one of the leading primary aluminum producers in Asia and one of the world's largest flat rolled products companies. Almex is a world leader in hard aluminium alloy casting technology with headquarters in Long Beach, CA. The JV was formed in November 2006 and a site purchased in early 2007 with construction following soon thereafter.

The new facility was commissioned in November 2008 and has a capacity to manufacture 12,000-tons per year of hard alloys, with an eventual capacity of 46,000 tons per year to be reached in four phases. The facility presently manufactures aluminum alloy billet with plans to manufacture slab at a later date. Product range is beyond the scope of a normal casthouse, both in terms of type of alloys and sizes. HAAL's billet tooling covers the entire range of sizes in the industry, starting from 178 mm (7″) diameter, going up to 1060 mm (41.5″) diameter. Some of the alloys cast include 2014, 2024, 2219, 5083, 6061, 7005, 7010, 7020, 7040, 7050, 7075, and 7175. Additionally, HAAL has the capability to cast alloys as per customer's required specifications. All billets are supplied in homogenized, machined, and ultrasonically tested condition.

New Line Supports Critical Casting Process

Phase I output of the casthouse is produced on a single casting line comprised of a melting furnace (Figure 4), metal transfer system, metal purification and refining systems, casting machine (Figure 5), billet tooling system,

Figure 4. Primary aluminum being staged for the melting furnace.

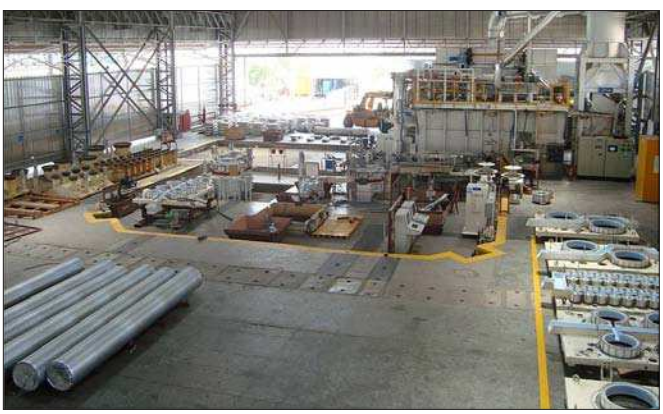

Figure 5. Overview of casting bay showing pit in center.

casting automation system, homogenization furnaces, lathes and saws, and quality control laboratory.

Melting: The melting furnace is a 34-ton reverberatory, stationary melting furnace manufactured by GNA of Canada. The furnace heating energy is from two Bloom regenerative burners with a 6,100 KW firing range fueled by liquid propane gas. The furnace configuration includes a deep sill for charging large sized scrap and also safely preheating scrap bundles in both dry and moist weather conditions. It is lined with specially selected refractories to ensure a long service life and that are resistant to furnace contamination, minimizing the requirement for furnace washes during alloy changes, and maintaining an acceptable free plane in the refractory floor. No metal treatment is planned for the furnace, but all inclusions and impurities are removed during the downstream purification systems. This lack of furnace treatment ensures minimal furnace melt loss, optimum refractory life, and environmentally sound operating practices.

Metal Transfer: Metal transfer launders supplied by Almex permit a non-turbulent, gravity flow to the casting line. They are custom built, minimizing sharp turns, and use a cross section optimized for the metal flow rate. The cross section minimizes heat loss to the atmosphere by ensuring a deep sump and a minimal surface area cross section which also limits hydrogen reabsorption and burning off of volatile alloying elements which are prone to oxidation. The refractory, having a lower density than liquid aluminum is selected so that, in the event there is any damage to the material and pieces flake off during a cast, they will be carried to the surface of the metal where they will either be skimmed or caught in the surface oxide layer and not introduced into the cast product. To further minimize heat loss and oxidation, and allow refractory pre-heat prior to a drop, electrically heated launder lids are used on all straight launder sections. Gas ports in the lids permit the addition of nitrogen gas to be introduced into the air gap between the molten metal. The lids provide an inert blanket to prevent significant changes in metal chemistry from furnace to casting machine and minimize melt loss of expensive alloying elements. This blanket also maintains optimum hydrogen levels in the molten metal at the casting machine.

Metal Purification and Refining: Metal purification is achieved through a grain refiner rod feeder, a degassing unit, and a ceramic foam filtration unit. The rod feeder supplies Ti-B-Al grain refiner wire into the metal transfer system just upstream from the degassing system to provide complete, homogeneous mixing of the grain refiner. To optimize the grain refining addition rate, the speed of the wire feeder addition is controlled by the casting line automation system which adjusts the feed speed based upon alloy type and metal flow rate. An Almex LARS RL-16 unit provides the required hydrogen, inclusion, alkali metal, and alkali metal salt removal. Final inclusion removal is achieved via a Selee single stage, 19″ ceramic foam filter system.

Casting: The casting machine utilizes a double acting, internally guided hydraulic casting cylinder. The casting cylinder is manufactured by Hunger Hydraulik to Almex proprietary design (Table I). The double-acting design coupled with the ultra-low friction operation provides ultimate motion control and complete linearity. These design features ensure steady hydraulic control throughout the cast (Figure 6).

Characteristic	Dimension
Piston Diameter	510 mm
Piston Rod O.D.	460 mm
Stroke	7,119 mm
Design Pressure	35/70 bar
Maximum Weight	400 kN
Casting Speed Range	10-250 mm/min
Maximum Lift Speed	1,500 mm/min
Anti-rotational Accuracy	±5 minutes
Piston Rod	Ceraplate 2000™

Table I. Characteristics of the hydraulic cylinder.

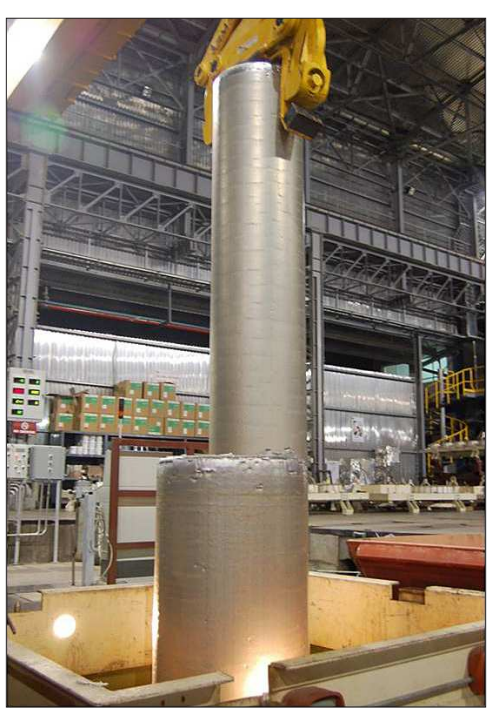

Figure 6. A 26″ billet of 7050 alloy being removed from the pit.

Billet Tooling: Billet production utilizes Almex Excel mold technology (Figure 7), which is designed to reduce the sump depth preventing both cracking and porosity and ensuring small equiaxed grain through the billet. Billet diameters for Phase I range from 7.0″ to 42.5″ in diameter (Table II)

Figure 7. 650 mm diameter tooling for hard alloy casting.

Diameter (mm)	Diameter (in)	Strand Density
178	7.0	36
254	10.0	20
384	15.5	10
450	17.7	8
550	21.7	6
585	23.0	6
650	25.6	4
777	30.6	3
816	32.1	3
916	36.1	2
1060	41.5	2

Table II. Billet diameters cast at HAAL.

Automation: The Almex Castright II automation system controls and monitors the entire casting line. Casting line control is accomplished via a recipe driven functionality with control of casting parameters specific to each alloy and mold size combination. Metal purification and refining is automatically controlled along with the water flow characteristics to the mold tooling and casting speed with this recipe control. A multiple step function permits controlled change of casting conditions at the start of a cast until steady state conditions can prevail.

Homogenization: Two 75-ton, traveling homogenization furnaces manufactured by GNA alutech provide the heat treatment of the billets (Figure 8). The furnaces are traveling batch type with a dedicated cooling fan bank. The three-zone, reversing fan configuration assures optimum heating of the load by reversing the air flow during heat up and soak times. The furnace travels on rails between two load pads, allowing a rapid transition from a completed soak to bringing a fresh stack into the heat up phase. Doors at each end of the furnace permit the unhindered travel of the furnace, and sealing is achieved utilizing a pneumatically actuated floor seal, which retracts during the furnace movement and then is lowered into position to minimize heat losses. Once the homogenizing cycle completes, the traversing cooling air fan bank is energized to air quench the load. As the fan bank is pre-positioned prior to the end of a soak, then the time between

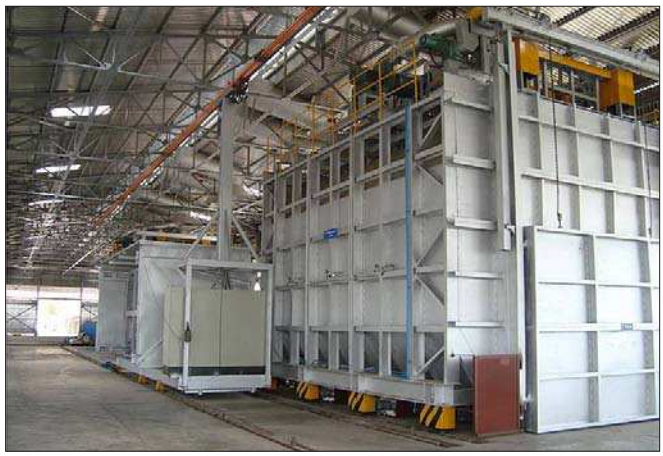

Figure 8. One of the homogenization furnaces.

soak and start of quench is minimized to less than three minutes, ensuring optimum homogenized properties with the billet.

Cutting Operations: Two cutting saws supplied by ITL Industries Limited, Indore, have the capacity to handle round billet from 150 mm to 800 mm diameters and 250 mm to 1,200 mm diameter billets respectively. Cutting speed is from 20 to 500 m/min with a cutting rate of 250 cm^2/min and 150 cm^2/min for soft and hard alloys, respectively. Three reconditioned, used lathes have been installed for scalping of billets to customer required diameters and to permit ultrasonic scanning of the billet prior to shipment to MIL-2154 Class AA standards.

Quality Control & Aerospace Requirements: Testing at HAAL is done in-house, through fully equipped metallurgical and physical testing laboratories, handled by qualified and experienced personnel. Chemical analysis, along with the in-line hydrogen content measurement, coupled with qualitative and quantitative analysis for gas and inclusion measurement, ensure all critical parameters in a casting are thoroughly monitored. Metallographic testing facilities with an image analyzer, macro etching facilities, and UV inspection enables HAAL to publish all metallurgical data for each heat. An ultrasonic inspection process, handled by qualified UT personnel is the final stage inspection.

HAAL is committed to adhere to all the stringent requirements of the aerospace industry and is one of the very few casthouses in the world to meet the stringent requirements of the AS 9100 certifications. This is in addition to its compliance to ISO 14001 and OHSAS 18001, Boeing D1-4426, and many other specific end customer requirements.

Future Outlook

A second casting line is scheduled to be installed by the end of 2010, as well as the expansion of two furnaces per casting line, further billet tooling systems, slab tooling systems, downstream processing equipment, and homogenizing furnaces. A dedicated R&D line will also be installed for alloy and casting technology development that will enable the ability to cast aluminum lithium alloys. A team of experienced sales personnel based in India and the U.S. coordinate the sales operation. With the open house, HAAL has introduced the latest state-of-the-art plant for melting and casting hard aluminum alloys with up to a 42″ billet size. With an excellent team, leading technology, and critical systems and quality processes in place, HAAL has firmly established the first stage in advancing an aerospace aluminum value chain in India, as well as a world-class operation for the global supply of hard alloy billet.

Congratulations to Hindalco-Almex Aerospace Limited for Earning BOEING Qualification and AS9100 Certification

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