

CELEBRATING 30 YEARS OF CONTINUOUS CASTING AT WHYALLA STEELWORKS



LIBERTY PRIMARY STEEL IS CELEBRATING 30 YEARS OF CONTINUOUS CASTING AT THEIR STEELWORKS. LOCATED AT WHYALLA, SOUTH AUSTRALIA, APPROXIMATELY 400KM NORTH-WEST OF ADELAIDE, IT IS AN INTEGRATED STEELWORKS USING MAINLY MAGNETITE IRON ORE-BASED FEED, SOURCED FROM SIMEC MINING'S IRON ORE MINES IN THE REGION. WITH A PRODUCTION CAPACITY OF 1.2 MILLION TONNES PER ANNUM, APPROXIMATELY 65% OF THE STEEL PRODUCED IS TRANSFERRED BY RAIL IN BILLET FORM TO INFRABUILD STEEL'S ROD BAR AND WIRE BUSINESS FOR FURTHER VALUE-ADDED PROCESSING, AND THE REMAINING STEEL IS CONVERTED TO FINISHED PRODUCTS IN THE FORM OF STRUCTURAL STEEL AND RAILS THROUGH THE WHYALLA STRUCTURAL MILL. A SERIES OF MAJOR INVESTMENTS, TECHNOLOGICAL ADVANCEMENTS, AND RESEARCH AND DEVELOPMENT PROJECTS AT THE STEELWORKS HAS RESULTED IN THE CONSISTENT MANUFACTURE OF HIGH-QUALITY STEEL PRODUCTS OVER THE LAST 30 YEARS.

Steel is a refined form of metallic iron with controlled quantities of alloying elements added. As the molten iron comes from the Blast Furnace, it contains approximately 4% carbon. During steelmaking, the percentage of carbon and other residual elements is lowered by oxidation to around 1%, depending on the type of steel being made.

The Whyalla steelworks currently produces around 90 grades of steel, which fluctuate depending on customer needs. By varying the carbon content and adding different proportions of various alloying elements, hundreds of

different grades of steel can be made.

The Basic Oxygen Steelmaking (BOS) furnace is simply a barrel-shaped steel vessel with an open top. It is lined with refractories about 700mm thick and can tilt through an arc of 360 degrees. The Whyalla BOS has two furnaces, each of which produce 130 tonnes of steel in every 'heat' (batch). To enable a consistent supply of steel, one furnace remains in constant operation, whilst the second can be taken offline for relining with refractory bricks or repair, if required.

During charging, the furnace is tilted.

Scrap, which may comprise up to 35 tonnes of the charge, is tipped in, followed by approximately 100 tonnes of molten iron from the blast furnace.

The vessel is then returned to the upright position and a water-cooled lance is lowered to a pre-determined height above the surface of the molten iron. Oxygen of 99.5% purity is then blown through the lance at high velocity onto the molten iron whilst nitrogen is 'bubbled' through the bottom of the furnace to improve the mixing. As the oxygen is blown into the BOS vessel, a flux of burnt lime and dolomite is



dropped in to control reactions and form a refining slag.

Exothermic (heat producing) chemical reactions occur as the oxygen combines with the carbon and other impurities in the molten iron, which are absorbed into the slag, or exit as gas. The oxygen blow goes on for about 20 minutes and sufficient heat is generated to melt the scrap and raise the temperature of the molten iron to above 1,600°C.

At the end of the oxygen blow, the furnace is tilted, a temperature reading obtained and a sample taken for analysis. The operator then makes any necessary adjustments to the steel before tapping (emptying) the furnace. The operator then tilts the furnace to the tapping position so that the molten steel runs through the taphole into a ladle below. The steel flows out from underneath the layer of slag.

During tapping, Ferro alloys (mainly Ferro manganese and Ferro silicon) are added to the ladle to bring the steel to the exact specification required.

After the steel has been tapped, the furnace is tilted to the opposite side to pour slag over the rim into the slag pot below. The BOS production cycle from charge to tap usually takes about 40 minutes.

The 130 tonnes of molten steel has its specifications fine-tuned after being transported out from the point where it was tapped.

The ladle of steel is 'bubbled' with argon (much like blowing through a straw into a milkshake) to stir the steel and ensure a consistent mix of the elements. At this point, further temperature readings and samples are taken and the analysis can be fine-tuned by adding alloys.

On completion of that process, the ladle of molten steel is picked up by a Kress Carrier, which transports the ladle to a separate building housing the Slab and Bloom and Billet Casters.

INGOT ROUTE

Prior to the opening of the Continuous Slab and Bloom Caster at Whyalla on

13 April 1992, all molten steel was poured into ingot moulds and allowed to cool. Opened in February 1965, the ingot route produced over 20 million tonnes of steel ingots before de-commissioning on 30 April 1993. The former ingot route process included the Soaking Pits and Bloom Mill, which are no longer used.

The ingot route process involved the molten steel being 'teemed' (poured) into ingot moulds to produce rough blocks of steel ingots that ranged in weight from around six to 13 tonnes, depending on the final product to be produced.

In closing the ingot route, Australia joined leading steelmaking countries in the world that produce the majority of their raw steel using the continuous cast method. In addition to the Whyalla operation, there are Continuous Casters at Port Kembla in New South Wales, Laverton in Victoria, Rooty Hill in Sydney, and in Newcastle.

Continuous casting provides a significant improvement in steel yield by eliminating the need for ingot cropping to remove the shrinkage cavity, as well as negating the need for intermediate rolling products such as Blooms. In addition to the direct process yield benefits, the continuous cast product has significantly better and more consistent internal properties, which further enable higher quality yield.

CONTINUOUS SLAB AND BLOOM CASTER

Commissioned in April 1992, the \$150 million Continuous Slab and Bloom (Combination or 'Combi') Caster represents a major addition to Whyalla Steelworks' facilities. It provides enhanced productivity and international competitiveness for the Steelworks.

Completed ahead of time and under budget, the Combi Caster has set high standards of productivity. It holds the Australian Slabmaking Record and Whyalla Break-Out (spillage of molten steel) Free Period of 830 days and 2,722,954 tonnes of continuously cast steel.

The casting process involves pouring liquid steel from a 130 tonne ladle into the 30 tonne tundish and then into water cooled copper mould. Initial solidification of steel happens in the mould and final solidification in the secondary cooling zone that is 34.5m long and where the strand is cooled by water sprays and supported by



water cooled rolls.

The Slab and Bloom Caster has a maximum production capacity of more than 1.2 million tonnes per annum. The following section sizes can be produced at the caster, single slabs (950mm to 2,070mm), twin slabs (600mm to 960mm) and triple blooms (350mm and 450 mm). Design product thickness range is 200mm to 250mm. Current caster production is around 300,000 tonnes of cast feed per annum for structural sections and around 100,000 tonnes of cast feed per annum for rail sections—both processed through the Steelworks' Rolling Mill complex.

BILLET CASTER

Commissioned in May 1999, the Steelworks' \$83 million Billet Caster and its associated Ladle Metallurgy Facilities incorporates state-of-the-art technology and operating practices.

The Billet Caster has a capacity to produce around 750,000 tonnes of billet steel per annum and has positioned the Steelworks as the principal supplier of billet steel feed for InfraBuild Steel operations on the east coast of Australia.

The five strand Billet Caster is designed to produce Special Bar Quality (SBQ) and engineering steel grades that have high requirements for mechanical properties, surface and internal quality. To meet quality requirements for SBQ grades the billet caster has mould

and strand electromagnetic stirrers to improve billet internal quality and to reduce harmful segregation in cast product. Convex mould technology is applied to increase mould heat transfer, which allows for a higher casting speed compared with the conventional mould design.

The following cast practices are available at the billet caster: open pour casting used for commercial steel grades, and submerged entry nozzle (SEN) casting for SBQ grades. Billet section sizes range from 127mm, 160mm to 175mm square and the maximum billet length is 12m.

Billet steel feed from Whyalla undergoes value-adding downstream processing at InfraBuild Steel's rolling mills to produce a range of products for customers in the automotive, fabrication and construction, fastener, manufacturing, mining, reinforcing, rural and wire industries.

COMBINATION CASTER UPGRADES

The single strand vertical-bending Combination Caster at the at Whyalla Steelworks was designed by Voest-Alpine Industrieanlagenbau (VAI) and was commissioned in April 1992. For over 27 years, the machine manufactured as-cast semis that consistently met the downstream rolling requirements for both surface and internal quality. In 2019, Liberty Primary Steel in collaboration with the Materials Processing Institute, completed a project aiming to extend the product range of

the Combination Caster to enable the machine to manufacture single width slabs for more demanding strip and plate grades without the need for costly capital expenditure.

The project identified that thermal tapering of the strand support rolls, and a static soft reduction zone could be retrofitted to the machine to improve slab internal quality. The machine was retrofitted with the new settings in November 2018, and in February 2019 the first order for single width slab was completed. This export order had a more demanding internal quality requirement than the steel plant would normally manufacture. Utilising the retrofitted thermal taper and static soft reduction settings, the order was completed with improved internal slab quality.

The machine upgrade greatly increased the capability of the Combination Caster to manufacture more demanding steel grades without the need for costly capital expenditure. The Whyalla Steelworks now supplies both single and twin width slabs to new markets that historically would not have been considered.

ADVANCED TECHNOLOGY

The original Combi Caster Mould Level Control (MLC) and Break-out Prediction (BOP) systems were installed when the Steelwork's Caster was first commissioned in 1992. These systems incorporated a VAX computer system to conduct the necessary process control

SYDNEY METRO RAILWAY TRACK LAYING ON TARGET UNDER SYDNEY HARBOUR

Track laying has finished in one of the Sydney Metro railway tunnels under Sydney Harbour, marking a major milestone in the Metro from Chatswood, to the city, to Bankstown. The Hon. Gladys Berejiklian MP, Premier of New South Wales, and the Hon. Andrew Constance MP, Minister for Transport and Roads, recently inspected the completed tracks on the Blues Point side of the northbound tunnel, which is about 40m below the harbour's surface.

The tracks in these tunnels connect the future Barangaroo and Victoria Cross (North Sydney) Metro Stations. Track laying in the southbound Metro harbour tunnel has reached 30% and is due for completion at the end of July.

"The 800m section of track in the northbound Metro harbour tunnel is complete, after 1,200 railway sleepers and 2,100 tonnes of concrete were installed," Constance said. "More than 4,000 tonnes of Australian steel has been used for the 31km of tracks from Chatswood to Sydenham, including 200 tonnes under the Harbour."

The 1,200 railway sleepers were manufactured by Liberty Primary Steel at the Whyalla Steelworks.

"Around 50,000 people will have worked on this incredible city-shaping project by the time services start in 2024, with about 800 involved in the tunnel fit out and 5,000 currently working on the project," Berejiklian said. "It will take just three minutes to travel between the new Victoria Cross Station at North Sydney to Barangaroo Station using the tunnels, transforming the way we travel around our great city."

Sydney Metro line-wide contractors Systems Connect, a joint venture between CPB Contractors and UGL Limited, took over the harbour tunnels in December last year to lay the tracks and fit out the tunnels. Metro trains will start running through the harbour tunnels in 2024, extending the North West Metro, into the city and beyond to Bankstown. New stations are being delivered at Crows Nest, Victoria Cross, Barangaroo, Martin Place, Pitt Street and Waterloo, along with new underground platforms at Central Station.

functions. Over time, these platforms had become obsolete and the ongoing support of the systems was proving to be increasingly challenging. When the VAX computers were originally installed the computation required to run the systems was too high for the PLCs of the day but with modern technology the latest Rockwell Programmable Logic Controllers (PLCs) were able to handle the calculations. So, in 2018, these systems were updated to the latest Rockwell PLCs with the first cast on the new system being conducted on 23 October 2018.

The use of PLCs enabled Liberty Primary Steel to make a variety of system enhancements, including:

- Clogged nozzle predictions
- Start-up sequence transitions (preventing getting stuck in transition)
- Adaptive gain control
- Manual take-over of slidegate during start-up
- Level control simulations (for training purposes)
- Auto flushing

At the same time, Liberty Primary Steel installed a new SCADA system to replace the old MasterView system that had become obsolete in the 1990s. Liberty changed its SCADA philosophy to be in line with the latest world-wide Alarm System Management (ASM) standard. As part of these two upgrades, an Ethernet Network back bone was installed that can be expanded to help steelmaking at

Whyalla move into the fourth Industrial Revolution, Industry 4.0.

LOOKING AHEAD

GFG Alliance has revealed further plans to transform its Whyalla steelmaking facility on the back of its South Australian mine products. The plant will transition to a direct reduced iron (DRI) facility to produce low-emission Greensteel from the company's South Australian magnetite resources and domestic steel scrap.

The new plant will be fed by natural gas, making use of green hydrogen produced from GFG's renewable energy projects, in alignment with the company's ambition to be carbon neutral by 2030. It will

transition away from a blast furnace to an electric arc furnace (EAF) and new rolling mill.

In addition, the Steelworks is expected to branch out with new products into new markets, widening product quality capabilities with potential introduction of vacuum degasser along with upgrades to secondary refinement stations. Sequence lengths will also be improved in a cost saving initiative, and 130mm billet size casting capability will be introduced. Finally, automation capabilities will be expanded to reduce the hot metal-human interface.

