'Apex' rolling ingot casting technology benefits casthouses and rolling mills

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Fig. 1: Apex ingot cast at Wagstaff R&D Centre

Rolling ingot butt swell problems have been dramatically minimized, and flatter rolling ingots are easier to produce through the use of a new technology available from Wagstaff. The company's Adjustable Profile Expandable (Apex) Rolling Ingot Casting Mould incorporates a fully automated, fully adjustable mould with a table-mounted touchscreen HMI.

Apex casting moulds focus primarily on eliminating butt swell with a continuously adapting mould bore opening. Wagstaff defines butt swell as a thick butt section on a rolling ingot. This defect results from a lack of shrinkage away from the Mould Bore Opening (MBO) – when the molten metal sump develops with increasing casting speed. The butt portion of the ingot rolling face becomes convex, and the swell will extend into the ingot's steady state portion. If this defect occurs, the thicker ingot butt (along with the ingot shell) will need to be removed through butt sawing and scalping prior to rolling operations. The Apex casting system's unique features can change the ingot's final shape with a constantly adapting mould bore, adjustable for a specific alloy and size combination.

Apex casting mould features

Each Apex mould position contains five control points on each mould rolling face to control the bore profile (Fig. 2). The End Control Points (ECPs) located near the end faces are stationary and passive. They manually clamp the rolling face against the end faces on each end of the mould. The Centre Control Point (CCP) and the two Quarter Control Points (QCPs) are the three points inside the end points. These points are active, and their displacements are controlled by cast recipe values. They can also be changed dynamically *during* a cast. The CCP is controlled to one displacement, and the QCPs are controlled together to a second displacement independent of the CCP. The QCPs and ECPs are mirrored around the CCP, and they are always at equal distance from the centre. The mould ends, the QCPs and ECPs can be moved along the length of the face to accommodate nearly any ingot width.

At the start of a cast, the active control points are set to zero, which forces the rolling face to be flat. After the cast begins, the QCP and the CCP displacement increases until the optimal ingot shape is reached in steady state. The CCP will increase in displacement more than the QCPs. The displacement amount is generally not linear with the cast length, and it changes according to the casting recipe so as to obtain the steady state position. The mechanism then holds the control points stationary through the steady state portion of the cast.

Apex moulds also utilize a 'floating' starting head, which reduces effort to centre the starting head inside the mould. The starting head base is equipped with a pneumatic system that combines air pressure and ball bearings to move the starting head into place. Specially designed starting head alignment fixtures place the starting head precisely in the mould, and after alignment, a pneumatic clamp locks the starting head in position and orientation so as to match the mould.

Apex moulds employ Wagstaff SplitJet enhanced cooling technology, which provides independent control of the primary and secondary water jets to optimize cast start and run states. SplitJet produces a very high cooling rate during steady state, which results in superior metallurgical properties. Apex moulds also use larger diameter secondary water jet holes on the mould ends. This allows the ingot's rolling faces to operate in film boiling for curl control, while the ends operate in nucleate boiling to eliminate the tendency to end crack or bleedout.

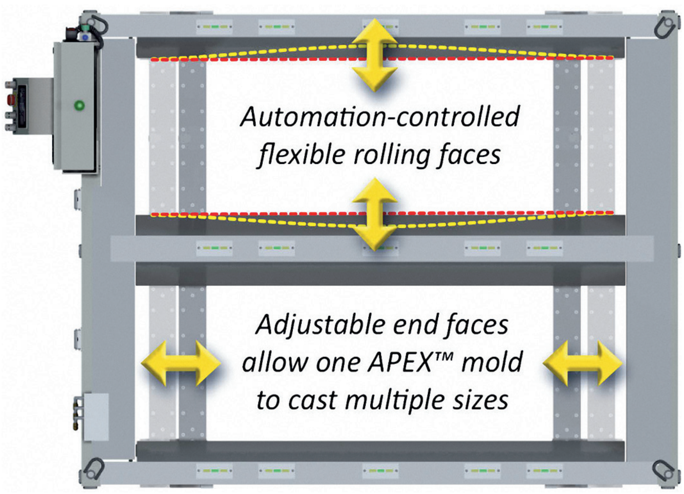

Fig. 2: Apex system automatically flexes the mould bore to produce a butt swell-free ingot

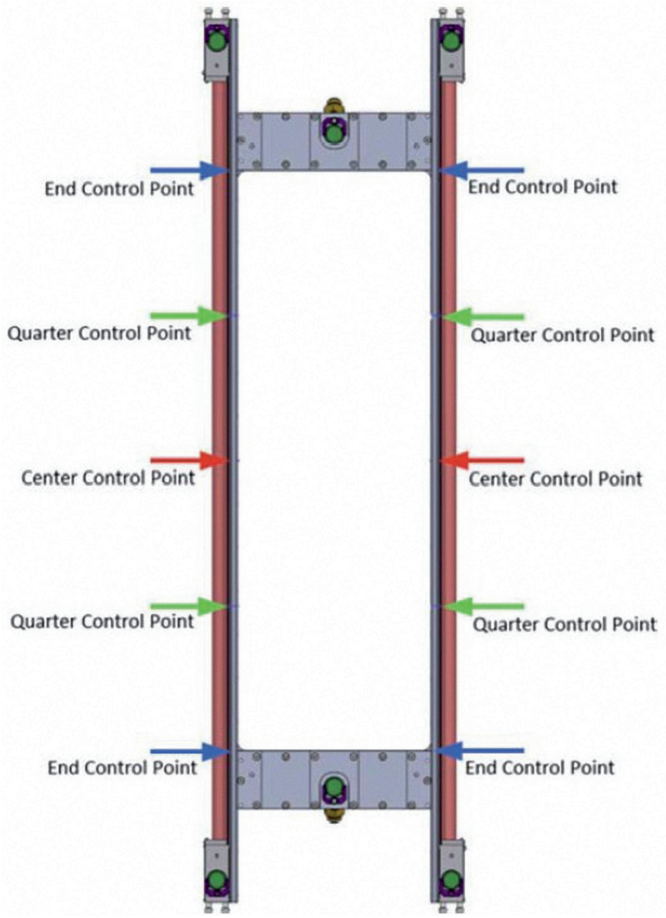

Fig. 3: Apex mould control points

Human-Machine Interface (HMI)

The Apex HMI has three standard operating modes – Operator, Process and Maintenance. Operator mode consists of the basic use settings, navigation and control functions. Process mode allows metallurgists or casting managers to change the process parameters. Maintenance mode allows the user who has access to view and change all casting parameters, and to bypass the Apex system to perform maintenance or troubleshooting.

The HMI has a precheck mode that requires all cast permissives to be met before a cast can begin, a Mould Detail screen that provides a detailed mould view, and a Language Selection command box that allows operators and metallurgists to review casts in their local vernacular. The HMI also has a Remote Support screen that allows Wagstaff Technical Service representatives to provide remote troubleshooting or assistance.

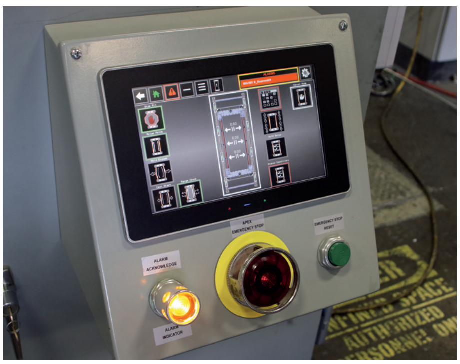

Fig. 4: Dedicated Apex HMI

The HMI monitors the present values (PV) and the recipe determined set points (SP) during casts, and notifies the operator (by highlighting the ingot's values) if the values do not match the recipe, or of other conditions that might be stopping a selected action.

Apex benefits

Reduce ingot but swell: While Apex casting moulds eliminate almost all butt swell, they also reduce butt curl. The reduction (or elimination) of thicker ingot sections will reduce the scalping and butt sawing required to create a finished ingot. These flatter ingots also require less storage space, they stack more consistently and they contribute to a safer work environment. By all but eliminating butt swell, faster casting speeds may be achieved while maintaining ingot shape. This is highly dependent on alloy, mould size, casting practices and downstream equipment capacity.

Apex cast speed: The optimized mould bore with the accompanying shape control automation has enabled cast speeds to increase without loss of product quality. One Apex ingot caster increased casting speed from 50 mm/min with a traditional mould to 65 mm/min with Apex, reducing the casting time of a five-meter ingot by 16 minutes per cast. Projecting the time saved over an average five casts per day and 365 days per year, this could add 20 days per year of casting capability. Increasing the casting speed from 60 to 80 mm/min on the same five casts per day of five-meter ingots would add weeks of extra casting production per year.

Graphite-lined Apex: Recently Wagstaff also developed Apex-GL, a graphite lined version of the Apex mould system. Apex-GL operates in similar form and function to Wagstaff's LHC technology, using up to 95% less oil during a cast, while minimizing the shell zone thanks to the low metal head. Apex-GL also allows for higher casting speeds without negatively impacting grain size (Fig. 6).

Minimal shell zones are preferred, as the shell zone of a rolling ingot must be removed before it can be processed by the mill. Shell zones in Apex-GL are similar to shell zones in ingots cast with Wagstaff LHC ingot casting technology. Recorded shell zones of 250 µm and 210 µm are typical in optimized LHC casting ingots for alloys AA3004 and AA5182 respectively, which are parallel to the shell zone ranges produced with Apex-GL technology.

Ingot size change: Apex also accommodates for simpler ingot size and alloy changes than a fixed mould, it eliminates the need for additional tooling, and it can reduce the amount of operational casting equipment needed to meet production requirements.

Fig. 5: Apex ingot cast at Wagstaff R&D Centre

New ingot size orders can begin in hours, as opposed to several months, using the Apex user interface and specialized controls developed for advanced DC ingot casting.

For more information on the Apex casting mould system, visit www.wagstaff.com or contact us at info@wagstaff.com.

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