Development of Submerged Entry Nozzle (SEN) for thin slab casting

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Overview

Continuous casting processes are categorized as slab, bloom, or billet casting, depending on the mold dimensions. Generally, automotive steel sheets are manufactured from slabs, bearing steel from blooms, and wire rods from billets. Although it is not currently operated in Japan, thin slab casting an even thinner continuous casting method is utilized overseas. Thin slab casting, also known as a rapid solidification process, offers the advantage of reducing capital and operating costs by eliminating intermediate rolling and heating steps.[1] Compared to the casting speed of typical slab continuous casting, which is 2.5 m/min, thin slab continuous casting is twice as fast, at 5 to 6 m/min.[2] As the casting speed increases, the speed at which molten steel is supplied from the SEN port also increases, causing greater fluctuations in the molten steel flow in the mold and increasing the possibility of problems such as breakouts. Krosaki Harima Corporation has developed and successfully commercialized the SEN for thin slabs, which minimizes disturbances in the molten steel flow (especially standing waves) in the mold even under high-speed casting conditions.

Features : Internal Equalizer Design

The mold thickness of thin slabs is 100 mm or less, less than half that of typical slabs (approximately 200 mm to 300 mm). Furthermore, high-speed casting increases the discharge flow rate, which also increases the meniscus flow velocity of the molten steel.

To address this issue, we have developed a uniquely designed thin slab SEN that uses a wall called an equalizer inside the SEN to change the direction of the discharge flow, reducing the surface flow velocity of the molten steel and stabilizing the flow inside the mold.

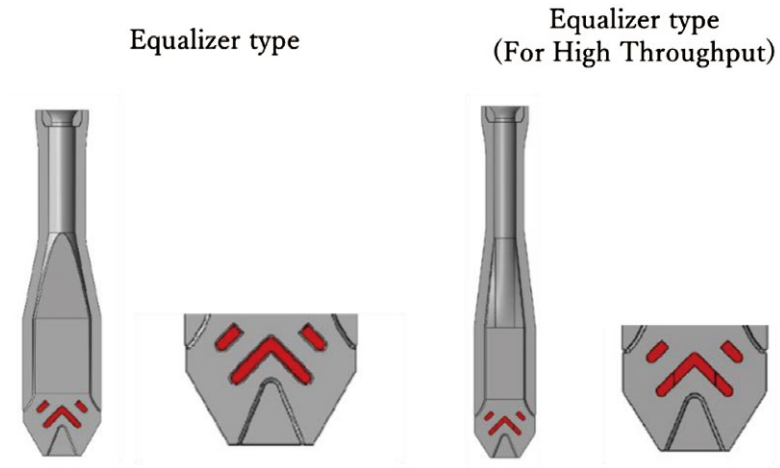

Fig. 1 Krosaki Original Thin Slab SEN

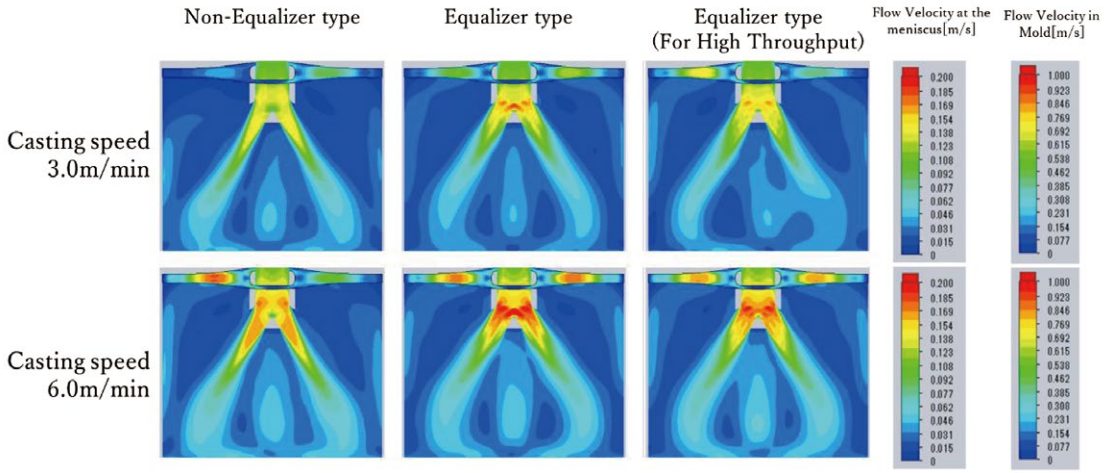

Fig. 2 CFD results of casting speed and equalizer

Proven Performance & Future Development

Kurosaki Harima's thin slab SEN has been introduced in North America, Southeast Asia, and India, demonstrating reliable performance across a variety of operating environments.

Looking ahead, we are actively working on the development of the next-generation SEN, which is compatible with even higher casting speeds, strengthening our commitment to improving steel quality and operational efficiency for our customers worldwide.

References

1) Pinggguang Xu, Fuxing Yin, : Kotobu Nagai Materials Transactions, Vol.45,No.7 (2004).
2) Tadao WATANABE,:Tetsu-to-Hagane,Vol.88,No.3(2002)