Effect of Casting Speed on the Inclusion Distribution in a LCAK Steel Rolled Plate Produced by the MCCR Process

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The multimode continuous casting and rolling (MCCR) process at Shougang Jingtang Steel is a newly designed multimode thin-slab continuous casting and rolling line which can continuously produce coils without cutting before the coiling machine. Under high-casting-speed conditions, the quality of rolled plates is more sensitive to changes in casting speed. To guarantee a balance between the high steel throughput and the high steel quality, a reasonable high casting speed is required. In the current study, the effect of casting speed on the distribution of inclusions in a low-carbon aluminum-killed steel rolled plate produced by the MCCR process was investigated. Inclusions in the rolled plate were of a Al_2O_3-CaO-MgO-CaS system. There was only a slight difference in the inclusion composition along the width of rolled plates, with an approximately average composition of 70 wt. % Al_2O_3, 20 wt. % CaO, and <10 wt. % MgO and CaS. As the casting speed increased from 4.7 to 5.2 m/minute, the average CaO content in inclusions decreased firstly at casting speeds lower than 4.9 m/minute and then slightly increased at casting speed higher than 5.0 m/minute. The CaS content presented an opposite changing trend. Meanwhile, the distribution patterns of the number density and area fraction of >2 μm inclusions along the width of rolled plates roughly changed from the "Λ" shape to the "M" shape. By comparison, there was the smallest number density and area fraction of >2 μm inclusions at 4.7 m/minute, while the number density and area fraction of >2 μm inclusions was the highest at 5.2 m/minute. However, the uniformity of the inclusion distribution along the plate width was the smallest at 4.7 m/minute and the highest at 5.0 m/minute.

The near-net-shape manufacturing technology of steel is one of the low-carbon technologies for achieving carbon neutrality in the steel industry.[1] This includes thin-slab continuous casting and rolling technology and thin-strip continuous casting technology, with the former being the main focus. The world's first thin-slab continuous casting and rolling production line (CSP) was built and put into operation at Newco Steel in 1989. After more than 30 years of development, the technology of thin-slab continuous casting and rolling has advanced to the third generation.[2] The multimode thin-plate continuous casting and rolling (MCCR) production line jointly developed by Shougang Jingtang and Danieli is one of the third-generation technologies which was put into operation in 2019. Currently, there is only one MCCR production line at Shougang Jingtang.[3] The thickness of the continuous casting slab in the MCCR production line is mainly 110 mm, with a width of 900–1,600 mm. The designed maximum casting speed is 6.0 m/minute. Currently, the continuous casting speed can be stable at 5.0 m/minute. There are differences in the structure of the mold and submerged-entry nozzle (SEN), continuous casting parameters, and hot rolling parameters between the MCCR process and traditional continuous casting-rolling processes, as well as other thin-slab continuous casting and rolling processes. Therefore, there must also be differences in the cleanliness and inclusion characteristics of rolled plates.[4]