Contribution ID: **129** Type: **Oral**

Characteristics of Nozzle Clogging and Evolution of Oxide Inclusion for Al-Killed Super304H Stainless Steel

Tuesday 7 October 2025 15:50 (20 minutes)

This study addresses the issue of nozzle clogging failure in the continuous casting of Super304H stainless steel, investigating the impact of inclusions on nozzle clogging formation through experimental and thermodynamic calculations. Initially, the clogged nozzles were systematically examined, followed by the study of the evolution of steel melt inclusions at different stages of the smelting process. The study revealed that nozzle clogging consists of three layers: Layer A, the initial cold steel layer, primarily composed of eroded refractory material and cold steel; Layer B, the slag-type inclusion layer, predominantly consisting of Al-Ca-Si-Mg-F-O inclusions, with a high content of Al2O3; and Layer C, the clogging layer, mainly composed of some slag-type inclusions, a large amount of endogenous Al-Ca-Si-Mg-O inclusions, and cold steel. The study demonstrated that slag-type inclusions in the steel melt gradually increase in Al2O3 content and decrease in liquid phase ratio under cooling and oxidation, leading to the formation of the slag-type inclusion layer B. To reduce the formation of Layer B, the Al2O3 content in inclusions during the tundish stage should be controlled to below 56%. Additionally, during the tundish stage, endogenous inclusions with a high Al2O3 content, in addition to slag-type inclusions, generate a porous network in Layer C, which ultimately impedes the flow of steel and leads to nozzle clogging formation. To ensure smooth continuous casting, it is recommended to control the T.O content within the range of 0.0049% to 0.0075% and ensure that the liquid phase ratio of endogenous inclusions exceeds 50%. This study provides theoretical basis and technical support for optimizing the steel melting process, reducing nozzle clogging defects, and improving steel quality.

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Session Classification: Mold Technology & Nozzle Performance

Track Classification: Steelmaking - Continuous casting, near-net shape casting and ingot casting