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Improving AISI 431 stainless steel ingot cleanliness by optimizing the refining and casting process

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Large inclusions (size ≥ 100μm) deteriorated the cleanliness of AISI 431 stainless steel ingots fabricated by a Chinese steel mill, resulting in the formation of defects that can be visually observed on the surface of the oil pump. Here, we revealed the Al contents and inclusion evolution route in the process of "AOD refining - LF refining - Casting - Rolling" by analyzing samples obtained during production. It was found that inclusion removal in the LF refining process is not enough owing to inappropriate LF slag composition. Reoxidation during casting and mold flux entrapment were considered as two main sources for the formation of large inclusions in ingots because the dissolved Al content decreases obviously and large inclusions form newly after casting and the composition consists of two main types of inclusion: Al2O3 and complex oxide inclusion with Na2O. The optimization of refining and casting process was proposed and utilized: (a) the LF refining slag with R=5.5 and Al2O3 content of 25% was designed for enhancing inclusion absorbing ability of slag, and the soft Ar blowing time at the end of LF refining must exceed 20 minutes, (b) the distance between the ladle nozzle and the central casting pipe should be minimized as much as possible to avoid reoxidation, (c) the Ar flow rate should be appropriately controlled for guaranteeing the stability of liquid steel flow during casting. (d) the height of placing mold flux before casting was adjusted. After optimization, the cleanliness of steel ingots improved because large inclusions decreased significantly.

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