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Development of an optimized SEM-EDS testing method for non-metallic inclusions and its application to evaluate the cleaning effect of different ESR-slags

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Non-metallic inclusions (NMI) are an essential quality criterion for electro-slag remelted products. Besides standardized testing methods such as ASTM E45, SEM-EDX-based methods have gained widespread application, as they provide not only information on shapes, sizes and numbers of NMI, but also about their chemical composition. Therefore, they are a useful tool not only for quality control but also for the investigation of the impact of process parameters and slag compositions on the cleaning effect during electro-slag remelting (ESR). However, the investigation method is quite time consuming and therefor often restricted to a small detection area, thereby limiting the significance of its results, especially regarding statistically rare, larger inclusion. Using a double raster-technique with a ten-time larger detection area, the probability range for medium size NMI could be significantly extended. As a result of this procedure, a better differentiation between NMIs newly formed during the solidification of the remelted material and such NMI, which did not dissolve and are therefore remnants of the electrode deoxidation, becomes possible. With this tool in hand, the opportunity was opened up to better understand and differentiate the cleaning effect of various ESR-slags. Laboratory ESR trials were therefore conducted, using several commercial slags with different CaF2-content and double-raster SEM-EDX measurements were applied on the remelted and deformed ingots as well as on the electrode material. The results extend the previous knowledge on the significant effect of the slag composition on the type, respective chemical composition of newly formed NMI, by a clearer differentiation of the cleaning effect of these slags regarding the remnant NMI from the electrode. Besides providing a better understanding of these two different influencing factors of the slag composition on NMI in ESR, the method offers also a useful tool for the optimization and development of new slag compositions with higher cleaning potential.

Speaker Country

Austria

Primary author: SCHNEIDER, Reinhold (Univ. of Appl. Sciences Upper Austria)

Co-authors: Mr RABL, Adrian (Univ. of Appl. Sciences Upper Austria); Dr GELDER, Siegfried (voestalpine Böhler Edelstahl GmbH & Co KG); Dr MARTINEZ, Carlos (voestalpine Böhler Edelstahl GmbH & Co KG); Mr REITER, Gerhard (voestalpine Böhler Edelstahl GmbH & Co KG)

Presenter: SCHNEIDER, Reinhold (Univ. of Appl. Sciences Upper Austria)

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