SUCCESS STORY

K1-MET SusMet4Planet Competence Center of Sustainable Digitalized Metallurgy for a Climate Neutral and Resource Efficient Planet

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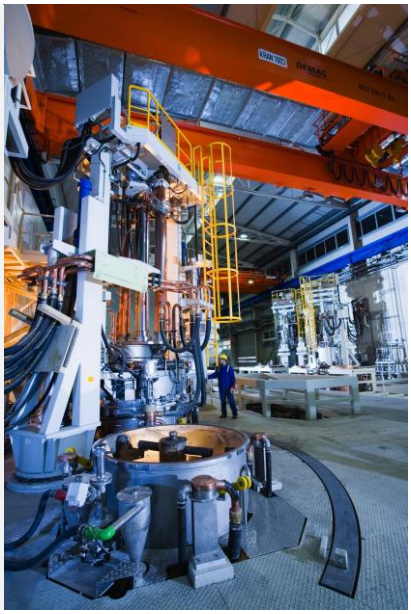

ESR plant (voestalpine Boehler Edelstahl)

ELECTRO SLAG REMELTING (ESR) WITH SLAGS OF A HIGHER RESISTIVITY

INDUSTRIAL-SCALE ESR TRIALS TO REALIZE A REDUCED ENERGY DEMAND DURING THE ESR PROCESS

Electro Slag Remelting (ESR) is a high energy consuming process to produce superior quality steels and alloys. Slags used to remove impurities (non-metallic inclusions, NMI) during the remelting process with high electrical resistivity, corresponding to compositions with low contents on Calcium Fluoride (CaF_2), offer the opportunity to reduce energy consumption, but are often regarded as detrimental to demanding cleanliness requirements.

In the current COMET Project 1.5 (Inclusion removal and steel cleanness), Work Package 1 (Inclusion removal by an energy optimized ESR process), the effect of different slag compositions with high electrical resistivity was examined on laboratory scale ESR plant at the University of Applied Sciences - Upper Austria (UAS-UA) with protective gas operation (Argon and Nitrogen atmospheres). ESR slags ESR2015 (~30 wt.% CaF_2) and another special slag provided by the industrial project partner Wacker Chemie AG (Wacker) were compared with each other in ESR trials done by UAS-UA and K1-MET.

The steel grade used for the investigations was a special steel and selected by the second industrial project partner, which is voestalpine Boehler Edelstahl GmbH & Co KG (vaBEG). Based on the laboratory results at UAS-UA, industrial-scale trials were conducted at the vaBEG site, in which ESR2015 and the special slag were used. Remelting trials were done under protective gas atmosphere.

The focus of the industrial trials was to quantify the effects on remelting behavior, energy consumption, slag skin formation and slag surface temperature. Furthermore, the effects on the ingot quality (see also

Fig. 1), namely changes in the chemical composition as well as amount, type and chemical composition of NMI, were determined.

There were several challenges to be met during in scaling up the lab experiments to industrial-scale operation. Only after specifically adjusting the process parameters, it was possible to extrapolate the results from the small-scale melts to the industrial-scale trials since the special slag exhibits different process behavior. Furthermore, after adapting the analytical technique used to characterize the NMI, it was possible to investigate the different behavior of the two slags with regards to steel cleanness with sufficient accuracy.

Impact and effects

Both remelting trials (with ESR2015 and the special slag) proceeded without problems and the ingots produced were successfully forged.

The mechanical properties and the results of the microstructural analysis are within the usual ranges of the steel chosen for the activities within Work Package 1 of the COMET Project 1.5. In addition, remelting with the special slag resulted in a measurable reduction in energy consumption. Furthermore, positive effects for ESR operation at vaBEG were proven. All in all, the results of the industrial trials demonstrate that high resistivity slags can be used to reduce energy consumption by keeping high levels of cleanliness and offer some possibility to affect the type of NMI.

Figure 1: Pressure ESR ingot (voestalpine Boehler Edelstahl)

Various follow-up laboratory tests using optimized slag compositions for NMI adjustment have revealed some potential for improvement and are already planned as further large-scale trials at vaBEG.

Project coordination (Story)
FH-Prof. DI Dr. Reinhold Schneider
Professor
Metallurgy and heat treatment techniques
University of Applied Sciences - Upper Austria
T +43 (0) 5 0804 - 43910
reinhold.schneider@fh-wels.at

K1-MET SusMet4Planet
K1-MET GmbH
Stahlstrasse 14
4020 Linz
T +43 (0) 732 6989 - 75607
office@k1-met.com
www.k1-met.com/en

Project partner

- University of Applied Sciences - Upper Austria, AT
- voestalpine Boehler Edelstahl, AT

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Federal Ministry
Innovation, Mobility
and Infrastructure
Republic of Austria

Federal Ministry
Economy, Energy
and Tourism
Republic of Austria

Austrian Research Promotion Agency
Sensengasse 1, A-1090 Vienna
P +43 (0) 5 77 55 - 0
office@ffg.at
www.ffg.at