SUCCESS STORY

K1-MET
Competence Center for Advanced Metallurgical and Environmental Process Development

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Centre (K1)

Type of project: Project 2.3 "Thermomechanical modelling of continuous casting and hot rolling", 2019-07-01 to 2023-06-30, multi-firm

AVOIDING CRACK FORMATION DURING THE CONTINUOUS CASTING OF STEELS

INVESTIGATION OF THE HOT DUCTILITY BEHAVIOR OF MICROALLOYED STEELS FOR IMPROVEMENT OF THE CONTINUOUS CASTING PROCESS

The continuous casting process is the most used steel production process in the world (almost 97%, according to the World Steel Association). During this process, defects can appear in the produced parts, called slabs, and those cannot be easily repaired, increasing costs and CO_2 emission on the way. Therefore, the study of the hot ductility behaviour of different alloys produced is important to avoid the formation of defects. This is the focus of the current work, investigating specifically the behaviour of microalloyed steels (steels that have a low carbon and other alloying elements content).

During the research period 2021-2022, two different alloys were under study and comparison. The difference between the two was mainly the contents of Cr, S, Ni, Ti, V, and B. This work has been carried in cooperation with the industrial partners voestalpine Stahl GmbH and Primetals Technologies Austria GmbH.

The investigations done aimed for understanding the hot ductility behaviour under different circumstances for both steels and the causes for the drops in ductility and formation of cracks. For that, hot tensile tests with in-situ melting of the samples were done, at different strain rates and holding times. The results were analysed not only for the hot ductility curves, but also for the stresses and strains, and microstructure. Additionally, compression tests were performed for additional analysis of the microstructure. Apart from the

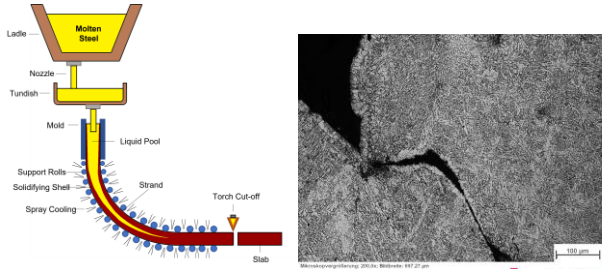
Federal Ministry
Republic of Austria
Climate Action, Environment, Energy, Mobility, Innovation and Technology

Federal Ministry
Republic of Austria
Digital and Economic Affairs

Version 01/2020

experiments, numerical simulations were also performed to obtain more information on the precipitation kinetics of both steels.

Furthermore, a cooperation with the University of New South Wales (Sydney, Australia) during an outgoing research stay of a PhD Researcher, enabled further investigations using the scanning electron microscope and the transmission electron microscope. There, work on the grain size analysis and the precipitates formed was done during this three-month research stay. The results obtained were crucial to the better comprehension of the reasons behind the mechanical behaviour seen.



The continuous casting process and crack formation along the ferrite films at grain boundaries.

Impact and effects

The results have shown that the steel with less alloying elements has a worse ductility, specially between 700-850°C. This indicates the temperature range that should be avoided during the steps of the process, where the piece is under more stresses, such as the straightening and bending operations. The lower ductility, combined with more stresses and strains might lead to the formation of the undesired defects.

The other steel analysed showed a much better ductility, with no region of significant drop. The reason for this difference was then investigated to understand the causes of the worsening (or improvement) of the ductility in these steels.

One of the reasons found was the lower sulphur content and more significant presence of boron on the second steel. Furthermore, the higher Ti-content was also beneficial. The addition of Ti avoids the formation of BN, leaving the B free to retard the formation of ferrite films at grain boundaries (which are detrimental to the ductility) and increase the resistance to grain boundary sliding. Lower amount of S is also beneficial since the formation of MnS can be very detrimental. The microstructure analysis also confirmed the results.

Through the results obtained, it was possible to provide the industry valuable information for the improvement of the process parameters regarding this group of steels. This brings more efficiency to the process, less CO_2 emission, and lower production costs.

Project coordination (Story)
Marina Gontijo, M. Sc.
PhD Researcher
K1-MET

T +43 (0) 3842 - 402 2280
marina.gontijo@k1-met.com

K1-MET / Project 2.3 Work Package 3
K1-MET
Stahlstrasse 14
4020 Linz
T +43 (0) 732 - 6989 75607
office@k1-met.com
www.k1-met.com/en/

Project partner

- Primetals Technologies Austria, Austria
- voestalpine Stahl, Austria
- Graz University of Technology, Austria
- Montanuniversitaet Leoben, Austria
- TU Vienna, Austria

This success story was provided by the centre management and by the mentioned project partners for the purpose of being published on the FFG website. K1-MET is a COMET Centre within the COMET – Competence Centers for Excellent Technologies Programme and funded by BMK, BMDW, and the provinces Upper Austria, Styria, and Tyrol. The COMET Programme is managed by FFG. Further information on COMET: www.ffg.at/comet