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Damage mechanisms of HSM work roll grades for roughing stands – Tribological approach

C. Vergne[1,a] – O. Joos[2] - C. Gaspard[3,b] – J. Tinoco[4,c] – M. Moujib[5,d] – C. Boher[2,e] – F. Rézai-Aria[2,f]

[1] Åkers Belgium, Centre of Research Liege, rue de l'Avouerie 5, 4000 – Liege, Belgium
[2] Université Toulouse, Institue Clément Ader, Site Ecole des Mines Albi.
[3] Åkers AB, rue de l'Avouerie 5, 4000 – Liege, Belgium
[4] Åkers Sweden AB, R&D Department, 647 83 Åkers Styckebruk, Sweden
[5] Åkers France Sedan, 80 avenue de la Marne, 08201 – Sedan, France
[a]catherine.vergne@akersrolls.com,[b]claude.gaspard@akersrolls.com,
[c]jose.tinoco@akersrolls.com, [d]mohammed.moujib@akersrolls.com, [e]boher@mines-albi.fr,
[f]rezai@mines-albi.fr,

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Abstract. The current hot strip mills for steel rolling require more and more severe running conditions in order to increase the mill performance in terms of length of campaign, wear of work rolls and saving of energy induced by the reduction of rolling forces and torques applied to the rolls.

At the level of work rolls that involves occurrence of increasing thermal and mechanical stresses which request improved mechanical, thermal and physico-chemical resistances of work roll grades.

The roughing stands constitute the first stands in thickness reduction of the rolled strip. At the exit of reheating furnaces, the strip to be rolled presents an average temperature around 1200°C. Despite a superficial cooling induced by the descalers and edgers, the strip enters into the roughing mill with a still high temperature (>1000°C). With the roughing stands are usually associated water jets for a continuous cooling and descaling of the strip during rolling. The cyclic contacts of work rolls with the hot strip and the cooling water jets have as consequence to promote the occurrence of cracking network by thermal fatigue on the work roll surface.
Furthermore the reduction in thickness imposed at the level of these stands is the highest of the mill which induce high rolling forces.
The roughing stands are also the location of a very high superficial oxidation of work rolls consequently to the high strip temperature.
Considering the damage observed on the work rolls issued from the roughing stands and the imposed solicitations, the required properties for the work roll grades are a high resistance to thermal cracks reinforced by a high yield strength at high temperature, a satisfying low cycle fatigue resistance as well as a high resistance to oxidation sustained by a high hot wear resistance.
The rolling conditions becoming nowadays really drastic, a particular interest in the work rolls metallurgy has been developed which enables to increase significantly the mill performances when decreasing damage of work rolls.

The aim of the study is to approach in a deeper way the mechanisms relating the chemical composition of a work roll grade for roughing stands with their oxidational, tribological and thermal fatigue properties.
It seems that the tendency of a grade to form a superficial oxide scale influences its tribological behavior as well as a part of its mechanical resistance through its contribution to the initiation and the propagation of cracks.