

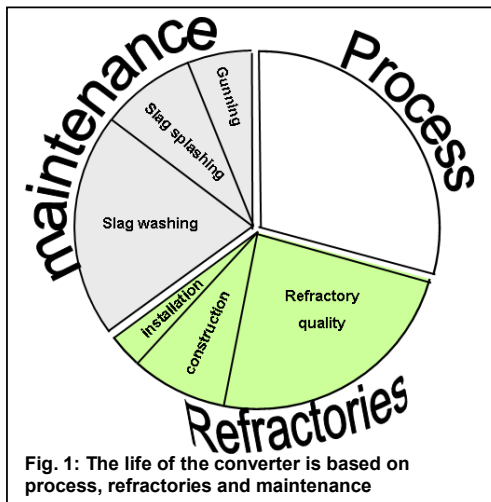
Integrated approach on improving converter linings; focus area thermo-mechanical improvements for the bottom

R. Siebring, K. Andreev, W.M. Heijboer, S.J. Everstein, A.P.Schmidt, J.P.T.M. Brockhoff

1 Introduction

There is a constant ambition within Corus steel plants to increase production. The availability of the converters is playing a key role in reaching this objective. Within the Corus plants several actions have been taken in the past few years to achieve improved availability; shorter cycle times, shorter repair times, longer life for the taphole including shorter re-sleeving time, lowering tapping temperatures as well as improved refractory life with lower maintenance time.

To increase the refractory life of the converter several projects have been set up for the different plants within Corus. One of these projects has focussed on the thermo-mechanical problems and solutions.



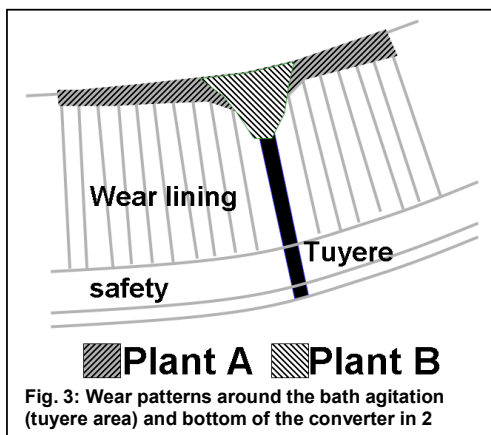
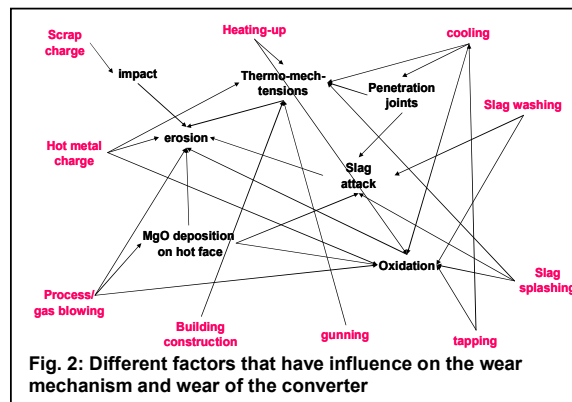
However not all wear mechanisms play an important role in every part of the converter. Therefore it is important to know and understand for each area the most important mechanism or, in case of a combination of mechanisms, how they interact (fig 2).

2 Wear mechanism in the converter

The life of converters differs between steel plants because of differences in design/refractories, process and maintenance practices (fig.1). To make improvements all these aspects have to be taken into consideration otherwise unexpected negative effects may occur.

The main wear mechanisms in the converter are:

- Impact
- Corrosion
- Thermo-mechanical stresses
- Erosion.



3 Bottom and bath agitation area

Bottom wear and especially the wear around the bath agitation elements is one of the determining factors for the converters in several plants of Corus.

Accelerated wear during the first 50 heats, stepwise wear of the bottom and crater formation around the bath agitation are some of the observations made at the beginning of the project.

The wear patterns between the plants differed as well. In one plant the wear focussed mainly around the bath agitation (in this case tuyere), whereas in the other plant stepwise wear in the rest of the bottom occurred as well (fig 3). Both plants had quick wear at the very early stage of the campaign. The project started with analysing the problem and trying to link the observed refractory wear to material properties, design issues, process issues and/or

maintenance practices. Several possible factors have been investigated, like slagwashing practice, heat up, cycle time, empty time, slag chemistry, design of the refractory lining etc. Moreover, a lot of

Deleted:

refractory material properties have been tested to see if they could be linked to the wear observed, like abrasion resistance, oxidation resistance, chemical attack, effect of carbon content and more. Even though some factors showed some minor correlation, very clear correlations could be found between the heat up practice and early accelerated wear in the first heats. There is also a clear correlation between the thermo-mechanical characteristics (strength, flexibility) of the refractory and the wear patterns in the bottom and around the bath agitation elements.

Thermo-mechanical modelling using the Finite Element Method is an excellent tool to analyse and to improve refractory construction [1,2]. This modelling showed that the different material characteristics could be linked to the difference in wear observed in the bottom and

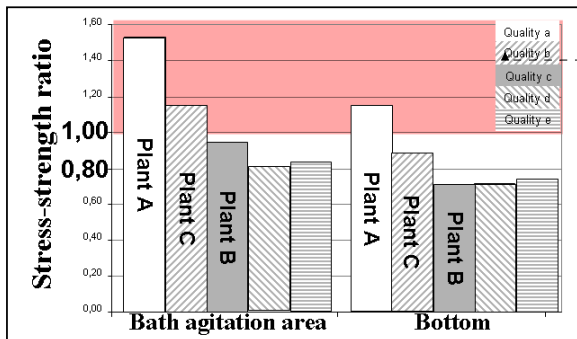


Fig 5: stress-strength ratio of 5 different material (different suppliers) around the bath agitation and bottom area. around the bath agitation (fig 4).

The material stresses calculated for plant A exceeded the strength of the material (fig 5) resulting in thermal spalling and stepwise wear. For plant B the material strength is only slightly better than the stresses calculated around the bath agitation. This doesn't cause spalling, but small cracks are formed. Together with the erosion of the gasflow this material is sensitive to accelerated wear around the bath agitation elements. Based on this, materials with better characteristics have been developed/ selected. Figure 6 shows the result of the first trial with better material (tapping side is at 180° and the charging side is at 0°). These results have been confirmed by trials in plant C, which has changed from quality B to quality D (measured improvement around 35%).

Together with the IJmuiden brick plant DSF, the Ceramics Research Centre is developing refractory qualities that have even better stress-strength ratios than the already existing qualities, so that further performance improvements may be expected in the near future.

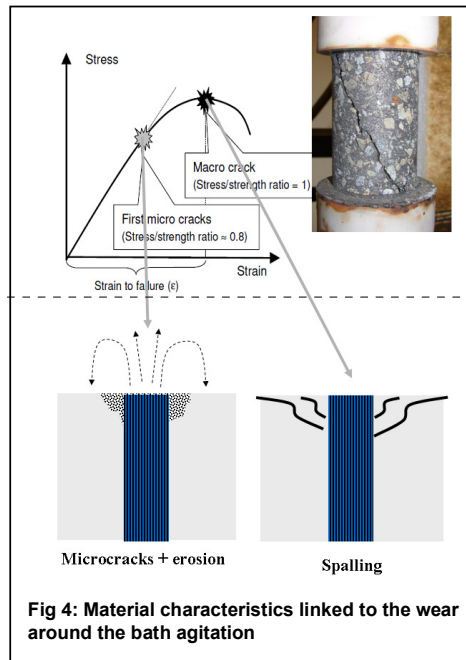


Fig 4: Material characteristics linked to the wear around the bath agitation

Formatted: English (U.K.)

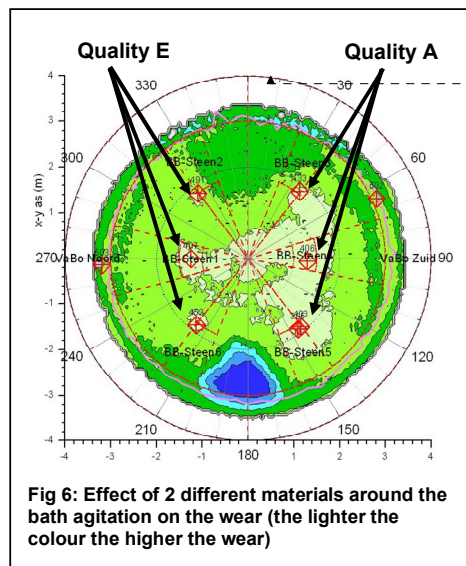
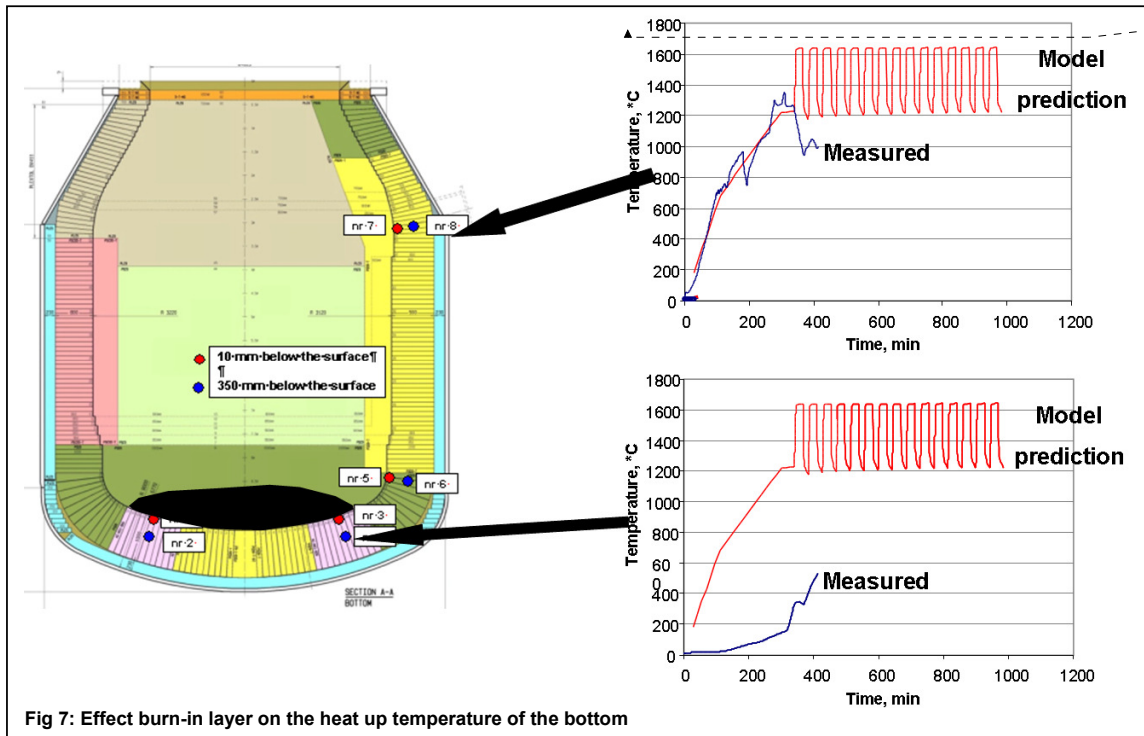


Fig 6: Effect of 2 different materials around the bath agitation on the wear (the lighter the colour the higher the wear)

Formatted: English (U.K.)

During thermal validating of the model a difference was found between measured data and model predicted values in the bottom (fig 7), while the rest of the converter measurements showed a remarkable good agreement with the modelled data.

The way of heating creates the situation that only at the end of the heating up the bottom is increasing in temperature. The temperature difference during the first heat and the bottom temperature creates very high stresses resulting in cracking and spalling of approximately 100 mm of refractory material during the first 50 heats. Special measures to protect the bottom for the first heat or improved heating procedures have been implemented, resulting in significant lower wear in the first heats (no spalling).



4 Conclusion

To improve life of a converter all wear mechanisms have to be considered. So analysis to find the main determining wear factor is crucial for improvement of the situation. If a correlation between the material/process characteristics has been established, quick and substantial improvements can be made. In case of the bottom/bath agitation area thermo-mechanical characteristics of the refractories (strength and flexibility) are found to be the determining factors for the life of the bottom. Even though significant improvements have been made, with new qualities in development in the Ceramics Research Centre and Corus' DSF brick plant, further improvements can be expected.

Acknowledgements

We like to thank the steel plants in Scunthorpe, Port Talbot and IJmuiden for their cooperation and support within this project.

References

1. [K.Andreev, W.Heijboer, R.Siebring, Y.Bi, M.Frith, S.Everstein, J.P.T.M.Brockhoff, M.Davis, C.Vaughan](#), BOF Bottom wear around tuyeres and blowing elements-thermomechanical investigations to optimise the lining performance, UNITECR 2007, p318-321
2. [R.Siebring, K.Andreev, T.Horio, J.W.Vos](#), Conventional Refractory lining for non-oxidising furnace of the galvanising line-thermo-mechanical computer analysis to find an alternative for ceramic fibre, UNITECR 2007, p414-417