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THE INSPYRO-SPARK CALCULATION TOOLBOX FOR SLAG ENGINEERING PROPERTIES

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Introduction

To enable maximal slag valorization with minimal costs, a number of processors have adopted batch-wise slag modification or treatment schemes. Batch-wise processing does not allow blending, and hence needs to cope with the full variability with a short reaction time. The strategy is that, based on the composition, the expected mineralogy can be calculated, and the best possible application can be selected – which may require a different cooling or treatment procedure. Or, the composition can be used to define the minimal amount of additions to reach the desired properties, as well as the amount of heat and hence combustibles needed to dissolve those additions. This immediately results in a cost for this batch, which can be balanced by the benefits in order to take a decision on the treatment or application route. To assist in this kind of decision process, as well as to support any other slag engineering activities, InsPyro has developed a toolbox for slag properties based on state-of-the-art thermodynamic calculations.

Calculation of slag properties

Based on slag composition and temperature, the Spark toolbox enables to calculate several important slag properties. Phase formation as a function of temperature, and the expected minerals in the slag after cooling, are important results for slag processors. Phase fractions at high temperature, liquidus and solidus temperature, and metallurgical properties, such as the sulphur capacity, are crucial to the metal plant operator. Viscosity of the slag as a function of temperature, which determines how easily the slag can be handled, can also be calculated.

The models behind this package are based on thermodynamic databases, combining Gibbs-free energy phase models to predict the stable phases at any composition and temperature. More details can be found elsewhere1. Combined with dedicated liquid viscosity models, this already gives the basic functionality, showing the melting point for a certain composition, and the liquid fraction, solid phases, and effective viscosity at a given temperature (Figure 1). The composition is then also plotted on a fully

customized phase diagram, taking into account the relevant impurities (Figure 2). A unique feature is the combination of liquid viscosity data with the solid fraction, which enables to have a much more realistic idea of the effective viscosity, as illustrated in Figure 3.

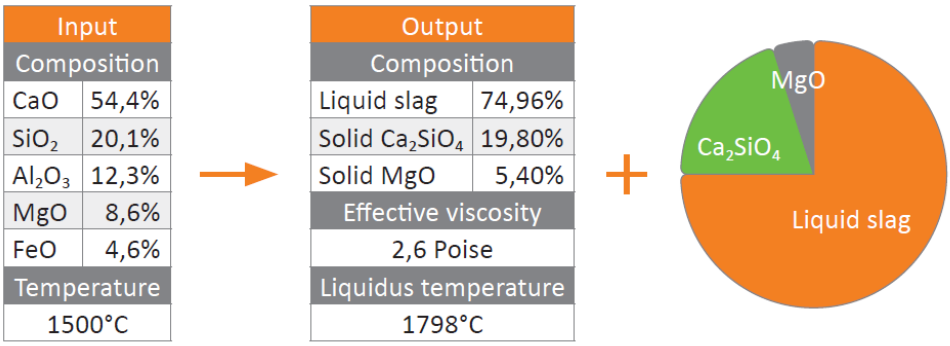

Figure 1: Basic hot stage Spark module: from composition and temperature to phase distribution, effective viscosity, and melting point. The applicable phase diagram can also be shown.

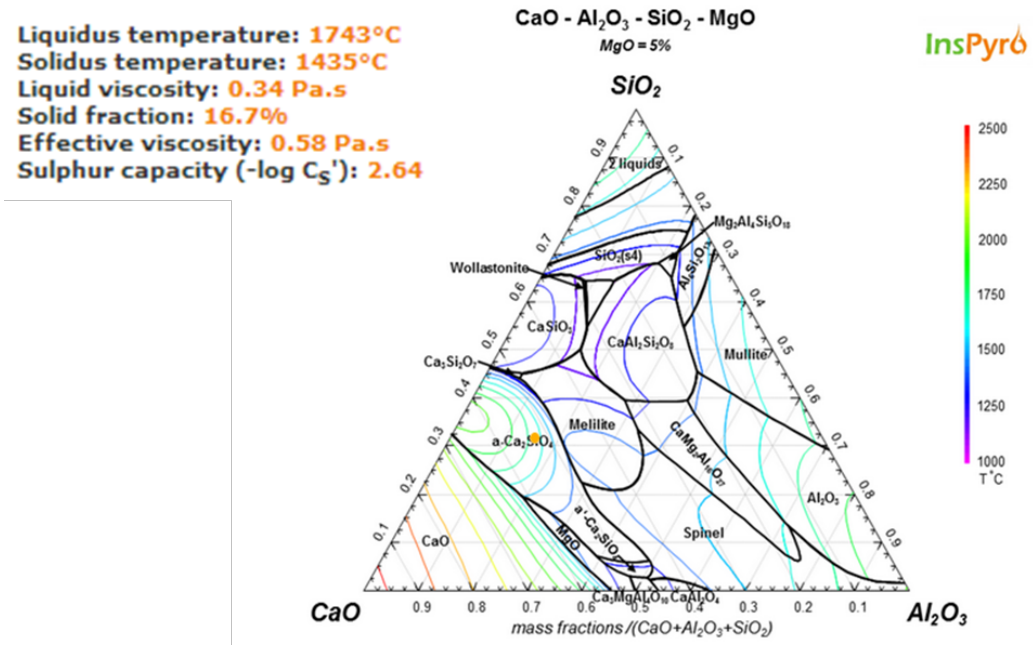

Figure 2: Typical multicomponent melting point (liquidus) projection for slags (interactive online demo version available at InsPyro website)

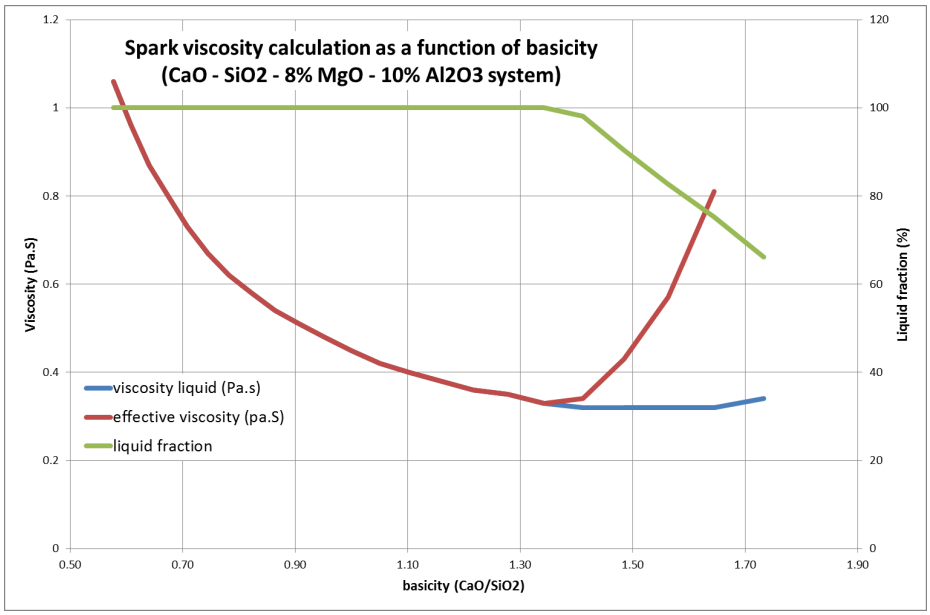

Figure 3: Spark calculation result for viscosity of a CaO - SiO_2 – 8 wt.% MgO – 10 wt.% Al_2O_3 slag as a function of basicity, showing the added value of combining phase diagram data (solid fraction) into the viscosity model

Additional functionality has been added recently. Energy recovery from slag is a growing concern, as several speakers in this symposium have already highlighted. Therefore, the toolbox has been enabled to provide the heat content of the slag (by the enthalpy release upon cooling, as shown in Figure 4), which could be recovered. Also, hot stage slag engineering is supported, by calculating the amounts of corrective additions needed for basicity control and avoiding powder formation. Finally, the mineralogy evolution during cooling can be calculated. Combined with literature data or customer insights on slag reactivity or other quality parameters, this approach enables to take corrective actions before the slag is even tapped.

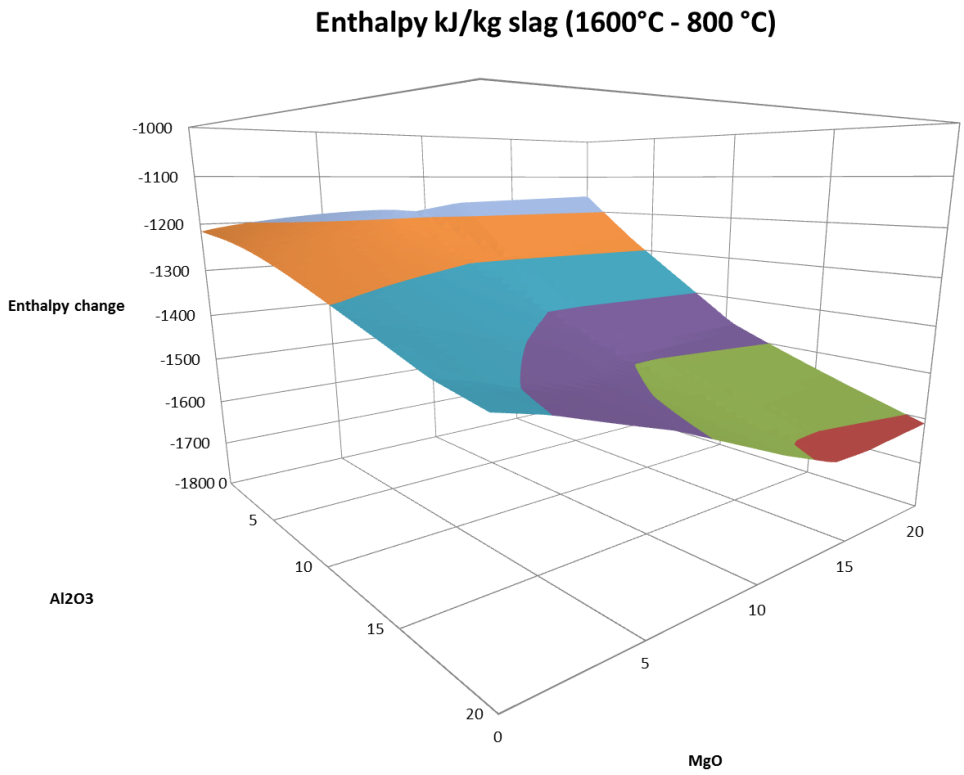

Figure 4: Heat release of a slag as function of composition as calculated with Spark

Conclusion

InsPyro has built up insight in slag processes, which is transferred through consultancy projects, as well as packed in customized software for maximal availability of the results. The resulting Spark-software gives the slag engineer or slag end-user a must-have toolbox with unique functionalities. The program features fast calculation with a single click, is fully integrated in Excel, and makes use of the state-of-the-art to come to quantitative and reliable results. Despite its scientific background, no expert interpretation is needed to use the user-friendly interface and customized results overview.

InsPyro believes that this toolbox will help slag handlers and researchers to develop smarter slag recuperation and engineering schemes, improving slag quality and value recovery. Also, it will help slag producers improve their metallurgical process, leading to better slag cleanliness and lower variability.

References

1. E. Nagels, S. Arnout and B. Soete, “Slag properties – Easy access using new dedicated software”, in *Proceedings of the 7th European Slag Conference*, IJmuiden, The Netherlands, 2013.