Slag-Induced Corrosion of Chromium Oxide-Free Refractory Materials Under Simulated Gasification Conditions: A Multi-Step Modelling Approach Using FactSage

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ABSTRACT

The corrosion of refractory materials is present in gasification or any other kind of high temperature conversion of solid fuels. Besides spalling, abrasive particles, and corrosive gases the liquid slag is designated to act as an aggressive medium. Thus, the high temperature behaviour of ashes and their interaction mechanisms with refractories have to be understood in detail.

Newly developed alumina and spinel based refractory materials are exposed to three different ashes under a reducing atmosphere composed of 5 vol.% H_2 and 95 vol.% Ar with a continuous gas flow.

Ashes from hard coal, brown coal, and biomass placed on the refractory samples are gradually heated up to a final temperature of 1450 °C in the performed lab-scale test. All ashes have shown a flow temperature in the range between 1246 and 1304 °C, which leads to the presence of liquid slag and its infiltration prior to reaching the final process temperature.

The slag infiltration and refractory corrosion in the experimental semi-open system are reproduced by thermochemical equilibrium calculations using the FactSage software package. Herein, a multi-step modelling approach is employed, which has considered the slag progression due to partial refractory dissolution. Slag infiltration into the refractory material and the resulting mineral phases are reflected by this model in a reasonable consistence with the experiment.

Different corrosion mechanisms under combustion conditions are well understood. The present study is focussed on the detection of corrosion mechanisms and related reaction pathways under simulated gasification conditions for which only a few mechanisms are known. Finally, the determined experimental slag infiltration depth is related to the different calculation steps by means of the characteristic mineral phases.