Applying Thermo 350M Underground - A FactSage Equilibrium Study for Underground Coal Gasification

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ABSTRACT

The behaviour, and importantly the mineral matter composition of a coal source, directly relates to the ash fusion temperature (AFT) profile of the coal source. This property is one of the parameters currently widely used in coal marketing and utilization to assess coal ash fusibility and melting characteristics and it is furthermore used to predict the melting behaviour of the coal ash in coal conversion processes. However, the flow temperature of a specific coal source alone does not provide enough insight into the slag formation behaviour at temperatures below the flow temperature or any indication of the viscosity of the ash. It has been demonstrated and published that the ash flow temperature can be correlated with equilibrium calculations, and that such equilibrium calculations provide useful information regarding the phase transitions that take place well below the final ash flow temperature as indicated by a standard AFT analysis. Previous studies have confirmed that the slag-liquid flow temperature simulations for coal and individual mineral types compared favourably with the actual measured ash flow temperature and are within the experimental error of an AFT analysis (±30^{o} C).

The overall objective of this study is to apply a FACTSAGE™ equilibrium approach to an Underground Coal Gasification (UCG) technology and simulating the slag and viscosity behaviour of a specific coal source. Although the effect of trace element speciation and leaching from the ash are also included in this study, the results will be presented in another paper.

FACTSAGE™ modelling showed that the amount of slag to liquid of the ash, that was studied, will be highly dependent on the temperature and operational procedure within the gasification cavity to which the minerals will be exposed. For example, the amount of slag to liquid can (in dependence of base-acid-ratio) double by only increasing the operating temperature of a process. Variation in operating temperature will also result in a variation of agglomeration and porosity of ash formed in the cavity. The optimal ash property for a UCG cavity will have to provide the desired porosity or even distribution of agent (air, steam and oxygen) through the slag in the cavity. Excessive clinker formation or porous ash structure formation in the mineral matter may cause channel burning, pressure drop problems or unstable gas production during operation, and in severe cases even oxygen break-thoughts.