Gasification is used to convert carbon feedstock (primarily coal and/or petcoke) into synthesis gas, a mix of carbon monoxide (CO) and hydrogen (H₂), for use in power generation or chemical production. In high temperature gasification processes, the mineral impurities in coal and petcoke melt and coalesce to form a liquid (slag) that must flow from the gasifier. If slag does not flow from a gasifier, its buildup will cause process shutdown and 1) the need for physical entry into the gasifier to remove the buildup (consuming time and damaging the refractory lining), and/or 2) the gasification temperature must be increased to lower slag viscosity so it will flow from the gasifier. Temperature increases, however, lead to greater refractory wear/corrosion (resulting in a shorter refractory service life), as well as an increase in gasifier fouling and downstream component wear.

The ability to accurately predict coal ash viscosity in advance of its gasification is important to gasifier operators so they know in advance how to control slag flow from a gasifier at a desired gasification temperature, and so they can predict interactions with refractory liners based on slag composition. NETL developed a first generation computer program to predict slag viscosity using an expandable database of coal slag viscosities, allowing a user to predict coal ash viscosity before use and to determine oxide material additives for the slag chemistry that will control its flow in the gasification chamber. The slag model is based on the assumption that similar slag chemistries will have similar slag viscosities. The basic architecture of the slag model used to predict slag behavior is shown below.

Viscosity predictions using the slag management model developed by NETL has been shown (1) to be of greater accuracy than thermodynamic predictions or predictive models available commercially or in the literature. Testing and validation of the model is still underway. Customization and validation of the model to a specific user’s coal ash chemistry is the goal of the current model.

The slag model is being evaluated commercially as part of a technology commercialization program at Eastman Chemical Corp. The slag model data base was expanded in a targeted area of the slag composition using select viscosity models, thermodynamic predictions, viscosity measurements of specific coal ash chemistries, proprietary slag chemistry/viscosity data of Eastman, and special viscosity measurements of actual and synthetic slags with/without additives. Viscosity, temperature, and chemistry data was modeled to predict viscosity behavior.

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