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Data Validation and Reconciliation of Entrained-Flow Gasification with Aspen Plus

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Partial oxidation of ash-containing carbonaceous feedstock is widely carried out as entrained flow gasification using water-cooled reactors with liquid slag discharge [1, 2]. Reactor temperatures can reach up to 1600°C in order to maintain high carbon conversion (>95%) and stable slag flow. Hence, the reactor temperature is a key parameter for defining the optimum operating point. However, the harsh conditions do not allow direct temperature measurement within the reactor. In addition, the delay of analyses (e.g. methane content in the raw gas) make the process hard to control. Sensitivity analysis shows that typical measurement uncertainties, e.g. in the carbon content of the feedstock, can lead to uncertainties of more than 150 K in the reactor temperature.
Data validation and reconciliation allow to incorporate all relevant measurements with their respective accuracies into a model so that a consistent solution is obtained which allows evaluation of all parameters including e.g. gasification temperature. The deviations between measurements and model variables are minimized while solving energy and mass balances, so that the most probable solution is obtained.

In this work, the Aspen Plus process simulation tool was used to reconcile operating data from existing plants in order to systematically determine the actual gasification temperature, carbon conversion and other key performance indicators. Therefore, a special procedure for feedstock definition and gasification modelling was developed. The Aspen Plus models were transferred to equation-oriented mode and a three-step process for conversion modelling was implemented including decomposition of the feedstock, oxidation of char and gas phase reactions.

Amongst other applications, this procedure was applied to the bio-slurry gasification of the Bioliq® demonstration plant. Results for this case are presented including comparison between measured and reconciled data, e.g. feedstock or gas composition. It was also found that the uncertainty in the reactor temperature can be decreased due to data reconciliation by more than 50%.

References

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