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Analysis of slag thickness in entrained flow gasification of biomass at the bioliq® plant.

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Total or partial substitution of coal by biomass in entrained flow (ETF) gasification processes allows for CO_2 emission reduction. A key process factor of ash containing feedstock gasification with an ETF is to ensure a stable liquid slag flow along the reactor wall. However, compared to coal, ash amounts and ash or slag properties are different for biomass. The bioliq® demonstration plant aims to validate high quality fuel production from biomass via syngas route. The partial oxidation unit is a 5 MWth entrained flow reactor equipped with a cooling screen, which can be operated at two different pressures of 40 or 80 bar(a). Dedicated experiments have been carried out to study the slag behaviour from biomass gasification at the Karlsruhe Institute of Technology (KIT).

The measured total slag thickness along the reactor wall is in the range of 2-7 mm which is significantly lower than what is reported in literature for coal gasification [1]. The model developed by Seggiani et al. [1] to describe the heat transfer through slag layers has been used to calculate the temperature profile across the cooling screen. Thermocouples measurements inside the ramming mass support the calculated profile. Based on this profile, liquid slag mass flow can be obtained.

An important parameter in the model is the critical viscosity temperature which is the temperature at which the slag flows down along the reactor wall [2]. As a practical rule, a slaging gasifier system should be operated at a temperature allowing for the flowing slag a viscosity of 25 Pa·s in order to avoid perturbation in process [3]. In order to be in agreement with the experimentally observed slag mass flow during biomass gasification, the slag starts to flow at a viscosity of ~ 1000 Pa·s. This work shows that for glassy slag from biomass, the spherical temperature of the ash is a good educated guess to make the distinction between the stationary and the mobile phase of the slag layer.

References

[1] M. Seggiani. Modelling and simulation of time varying slag flow in a Prenflo entrained-flow gasifier. Fuel 1998;77:1611-1621.
[2] S. Vargas, F. J. Frandsen, K. Dam-Johansen. Rheological properties of high-temperature melts of coal ashes and other silicates. Progress in Energy and Combustion Science 2001;27:237-429
[3] M. Gräbner. Industrial Coal Gasification Technologies Covering Baseline and High-Ash Coal, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany; 2015.