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Mathematical Modelling of Slag Formation in an Entrained-Flow Gasifier

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Abstract : Gasification processes are of great interest due to their generation of renewable energy in the form of syngas from biodegradable waste. It is, therefore, important to study the factors that play a role in the efficiency of gasification and the longevity of the machines in which gasification takes place. This study focuses on the latter, aiming to optimize an entrained-flow gasifier by reducing slag formation on its walls to reduce maintenance costs. A CFD mathematical model for an entrained-flow gasifier is constructed – the model of an actual gasifier is rendered in 3D and appropriately meshed. Then, the turbulent gas flow in the gasifier is modeled with the realizable k-ε approach, taking devolatilization, combustion and coal gasification into account. Various such simulations are conducted, obtaining results for different air inlet positions and by tracking particles of varying sizes undergoing devolatilization and gasification. The model identifies potential problematic zones where most particles collide with the gasifier walls, indicating risk regions where ash deposits could most likely form. In conclusion, the effects on the formation of an ash layer of air inlet positioning and particle size allowed in the main gasifier tank are discussed, and possible solutions for decreasing a number of undesirable deposits are proposed. Additionally, an estimate of the impact of different factors such as temperature, gas properties and gas content, and different forces acting on the particles undergoing gasification is given.

Keywords : biomass particles, gasification, slag formation, turbulence k-ε modelling
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