Feasibility study of the gasification of glycerol: CFD Modeling based on Lagrangian-Eulerian Approach

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Abstract: With increasing biodiesel production, the growth in glycerol annual quantities continues to rise. The global glycerol production was estimated to increase from 5.1 million tons in 2011 to 7.66 million tons in 2020. Although glycerol has found different applications, significant proportion of annual glycerol produced goes into surplus, reaching about 60% of global production in 2011. Gasification is one technology that would assist in better usage of the surplus glycerol due to feedstock flexibility and additional to carbon capture potentials. Hence, the feasibility of the gasification of glycerol in a drop tube reactor was evaluated in this study through reacting flow computational fluid dynamics (CFD) models. The model is based on a Lagrangian-Eulerian approach, whereby the feedstock was represented as a discrete phase in a continuous gaseous turbulent regime. The viscous realizable k-ε model was used to account for the turbulence and the particle dispersion was represented through the Stochastic Discrete Random Walk model. These main devolatalization chemical kinetics are obtained from TGA experimental data using an approximation method. Initial results obtained from high fidelity modeling indicate that glycerol converts to syngas at moderate temperatures (627°C). Moreover, the model of hydrogen and carbon monoxide increased along the reactor centerline reaching 0.557 and 0.420 at the exit, respectively. The CFD model showed better prediction as compared to 0-D low fidelity thermodynamics based estimates.