Entrained Flow Gasification of Solid Waste and Coal Mixture

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Abstract

The high variability of solid waste composition affect the amount of volatile and solid carbon contents. This posse huge challenge for gasification. To limit such variability co-mixing with coal can lead to better gasification metrics. This mixture is a dual solution to the discarded waste as well as the generation of energy at high conversion efficiency when using IGCC inside the highest gasification technology like the entrained flow gasifier. The two mixtures can be mixed and prepared as the slurry and skipping the burden of liquid carrier like water that compromising their high conversion efficiency. In this work two level of modeling are pursued for the gasification of MSW coal mixture. The thermodynamic equilibrium approach is used first to calculate the maximum cold gasification efficiency (CGE) at different mixture in an attempt to narrow down and focus on the appropriate mixing rate of the two feedstock within the entrained flow gasifier. The high temperature of the entrained flow gasifier (1200 to 1500^{o}K), the ease in crushing/preparing coal appropriate size (10μm to 0.1mm), and the well mixing environment of the entrained flow gasifier is all amenable for equilibrium analysis. A sweeping values of the feedstock mixture is attempted using oxygen as oxidizer and water as moderator. A parametric study is conducted to show the gasification metrics, i.e., CGE and feedstock conversion, and the syngas composition at different gasification conditions. The model is based on 8 unknowns in the gasification product: H2, CO, CO2, H2O, CH4, O2, C_{solid} and Temperature under variable O2 and H2O molar ratios. Using four elemental mass balance and three equilibrium (C_{solid}) constant relations and energy balance mathematical code is developed that also incorporate the solid un-burn carbon in product species. The temperature of gasification is determined following iterative approach. Result of model shows that the maximum CGE is achieved when all the solid carbon is converted into the carbon monoxide with nearly all hydrogen present in the feedstock converted into the hydrogen gas. Using this result a high-fidelity reactive flow model that accounts for the reactor geometry and the devolatilization kinetics is developed. This model accounts for extended set of reaction covering the combustion, water and gas shifts, and boudwards beside the devolatilization. Result shows a growing-falling trend of CGE and conversion that peaks at 20% MSW to 80% to coal mixtures.

Keywords: *Thermodynamics equilibrium, entrain flow gasifier, cold gasification efficiency*