Gasification of Plastic Waste: High fidelity modeling and simulation

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Abstract: Gasification is will developed technology for coal but as energy recovery from municipal solid waste (MSW) and its recyclable derivatives, (i.e. RDF, Tire, Plastics etc.) is still at the infancy stage and economically challenged compared to the land filling and incineration. It, however, is receiving considerable interest offering landfill diversion, feedstock flexibility and downstream customization for product variety from syngas, electricity, ethanol, diesel to other chemical or simple sensible heat and steam. Plastic in the form of Polyethylene, polypropylene, polystyrene holds about 12% of the MSW fraction and characterized with the highest caloric value (near 40 MJ/kg) and that entice their gasification. It differs from any conventional solid fuel or waste (coal, pet coke, biomass, MSW) being composed of 100% volatile. In this work TGA analysis carried first for sample plastic waste to evaluate their biodegradation activation energy which is the main parameter used in develoatilizatoin. This then integrated to high fidelity numerical model in an attempt to obtain a comparative analysis for the three different plastic feedstock and their co-gasification. The model is based on an Eulerian-Lagrangian approach, i.e. discrete feedstock phase in a continuous oxidant gaseous phase. A turbulent flow is considered (using SST k-ω model), gas phase gasification (Species Transport model), particles devolatilization (Kobayashi Two-Competing Rate model), particle dispersion by turbulent flow (Stochastic Discrete Random Walk model), radiation (P1 model) and solid particle distribution (Rosin Rammler model). The temperature and product distributions are captured as well as the gasification metric. Main results suggests, no significant changes in both temperature and species distribution in these plastics or their combination and revealing the average Cold Gas Effeciency of 70, 71, and 73 for PE, PP, PS, respectively.
Keywords: Plastic Gasification; Plastic Waste; TG Analysis; Chemical kinetics