Effects of Preheated Temperature and Change in Gas Composition on Soot Formation in Gas Reforming Process by Partial Combustion Method

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Partial combustion can be an effective way to reform fuel gases. The possible application we assume is reforming of tar in a producer gas from woody biomass gasification. The reforming process of tar by partial combustion of the producer gas is conducted in a gas reformer by the combination of oxidative and thermal cracking of tar. The partial combustion type gas reformer is an apparatus stage subsequent to the biomass gasifier. The inverse diffusion flame is formed when the oxidizer for partial combustion is supplied to the producer gas. Cracking and polymerization of the tar occur simultaneously at proximity of the inverse diffusion flame. This polymerization of tar into soot is, however, a significant problem in the gas reformer, e.g. the reduction in the carbon conversion ratio and the change in temperature field by radiation from soot. The experimental study and numerical study have been performed to clarify effects of hydrogen addition to the oxidizer on soot formation and growth of the polycyclic aromatic hydrocarbons (PAHs) that is precursor of soot.

The experimental results are as follows. Increase in the set temperature of a tubular electric heater to preheat the model producer gas suppresses soot formation. There can be two groups of effects derived from the preheating of model producer gas. One is simple increase in preheated temperature of model producer gas. The other is composition change of the model producer gas just before the combustion region. Polymerization characteristics of PAHs (precursor of soot) have been investigated by numerical simulation where the opposed-flow diffusion flame model coupled with an elementary reaction mechanism is used. The numerical results are as follows. On the one hand, the increase in the preheated temperature of the model producer gas by increase in the set temperature of the tubular electric heater has little effect on polymerization characteristics of PAHs. On the other hand, a composition change of model producer gas, especially the decrease of toluene (supplied model tar) is dominant in a suppression effect in polymerization of PAHs.

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