Oxy-steam gasification of biomass for hydrogen-rich syngas production

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Keywords: Oxy-steam gasification, hydrogen, biomass, syngas, Aspen plus

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Abstract

Rapid population growth and improvement in the masses' standard of living have led to an exponential increase in energy requirements. Accelerated use of conventional energy sources, which are limited in quantity, leads to increased cost and environmental degradation due to emissions. Renewable energy sources like solar, wind, and biomass can help solve these problems. Biomass, a carbon-neutral energy source, can be converted to useful gaseous fuel via gasification technology. Further, using oxy-steam gasification of biomass, H_2-rich syngas can be obtained, which can be used for cleaner combustion or synthesis applications upon downstream processing.

The present research focuses on producing hydrogen-rich syngas using oxy-steam gasification of biomass in a downdraft gasifier, which can be used for hydrogen production. A comprehensive equilibrium model for oxy-steam gasification of biomass for H_2-rich syngas production has been developed using Aspen PLUS process simulation software and validated with experimental data available in the literature. Increased gasification temperature from 700 ℃ to 1000 ℃ resulted in a monotonic reduction in H_2 and CO_2 content in syngas with a subsequent increase in CO content. This increase in gasification temperature also results in an increase in syngas lower heating value (LHV) and cold gas efficiency (CGE) from 7.55 to 8.34 MJ/Nm^3 and 63.5 to 64.85 %, respectively. The increase in equivalence ratio has an opposing trend, both on syngas LHV and CGE. An increase in steam to biomass ratio increases syngas H_2 content by about 8 % at an expense of approximately 21.5 % in CGE.