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Modeling and simulation on hydrogen-rich syngas production via gasification of palm kernel shell

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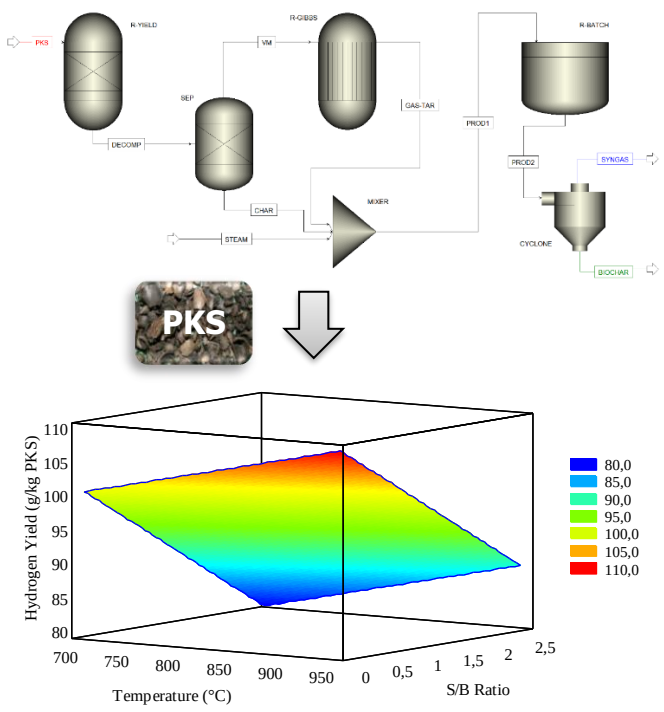
Graphical Abstract



Abstract.

The high world energy demand has caused sustained growth in the use of fossil fuels, depleting its reserves, raising the cost of energy in many places, and contributing significantly to climate change [1]. Biomass is considered a sustainable energy source by having a net neutral production of carbon dioxide [2], such that it can partially replace fossil fuels. One of the ways of using biomass is to obtain new energy vectors, such as hydrogen, whose production from residual biomass is technically and economically feasible [3]. On the other hand, the Aspen Plus simulation software has been used in various petrochemical processes, such as methanol synthesis, indirect liquefaction and hydrogasification of coal, combined cycles in power plants; however, its application in biomass transformation processes has been limited [4]. Therefore, in this research the gasification process of palm kernel shell (PKS) was modeled and simulated at steady-state using Aspen Plus, varying the temperature (750 to 950 °C) and the steam/biomass ratio (S/B) between 0 and 2.5 (w/w), to determine its effect on the production of H_2 present in the syngas. The kinetic parameters of the gasification were determined by means of a thermogravimetric analysis (TG/DTG) using two gasifying agents (CO_2 and steam) and applying three semi-empirical kinetic models to interpret the experimental results (linear model, grain model, and volumetric model). Linear model and grain model have the best fit with the experimental results of PKS

	gasification with steam and CO_2, with R^2 values of 0.966 and 0.965, respectively. The simulation allowed obtaining results with a good fit with the experimental data (RMSE 0.135) and with greater precision compared to another model simulated in Aspen Plus (RSME 0.282) [4]. The yield of H_2 production as a function of temperature and S/B ratio was estimated by a multiple linear regression model, obtaining that its production oscillates between 80 and 109 g H_2/kg PKS, reaching its maximum peak at 950 °C and an S/B ratio of 0, and the minimum production at a temperature of 700 °C and an S/B ratio of 2.5.

Keywords: *palm kernel shell; kinetic modeling; gasification; hydrogen.*

References

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