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CFD-ADGBR-CFD analysis of a downdraft gasifier working with biomass residues

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The study and characterization of various biomasses as an energy resource has been a topic of research that has been given more L attention in recent years, mainly due to its potential energy potential and high production volumes. Biomass gasification is a promising technology, efficient in energy production, which can make a significant contribution to the generation of renewable energy. Costa Rica presents great potential for the use of biomass residues for energy production. The production of lignocellulosic biomass residues from the main agricultural activities at the national level reached approximately 6 500 000 tonnes per year in 2010, which highlights the importance of implementing this type of techniques as a means of exploiting biomass residues in the agricultural industry. In the present investigation, gasification was evaluated as an alternative to the use of biomass residues, studying the behavior of synthesis gas production through the computational fluid dynamics modeling by varying different physicochemical conditions, which allow to validate the implementation of this type of technology as an efficient biomass conversion tool in a renewable fuel. A mathematical model has been developed which describes the behavior of the biomass when exposed to the gasification dynamics, analyzing the thermodynamic behavior and the production of chemical species in the different stages of gasification. The simulation of Computational Fluid Dynamics (CFD) is based on the biomass downdraft gasifier designed by the Institute of Engineering Research (IINI) of the University of Costa Rica, in San José, Costa Rica. Biomass gasification modeling was based on a multiphase approach, where both the gas phase and the solid phase were described using an Eulerian approach to model mass, energy and momentum exchanges between phases. The biomass bed constituted by sawmill residue pellets was described using the kinetic theory of granular flows. The chemical modeling was based on the transport of species, involving five homogeneous reactions and eight species in gas phase (CO₂, CO₃, O₃, N₄, CH₄, H₂O, H₂ and volatile compounds). The standard κ - ϵ model was included as a representative model of the turbulent flow characteristics in the reactor.

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