

Numerical Simulation of Different Configurations for a Combined Gasification/Carbonization Reactors

Authors : Mahmoud Amer, Ibrahim El-Sharkawy, Shinichi Ookawara, Ahmed Elwardany

Abstract : Gasification and carbonization are two of the most common ways for biomass utilization. Both processes are using part of the waste to be accomplished, either by incomplete combustion or for heating for both gasification and carbonization, respectively. The focus of this paper is to minimize the part of the waste that is used for heating biomass for gasification and carbonization. This will occur by combining both gasifiers and carbonization reactors in a single unit to utilize the heat in the product biogas to heating up the wastes in the carbonization reactors. Three different designs are proposed for the combined gasification/carbonization (CGC) reactor. These include a parallel combination of two gasifiers and carbonized syngas, carbonizer and combustion chamber, and one gasifier, carbonizer, and combustion chamber. They are tested numerically using ANSYS Fluent Computational Fluid Dynamics to ensure homogeneity of temperature distribution inside the carbonization part of the CGC reactor. 2D simulations are performed for the three cases after performing both mesh-size and time-step independent solutions. The carbonization part is common among the three different cases, and the difference among them is how this carbonization reactor is heated. The simulation results showed that the first design could provide only partial homogeneous temperature distribution, not across the whole reactor. This means that the produced carbonized biomass will be reduced as it will only fill a specified height of the reactor. To keep the carbonized product production high, a series combination is proposed. This series configuration resulted in a uniform temperature distribution across the whole reactor as it has only one source for heat with no temperature distribution on any surface of the carbonization section. The simulations provided a satisfactory result that either the first parallel combination of gasifier and carbonization reactor could be used with a reduced carbonized amount or a series configuration to keep the production rate high.

Keywords : numerical simulation, carbonization, gasification, biomass, reactor

Conference Title : ICSEEA 2020 : International Conference on Sustainable Energy Engineering and Applications

Conference Location : Lisbon, Portugal

Conference Dates : September 16-17, 2020