Thermodynamic Analysis and Computational Fluid Dynamic Modelling of Heat Transfer in a Double Barrel Batch Pyrolysis Reactor

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Conventional mass and energy calculations are lengthy, time consuming and visualization is difficult when it comes to higher order simulations. Thus, use of CFD tools for modeling is more efficient and sophisticated. In this study, heat transfer in two cylindrical geometries of a double barrel batch pyrolysis reactor having an inner pyrolysis chamber and outer combustion chamber was mathematically built. Finite element analysis of physical geometry using COMSOL® Multiphysics software was done. Finding the appropriate temperature distribution in the combustion zone to achieve the minimum temperature of 450^0C for 30 minutes duration in the inner pyrolysis chamber was the objective of model simulation. Rice husk was used as the feedstock for pyrolysis while dried Gilicidia (*Gliricidia sepium*) biomass was used as the combustion biomass both in simulation and actual field testing. During the field experiment at Meewatura experimental station, four K-type thermocouples were placed along the vertical axis of the outer chamber to capture the temperature profile during the twenty-two hours of reactor operation process. According to COMSOL® Multiphysics simulation model, the temperature of the combustion zone should reach minimum of 600^0C temperature to ensue pyrolysis at 450^0C in pyrolysis chamber. The field testing of actual reactor showed that the combustion zone temperature reached 800^0C and retain a minimum of 90 minutes giving adequate temperature and retention time for paddy husk pyrolysis at 450^0C. In conclusion, it was found that COMSOL® Multiphysics simulation model can be effectively used to simulate the heat transfer mechanism of Double Barrel Batch Pyrolysis Reactor.

Keywords: CFD modeling, COMSOL® Multiphysics, Heat transfer, Pyrolysis

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