**Abstract**

Hydrogen production from biomass such as palm oil wastes is an attractive option due to its abundance particularly in country such as Malaysia. Biomass thermal conversion processes including biomass steam gasification with in situ CO2 adsorption shows a great potential for renewable hydrogen production. Limited research focused on the utilization of palm waste material in steam gasification system with in-situ CO2 capture. The book highlights the theory, design and introduction of catalyst in the process for enhancement of hydrogen yield in product gas. The design of fluidized bed gasifier is highlighted based on the hydrodynamic parameter such as fluidization velocity to evaluate gasifier diameter and height. The performance of the system is included along with heat and mass transfer aspects of the fluidized bed system based on dimensionless Nusselt and Sherwood numbers with respect to Reynolds number. In addition, design of experiments (DOE) is performed using Response surface methodology (RSM) in conjunction with central composite rotatable design (CCRD) based on process variables range of Expert Design-8 software. The effect of process variables i.e. temperature, steam to biomass ratio, adsorbent to biomass ratio, fluidization velocity and biomass particle size on hydrogen production are investigated. The kinetic parameter evaluation of different chemical reactions i.e. char gasification, methanation, boudouard, methane steam reforming, water gas shift and carbonation reactions in ICA steam gasification is discussed.