

Similitude for Thermal Scale-up of a Multiphase Thermolysis Reactor in the Cu-Cl Cycle of a Hydrogen Production

Authors : Mohammed W. Abdulrahman

Abstract : The thermochemical copper-chlorine (Cu-Cl) cycle is considered as a sustainable and efficient technology for a hydrogen production, when linked with clean-energy systems such as nuclear reactors or solar thermal plants. In the Cu-Cl cycle, water is decomposed thermally into hydrogen and oxygen through a series of intermediate reactions. This paper investigates the thermal scale up analysis of the three phase oxygen production reactor in the Cu-Cl cycle, where the reaction is endothermic and the temperature is about 530 °C. The paper focuses on examining the size and number of oxygen reactors required to provide enough heat input for different rates of hydrogen production. The type of the multiphase reactor used in this paper is the continuous stirred tank reactor (CSTR) that is heated by a half pipe jacket. The thermal resistance of each section in the jacketed reactor system is studied to examine its effect on the heat balance of the reactor. It is found that the dominant contribution to the system thermal resistance is from the reactor wall. In the analysis, the Cu-Cl cycle is assumed to be driven by a nuclear reactor where two types of nuclear reactors are examined as the heat source to the oxygen reactor. These types are the CANDU Super Critical Water Reactor (CANDU-SCWR) and High Temperature Gas Reactor (HTGR). It is concluded that a better heat transfer rate has to be provided for CANDU-SCWR by 3-4 times than HTGR. The effect of the reactor aspect ratio is also examined in this paper and is found that increasing the aspect ratio decreases the number of reactors and the rate of decrease in the number of reactors decreases by increasing the aspect ratio. Finally, a comparison between the results of heat balance and existing results of mass balance is performed and is found that the size of the oxygen reactor is dominated by the heat balance rather than the material balance.

Keywords : sustainable energy, clean energy, Cu-Cl cycle, heat transfer, hydrogen, oxygen

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