World Academy of Science, Engineering and Technology
International Journal of Mechanical and Mechatronics Engineering
Vol:10, No:6, 2016

Heat Transfer Analysis of a Multiphase Oxygen Reactor Heated by a Helical Tube in the Cu-Cl Cycle of a Hydrogen Production

Authors : Mohammed W. Abdulrahman

Abstract : In the thermochemical water splitting process by Cu-Cl cycle, oxygen gas is produced by an endothermic thermolysis process at a temperature of 530ºC. Oxygen production reactor is a three-phase reactor involving cuprous chloride molten salt, copper oxychloride solid reactant and oxygen gas. To perform optimal performance, the oxygen reactor requires accurate control of heat transfer to the molten salt and decomposing solid particles within the thermolysis reactor. In this paper, the scale up analysis of the oxygen reactor that is heated by an internal helical tube is performed from the perspective of heat transfer. A heat balance of the oxygen reactor is investigated to analyze the size of the reactor that provides the required heat input for different rates of hydrogen production. It is found that the helical tube wall and the service side constitute the largest thermal resistances of the oxygen reactor system. In the analysis of this paper, the Cu-Cl cycle is assumed to be heated by two types of nuclear reactor, which are HTGR and CANDU SCWR. It is concluded that using CANDU SCWR requires more heat transfer rate by 3-4 times than that when using HTGR. The effect of the reactor aspect ratio is also studied and it 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. Comparisons between the results of this study and pervious results of material balances in the oxygen reactor show that the size of the oxygen reactor is dominated by the heat balance rather than the material balance.

Keywords : heat transfer, Cu-Cl cycle, hydrogen production, oxygen, clean energy
Conference Title : ICFMHTT 2016 : International Conference on Fluid Mechanics, Heat Transfer and Thermodynamics
Conference Location : Toronto, Canada
Conference Dates : June 13-14, 2016