THERMOHYDRAULIC PERFORMANCE OF A DOUBLE PASS COUNTER FLOW SOLAR AIR HEATER WITH LONGITUDINAL FINS

Abstract

Hot air relatively at low temperature is required in both domestic and industrial purposes. Fossil fuel has been the prime source of energy to generate hot air for these applications. Rising fuel prices, depleting fossil fuel and environmental concerns are leading ways to the wider applications of renewable and clean energy sources. Solar energy is one of the most important renewable energy sources. The simplest method to use solar energy for heating is by converting it into thermal energy using a suitable fluid. Some of the most common application areas are steam, hot water, preheating, pasteurization, sterilization, cleaning, space heating, chemical reactions, drying and dehydration processes etc. The implementation of solar energy in supplementing the process heat generation in Assam tea factories is promising keeping in view the state government's policy and the achievable attractive economies. In this project an attempt has been made to design and fabricate a low cost double pass counter flow solar hot air generator (DSHAG) with longitudinal fins using flat plate collector for harnessing solar energy to produce hot air. The designed parameters are assessed through simulation models concerning thermal and hydraulic performances of the solar hot air generator. The optimum spacing and height of fin in the absorber plate were estimated from the simulation results at varying flow rates (0.01-0.1 kg/s) and varying level of insolation (400-1000W/m^2).the achievable output temperature from the optimal absorber plate has been 93^{o}C corresponding to the flow rate of 0.02 kg/s and insolation of 1000 W/m^2. The performance testing is also conducted under varying mass flow rate and varying intensity of solar radiation. The pressure drop is also measured to investigate the thermohydraulic performance of the heater. The thermal performance of DSHAG was found to vary with mass flow rate and solar insolation. The highest temperature 93^{o}C was achieved at 0.02 kg/s and insolation level of 905 W/m^2. Interestingly the thermal performance during afternoon was found higher compare to morning hours. This might be due to storage of thermal energy by the device during the morning time and releasing the same during the afternoon time. The flow and insolation condition corresponding to (a) highest possible temperature (b) highest possible thermal efficiency (c) highest possible thermohydraulic efficiency and (d) minimum pressure drop were found as (0.02 kg/s,905 W/m^2), (0.04 kg/s, 247 W/m^2), (0.05 kg/s, 906 W/m^2) and (55 N/m^2, 894 W/m^2) respectively. The instantaneous thermal efficiency was found to increase in evening hour because stored energy. The highest observed instantaneous thermal efficiency is 141% for mass flow rate of 0.04 kg/s.

Keywords: Double Pass counter flow Solar Hot Air Generator, Solar thermal energy, Thermohydraulic performance