ABSTRACT

In this study the flow field, temperature field and the performance of a flat plate solar air heater are investigated. Heat transfer characteristics in a turbulent flow, 3-D, incompressible, single-pass, steady state flow are considered. The continuity equation, Navier-Stokes equations (momentum equations), and energy equation for the fluid are solved with the two equations of the (k-ε) turbulence model .The governing equations are discretized using finite-volume method-upwind scheme, and then are solved using SIMPLE algorithm method on staggered grid with (FORTRAN ٩٠) code. The pressure-correction method is used to obtain the velocity field, required for the solution of the energy equation. Three duct configurations are studied ,with different aspect ratio (i.e. (height/width)) (1, 1/4, 1/11), the length of the duct is (4.5 m). The governing equations are solved for two cases, constant absorber plate temperature (CAPT), and constant solar radiation flux (CSRF). This work is done in Hilla city- Iraq with Latitude equal to 32.30^{o} N and Longitude equal to 44.25^{o} E.

The effects of inlet air temperature, absorber plate temperature, duct configuration, and mass flow rates, on local air temperature growth. Also isothermal contours, local bulk air temperature, exit bulk air temperature, and pressure drop,of the present solar air heater are investigated.

From the obtained results it was found, the maximum exit bulk air reaches a maximum value at time of maximum solar radiation during the day which at (14:00PM) in clear sky condition. For example exit bulk air temperature equal to (42.43 ºC) for the minimum mass flow rate (0.109 kg/s). This result for the day (18/4/2010), and equals to (48.28 ºC) for mass flow rate which equal to (0.109 kg/s), and this result for the day (9/6/2010) for duct configuration 1. These results are for configuration (2, and 3), (49.37, and 51.34 ºC) respectively, for the day (9/6/2010). The present results showed that the maximum temperature rise of duct configuration 3 is higher than two others (2, and 1), for both cases (CAPT,

and CSRF). The duct configuration 3 efficiency is greater than the other two. The results also show that in the narrow duct case (configuration 3) ,the air reaches its maximum exit bulk air temperature at shorter duct length. This means that the narrow duct design (low aspect ratio) is best suited for solar air heater .Also ,it is found that the pressure drop increase with the decrease in the flow depth.

The model was compared with results of other authors (experimental data), and the comparison showed a good agreement.