Chapter 6
SUMMARY CONCLUSIONS AND RECOMMENDATIONS

The present study is concerned with the convection heat transfer in the horizontal circular annulus between two cylinders. The outer cylinder is fixed while inner cylinder is rotating. Two cases are considered concentric and eccentric annulus. Air is considered here as a working fluid which is filling the annulus. The heat transfer enhancement due to the rotation and eccentricity of the inner cylinder has been studied numerically and experimentally. A mathematical model is formulated in two-dimensional coordinates for the space between two concentric horizontal cylinders. Steady state, laminar, model is introduced with the corresponding boundary conditions to solve natural convection heat transfer. The numerical study is used the commercial package "FLUENT 6.3.26" [87] to solve the governing equations with the boundary condition. The predicted streamlines and isotherm contours is used to show the fluid movement and the temperature gradient within the annulus. A test rig is built to measure the temperatures and hence calculates the average heat transfer coefficient under various rotation and eccentric conditions. The main conclusions drawn from the present study are summarized as follows:

1 The experimental results are in good agreement with the present numerical results.

2 The experimental results compare favorably with the available literature data.

3 The numerical results are in fair agreement with available published data.

4 The average heat transfer coefficient increases with the increase of rotational Reynolds number.

5 The increase in the average heat transfer coefficient is directly proportional to Raleigh number.

6 The average heat transfer coefficient increases with the increase of eccentricity ratio.

7 The rate of heat transfer is greater for eccentric annulus in comparison with the concentric annulus.

8 For high Grashof number the rotational Reynolds number is almost having no effect on isothermal contour lines and stream lines.

9 The average heat transfer coefficient increases with the angle of eccentricity and has it maximum value at angle of 60^{o}.

10 The average heat transfer coefficient increases with the Rotational Reynolds number and angle of eccentricity, its maximum value occurs at angle of 67^{o}.

11 The average Nusselt number has a strong dependence on the rotational Reynolds number and the Rayleigh number.

12 The average Nusselt number is increased with the increase of eccentricity ratio.

13 The present experimental results fit the deduced correlation that relates the average Nusselt number, Rayleigh number, rotational Reynolds number, Aspect ratio, Radii ratio and eccentricity. This correlation is given as:

$$\overline{Nu} = 0.714 Ra^{0.27} As^{-0.264} R^{0.14} (1 + 0.002 Re_{\Omega}^{0.98}) (1 + 0.1623\varepsilon)$$

The results of the present work may play an important role on enhancing the performance of many engineering application based on a wide range of pertinent parameters studied in this work.

Increasing the thermal efficiency by higher turbine inlet temperatures is one of the most important aims in the area of gas turbine development. Because of the high temperatures, the turbine vanes and blades have to be cooled, and also knowledge of the mechanically and thermally stressed parts in the hottest zones of the rotor is of great interest. The prediction of the temperature distribution in gap between two cylinders has to account for the heat transfer conditions encountered in this gap. These predictions are very important used in of cooling systems of gas turbine, electrical machine and electronic device.

Recommendations

The study indicates that inspite the intensities studies made here and by different investigators still some questions need answers. The following summarizes the main recommendations for further future work:

1- Study the effect of rotation on the heat transfer rate from tubes in cross flow.

2- The effect of rotation on the heat transfer rate from non circular tubes (square – elliptical…… etc).

3- The effect of combined rotation and oscillations on the heat transfer characteristics.

4- Study the effect of rotation on the pressure drop in an annulus using different fluid.

5- Study the effect of rotation and eccentricity on the heat transfer rate with different working fluid, such as oil.