Hayder Zuhair Zainy. The effect of vibration on the heat transfer process in a developed region of annulus with rotating inner cylinder. University of Technology. Department of Mechanical Engineering. M.Sc. Supervisor: Asst. Prof. Dr. Mauwafak A. Tawfik , Lecturer Dr. Akeel A. Mohammed. 2012 , 124 p

Abstract

Theoretical and experimental investigations have been carried out to study the effect of induced vibration of a simply supported annular cylinder on the heat transfer process in the simultaneously developed of hydrodynamic and thermal boundary layer region of annulus with uniformly heated outer cylinder and rotating solid inner cylinder.

The theoretical study covers two parts. The first part deals with the dynamic vibration of the outer cylinder which depends on the combined finite element-transfer matrices technique (FETM). It is accounted for the dynamic loads applied on the outer cylinder and the temperature effect on the material elasticity and rigidity. The values of velocities at the inner surface of outer cylinder in the normal direction of flow resulted from the dynamic part of theoretical study are used as boundary conditions in the second part that deals with a study of the mixed convection heat transfer in a vertical annulus with a constant heat flux for outer cylinder. The governing equations of continuity, momentum and energy have been simplified and rewritten in a dimensionless form and transformed to algebraic equations using the finite difference technique.

An experimental investigation has been carried out to study the local and average heat transfer by mixed convection in the entrance region of a vertical concentric cylindrical annulus. The experimental setup consists of an annulus which has radius of 0.019 m and 0.052 m for inner soled cylinder and outer cylinder, respectively with uniformly a heated length 1.2 m, while the inner solid cylinder is subjected to the surrounding of annular gap. The investigation covers Reynolds number rang from 514 to 1991, Taylor number values are 10.44×10^4 & 82.23×10^4, heat flux varied from 468 W/m^2 to 920 W/m^2 and frequency values are 32 & 77 Hz.

The numerical results of theoretical study have been covered the range of Re^2/Ta from 2.417 to 38.681 and heat flux varied from 320 W/m^2 to 1200 W/m^2 with frequencies of 32 Hz and 77 Hz. Results show that the temperature decreases with increasing Reynold number and decreases at vibrated the system.

The experimental results for frequency values considered which show an increase (17%) in the Nu_z values as the heat flux increases when the value of frequency near the natural frequency and the value of surface radiation decrease (8%).

A comparison has been made between the experimental and theoretical results with each other for temperature and local Nusselt number variations and it has given a good agreement.