

Abstract:-

This research presents an experimental study of free and forced convection heat transfer for three dimensional laminar steady flows in a cubic space manufactured from glass with dimensions (30×30×30 cm) filled with saturated porous medium. Plastic balls porous media is used with homogeneous in diameter (11.7 mm). Whilst the lower wall is heated by an electrical heater, the other walls are thermally isolated. Two vents were made at the two vertical opposite walls, one for inlet and the other for outlet of air with equal dimensions (6×6 cm). Also, a square section cavity was manufactured with dimensions (6×6 cm) and (70 cm) length made of transparent plastic for air entering.

The experimental work was divided into two parts:-

The first part dealt with study the effect of a porous medium on free convection heat transfer with selected values of heat flux (348.33 q_w 1383.55) W/m². The experiments were carried out for Rayleigh number (1537.64 Ra 5260.62) and for average Nusselt number (52.44 $\overline{Nu} \leq 61.24$).

The experimental results showed that the temperature inside the space increases as Rayleigh number (Ra) increases. Also, the average Nusselt number (\overline{Nu}) increases with increase of Rayleigh number (Ra) for the first three values of heat flux, but it decreases after heat flux (1146.67 W/m²) because of domination of the conduction heat transfer on convection heat transfer.

The second part include the study of a porous medium effect on the forced convection heat transfer at the same heat flux values and for a

Porous Medium Reynolds number range (17.45 Re_{PM} 22.13) for every heat flux. In this part, the experimental work was subdivided into two cases.

First case: the air enters from down and exits from up for an average Nusselt number range (41.52 $\overline{Nu} \leq 82.85$). The results showed that the rate of

average Nusselt number (\overline{Nu}) increases with the heat flux increase until reaching heat flux (838.98)W/m², and then it starts to decrease with the increase of heat flux.

Second case: the air enters from up and exits from down for (45.2 $\overline{Nu} \leq$ 153.6).The temperature contours were drawn for different (x), (y), and (z) planes.

The experimental results of The three cases showed that the best case of heat transfer is by forced convection, and the air flows from down to up where (\overline{Nu}) increases proportionally with Porous Medium Reynolds number for the first case. But, the values of the second case are higher in spite of the relationship between (\overline{Nu}) and (Re_{PM}) is an inverse proportion. The best case of heat transfer is at heat flux (348.33) W/m² within the current working conditions.

Also, in the present work, empirical correlations for free and force convection heat transfer were obtained.

Keywords: convection, Porous media, Laminar flow, Opened cavity.