AN EXPERIMENTAL INVESTIGATION ON EFFECT OF PORES PER INCH IN COMPACT HEAT EXCHANGER WITH ALUMINUM FOAM

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Metal foams are a new class of materials with low densities and novel thermal and mechanical properties. Aluminum foams combine low weight with good rigidity, strength, damping of vibrations and noise, shock resistance and low thermal conductivity [1]. An experimental investigation on a single row of aluminum tubes, covered with layers of aluminum foams, was carried out by T'joen et al. [2]. A range of foam layer thickness, Reynolds number tube spacing and different type of foam were considered and compared with compact helically finned tube heat exchangers. An experimental investigation was carried out by Sertkaya et al. [3] to compare three metal foam heat exchangers (10, 20 and 30 PPI) to three finned heat exchangers with the same tube layout and overall dimensions. Results showed that the finned heat exchangers furnished a higher heat transfer and a lower pressure drop than the foamed heat exchangers. A numerical analysis to evaluate the performance of metal foam heat exchangers and compare it to the performance of a bare tube bundle and of an existing conventional louvered fin heat exchanger was presented by Huisseune et al. [4]. It was found that, at the same fan power, the foamed heat exchangers show up to 6 times higher heat transfer rate than the bare tube bundle. The aim of the present experimental investigation on a air-water aluminum foam heat exchanger is to evaluate its thermal and fluid dynamic characteristics. Results are given for different pores PPI (10, 20 and 30 PPI), porosity equal to 0.93 metal foam and air mass flow rate in a range of laminar flow

The features of heat transfer related to the aluminum foam heat exchanger, in terms of convective average coefficient and Nusselt number, is carried out. The hot fluid is water and it flows in internal tubes placed inside the metal foam, the cold fluid is air. The air enters inside a duct where is placed the heat exchanger, through a convergent channel, on the right of the upper part. The duct has a square transversal section of 220 mm x 220 mm and 760 mm long, the convergent duct is 454 mm long and it has the squared transversal inlet and outlet sections equal to 490 mm x 490 mm and 220 mm x 220 mm, respectively. Air motion is obtained by means of a fan, which is modulated by a valve, in order to obtain different air flow rates. At the end of this duct there is the heat exchanger. A series of pipes allows to reduce the section from 160 mm, downstream the fan, to 36 mm at the exit section of apparatus in order to obtain a more accurate measurement of the velocity. To evaluate the pressure drop a digital manometer is used. The measurements are obtained estimating the pressure upstream and downstream the heat exchanger. Steady state for a heat exchanger is reached later for hot fluid at 50°C than for 60°C and 70°C. The heat transfer rate is a function of flow rate. In particular, it increases until it reaches a critical value beyond which, also increasing the flow rate the thermal power tends to remain constant.

References

[1] Zhao C.Y., "Review on thermal transport in high porosity cellular metal foams with open cells", *Int. J. of Heat and Mass Trans.,* vol. 55, pp. 3618-3632, (2012).
[2] T'Joen, C., De Jaeger, P., Huisseune, H., Van Herzeele, S., Vorst, N., De Paepe, M., "Thermo-hydraulic study of a single row heat exchanger consisting of metal foam covered round tubes", *Int. J. of Heat and Mass Trans.*, vol. 53, pp. 3262–3274 (2010).
[3] Sertkaya, A. A., Altinisik, K., Dincer, K., "Experimental investigation of thermal performance of aluminum finned heat exchangers and open-cell aluminum foam heat exchangers", *Exp. Thermal and Fluid Sciences*, vol. 36, pp. 86–92 (2012).
[4] Huisseune, H., De Schampheleire, S., Ameel, B., De Paepe, M., "Comparison of metal foam heat exchangers to a finned heat exchanger for low Reynolds number applications", *Int. J. of Heat and Mass Trans.*, vol. 89, pp. 1-9, (2015).