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Artificial Neural Network Analysis of Sintered Bronze Porous Sinks for Heat Dissipation

Dr. Ashish Mahalle
Associate Professor
Laxminarayan institute of Technology,
Nagpur (M.S.) India

Kishor R. Borakhade
Research Scholar, S.G.B. Amravati University,
Amravati (M.S.)India

***Abstract*— The use of porous fins will be evaluated and comparison made to some commercially available heat sinks in order to prove the use of these materials as heat transfer promoters for the application of cooling electronics. However utilizing metal foam in conjunction with a block heat sink requires additional mechanical connections. The mechanical connections may be accomplished using solder or a layer of thermally conductive adhesive. This additional connection increases thermal resistance and hinders effective dissipation of heat. The flow analysis studies are how to enhance heat transport for given flow geometry and externally imposed physical constraints. The analysis of porous fins is carried out using ANN for the estimation of thermocouple temperatures on the fin. The initial parameters like heat input, valve opening position and various temperatures are given to ANN software for training to create a dynamic environment. The predicted values of temperature are in close agreement with actual values.**

Keywords*— *ANN, Metal foam;Pore diameter ; pressure drop;friction factor,Heat transfer coefficient.

I. INTRODUCTION

Metal foams consist of small filaments that are continuously connected in an open celled foam structure as shown in fig 1. They are used to construct light weight structures, to develop energy absorption devices and for thermal applications. Although it is proven to be very promising, the use of the open-cell porous materials in fluid flow and heat transfer application requires an extensive effort to better understand the behavior of the fluid flowing through its matrix composition and the heat transfer mechanism occurring in the medium. To enhance convective thermal transport we have focused on the utilization of metal foam in thermal system. The motivation is attributed to enhance heat transfer due to the high surface area to volume ratio as well as flow mixing due to toutuosity of metal foam.. The flow recirculates at the back of the solid fibers; and for high enough pore scale Reynolds numbers, turbulence and unsteady flows occur [1].

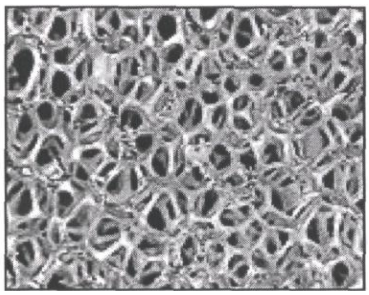

Fig. 1. Open celled foam structure. [1]

II EXPERIMENTAL APPARATUS

The air duct is used for experimentation. The equipment consists of a rectangular area designed and constructed, clipped tightly together with fasteners and supported at four points along its length. The duct was 230mm wide and 200mm height. The cross-sectional area of the duct is 0.046m^2 and the overall length of the duct section was 1200mm. Entry and exit duct-sections are separated by a plain center-section which was easily removed. The test portion was fitted with the help of flanges and high temperature resistance gaskets, so that air should not bypass at the test section directly. A centrifugal blower was fitted with an electric motor of specification 200/240 V, 3-phase, 4.6 amps, 2850 rpm to induce air from wind tunnel. Figure 2 is a picture of equipment.

Fig.2. Air duct used in the experimental work

III MODEL DEVELOPED

Heat transfer model in the porous material fin. The directions, in which the temperature distribution is studied, and the dimensions of the fin are shown in Fig. 3

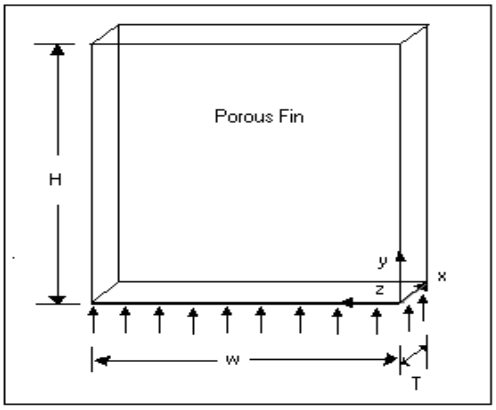

Fig. 3. Fin model is used for ANSYS

To begin the analysis of the heat transfer in the fin, model is defined are shown in Fig. 3 and the law of conservation of energy is applied to it. To balance the equation, the heat transfer by conduction through the copper alloy filaments and the air is combined with the heat transfer by convection that takes place inside the pores of the fin. Volume defined inside the porous fin and used for the analysis, where *W* represents the width of the fin and *dx* and *dy* are small thickness in the *x* and y directions, respectively. The energy fluxes due to the conduction and applying energy balance in the control volume, yields,

$$q_y + q_x = q_{y+dy} + q_{x+dx} + q_{conv} \qquad (1)$$

IV ANALYSIS

The experimental study was carried out on three different grades of fin samples (i.e. 60k, 100kand 200k) with constant porosity. For this experimentation total seven thermocouples are used for the measurement of temperatures. One was at inlet section and other was at outlet section and five thermocouples are located along the fin height in the test section. In the assembly of the fin sample insulation was fitted in test section in such a way that heat will not be transferred from fin to metal portion of the wind tunnel.

V ANN RESULTS

It was also observed from the various plots (fig. 4 to 6) i.e. temperature vs. Valve openings at 130w heat input, the estimation of actual and predicted values using the ANN simulation has been in agreement and of very high accuracy level. The mentioned figures are the representative samples of 60k, 100k, 200k grade fin samples at 130w heat input study cases

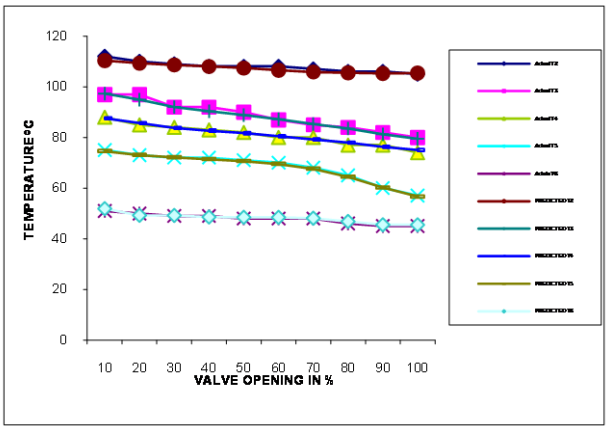

Fig. 4. Comparison of actual and predicted values of thermocouple Temperatures at 130w for 60k grade fin sample

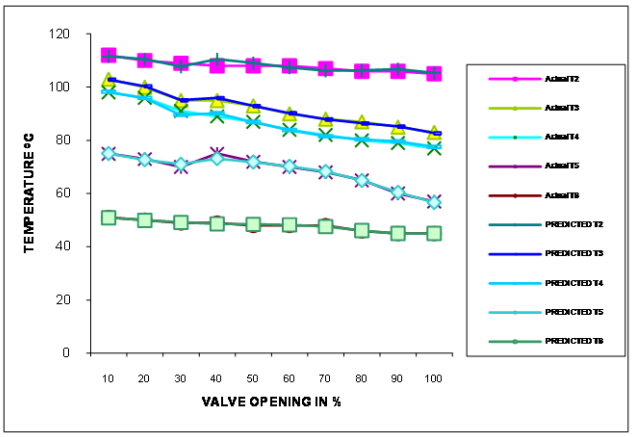

Fig. 5. Ccomparisons of actual and predicted values of thermocouple Temperatures at 130w for 100k grade fin sample

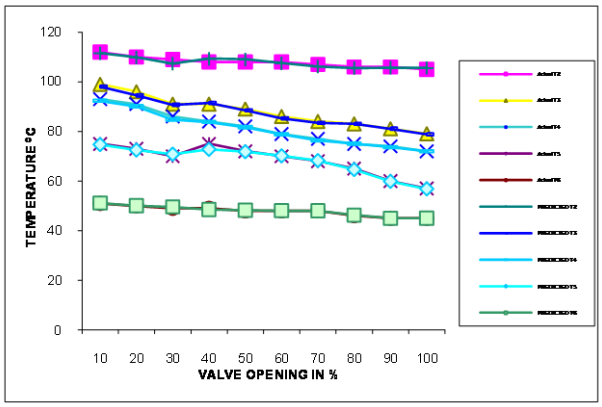

Fig. 6. Ccomparison of actual and predicted values of thermocouple Temperatures at 130w for 200k grade fin sample

VI CONCLUSION

Using ANN (Artificial Neural Network) simulation the estimation of actual and predicted values of thermocouple temperature has been in good agreement.

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