ABSTRACT

This work investigates a technique to improve extended surface heat transfer through the use of perforation geometric patterns. When perforation geometries are considered, significant gains in the available surface area for fins can be achieved without increases in fin volume or mass. For perforation patterns, the surface area of a fin can even be increased while reducing the mass of the fin. This would provide direct benefit for situations where the extended surface volume is restricted or minimized weight is desired. Perforation geometries are presented to increase the effectiveness and effectiveness per unit mass of fins for forced convection heat transfer as well as increase effectiveness per mass for radiation heat transfer. Common extended surface heat transfer methods and developments were reviewed to obtain an understanding of the focus and limitations of previous work. Based on this literature review, it has been observed that the use of fractal-like geometries has been utilized for engineering applications. However, the use of perforation geometries for extended surface heat transfer has not been studied experimentally and numerically simultaneously, therefore justified an investigation into their behavior. The thermal performance is examined for an array of rectangular fin (30 fins) with uniform cross-sectional area (70x100 mm) embedded with various vertical body perforation patterns that extend through the fin thickness. The patterns include rectangular perforation (slot), square perforation, circular perforation and augmented fin. Comparisons of the maximum heat transfer rate of the fin with the three perforation patterns are made to demonstrate the preferences of the various types of perforation configurations. The dominant parameters that affect heat transfer are considered including dimensions of perforation (8-22.5 mm). Perforation patterns, perforated area (24 cm^2), and number of perforations (0-15). The

fin with rectangular perforations shows a greater heat transfer enhancement (16% of non–perforated) than square and circular perforation patterns equal in perforation area ($24cm^2$). The fin with square perforations indicates a greater heat transfer enhancement (13% of non – perforated) than circular perforations which indicate about (11% of non – perforated). Augmented fin shows great heat transfer dissipation compared to that of the equivalent conventional fin (about 14%).The efficiency of the perforated fin is always less than that of the non–perforated one (82 to 97%of non–perforated) due to the larger temperature drop. In the other hand, the effectiveness of the perforated fin is larger than that of the non–perforated one (10 to 80% of non–perforated) as long as the heat dissipation rate ratio is greater than unity. It is well known that light weighted fins are in high demand. This work provides significant weight (mass) reduction (66 to 96% of non-perforated). At the time when both the surface area and heat transfer coefficient are simultaneously increased. The Radial Basis Function neural network (RBFNN) model is best for predicting the Nusselt number with a comprehensive performance.