In air-cooled heat exchangers, air-side thermal resistance is usually the largest compared to conduction and liquid-side thermal resistances. Thus, reducing the air-side thermal resistance with fin-like structures can greatly improve overall cooling performance. The performance of these structures is usually characterized by the rate of heat which can be transferred and the pumping power required. One promising solution is to use a high-conductivity material with a large surface per unit volume such as carbon foam. This study presents a method of utilizing V-shape corrugated carbon foam. The air-side heat transfer coefficient and the pressure drop across the foam have been investigated using different V-shape foam geometrical configurations obtained by varying its length and height. Based on design considerations and availability, the foam length has been chosen to be 25.4, 38.1 and 52.1 mm while its height is 4.4, 6.8 and 11.7 mm, resulting in nine different test pieces of foam with different heights and lengths. A total number of 81 experiments were carried out and results show that of nine V-shape configurations, the foam with the shortest length and tallest height gives the best performance. Experimental results are also compared with the results of prior work using different carbon foam geometries. It is shown that V-shape corrugated carbon foam provides better heat transfer coefficient and the overall performance.

Numerical method is performed next. The effect of the foam length and height on thermal and hydraulic performance is demonstrated and discussed. There is a good agreement between numerical and experimental results. An analysis is also made to better understand the transport phenomena that occur within the porous matrix. For laminar flow of air, one of the findings is the high heat transfer effectiveness of the foam which means a foam thickness of 1 mm or less is sufficient for heat transfer enhancement.

To demonstrate the feasibility of using carbon foam, an analytical case study of carbon foam heat exchanger was performed and compared to traditional heat exchanger with the same heat load. Results show that a volume saving of up to 55% can be obtained by using carbon foam instead of traditional aluminum fins.

Another attractive carbon-based material is the highly oriented pyrolytic graphite (HOPG) which has an in-plane thermal conductivity of about 1700 W/m.K and an out-of-plane k of about 8 W/m.K at room temperature. HOPG is a graphite material with a high degree of preferred crystallographic orientation of the c-axis perpendicular to the surface of the substrate. HOPG can be very useful in thermal applications in which axial conduction is crucial and needed to be minimized such as cryocoolers and recuperators. An analysis of HOPG micro-channel shows that HOPG can achieve higher fin efficiency than copper and aluminum which allows increasing the height of the micro-channel. This translates to an increase of the rate of heat transfer by two or three times.

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The public is welcome to attend.