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NUMERICAL STUDY OF HEAT TRANSFER ENHANCEMENT OF EARTH-TO-AIR HEAT EXCHANGER USING POROUS MEDIA

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ABSTRACT In Earth to Air Heat Exchanger (EAHE), limited convective heat transfer coefficient and limitation of available space have been the main concern of scientists. Thus, reducing the air-side thermal resistance using V-shaped porous insert attached to the air path can greatly improve the overall thermal performance and reduce the space needed to achieve the heat transfer process.

Thermal performance of the EAHE is usually characterized by the outlet bulk temperature which represents how effective heat can be transferred to the air-side. The pumping power required to overcome the pressure loss across the EAHE however is a dominating factor and must be considered. Using V-shaped porous insert made of highly conductive material, like carbon, copper or aluminum, can efficiently increase the contact area with air and thus decrease the air-side thermal resistance with a reasonable pressure drop.

If porous media is inserted normal to the air stream in a closed duct, that would dramatically increase the pressure drop across the heat exchanger. The pressure drop can be decreased by inserting V-shaped porous media because the penetration velocity decreases as the penetration area or the mass flow area increases.

This study represents a method of utilizing different V-shaped porous inserts in EAHE to investigate the enhancement that can be achieved in thermal and hydraulic performance of the EAHE. Three configuration with three different apex angles, 13^o, 23^o and 30^o were used to perform the analysis on a 2D numerical model. The numerical model is established by the finite element method.

Results show that for laminar flow an enhancement in the bulk temperature difference across the EAHE of up to 25 % can be achieved using only 10 mm thickness of carbon foam V-shaped insert. Results also show that changing the apex angle of the V-shaped insert can significantly reduce the pressure drop across the porous insert. A volume saving of up to 40 % can be obtained in the EAHE by using the V-shaped configurations.

Keywords: Earth to Air Heat Exchanger –Air-side heat transfer enhancement – pressure drop across V-shaped porous media.