Heat Enhancement In Backward Facing Step Channel Equipped With Inclined Solid And Permeable Baffles

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Abstract

Enhancing heat transfer in a backward facing step air channel equipped with a aluminum solid baffle followed by permeable one was investigated by using COMSOL® Multiphysics program. The air channel was composed of three sections, the entrance, test, and exit ones to ensure minimal entrance and exit effect on the simulation results (See Figure 1). The walls of the entrance and exit sections were assumed to be insulated as well as the top wall of the test section. The bottom wall of the test section was assumed to be at constant temperature of 330 K. The air enters the entrance section at 293 K. The tested parameters were Reynolds number, baffle inclination angel, and permeability of the second baffle. Tested Reynolds number were 3000, 5000, and 10000 to ensure turbulence mode operation. Baffle inclination angels were 0o, 30o, 45o, and 60o. The second baffle permeability ranged from 8.5×10-11 to 1.0×10-8 m2. In the simulation, Free and Porous media Flow module and heat Transfer in Porous Media module were used. The velocity and temperature profiles were obtained for all cases as well as the streamlines. The comparison between different cases was based on the heat transfer enhancement parameter, HEF, that relates the heat gain increase and pressure drop increase in the studied case to the reference case without baffles, where the higher value for this parameter the better the case. Figure 3 shows the streamlines obtained at different 2nd baffle permeability. These streamlines shows different eddies generated due to the flow amount inside the baffle that will enhance the heat transfer by the turbulence in the bulk as well as the flow inside the baffle. Moreover, the results show that as the inclination angel increases, the pressure drop decreases, and the temperature rise decreases as well for certain permeability range. On the other hand, increasing permeability would decrease temperature gain and decrease pressure drop at constant inclination angel. These observations are similar for all Reynolds' numbers. Accordingly, the major achievement of using heat transfer enhancement parameter is shown in Figure 3 that shows operating with the second baffle permeability of 2.0×10-9 and inclination of 45o would result in the optimum heat enhancement that provides the most heat gain in the lowest pressure drop.

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Figures used in the abstract

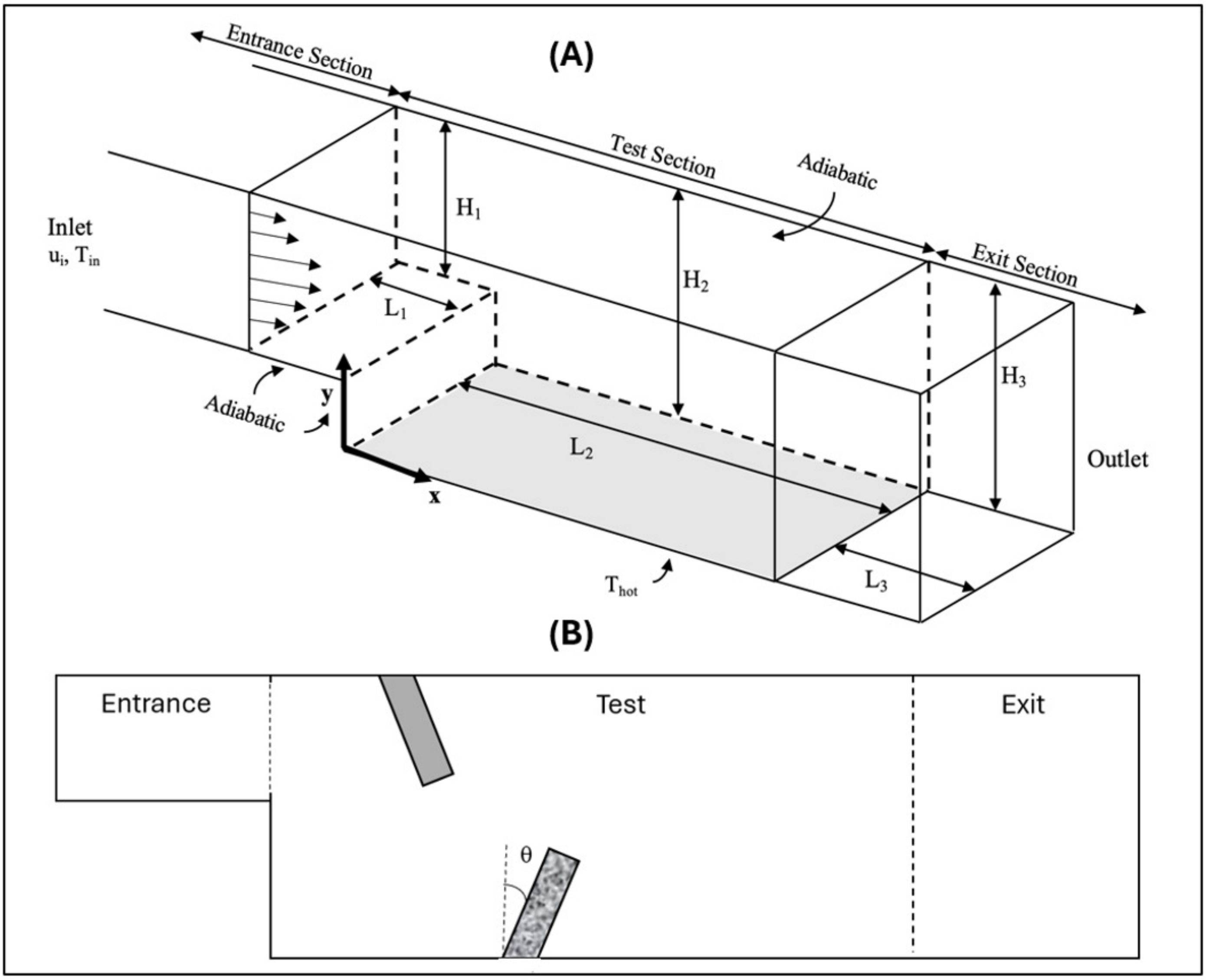


Figure 1 : Figure 1: A) Schematic 3D-diagram for the horizontal backward-facing step channel without baffles. B) 2D-diagram for the simulated channel with baffles.

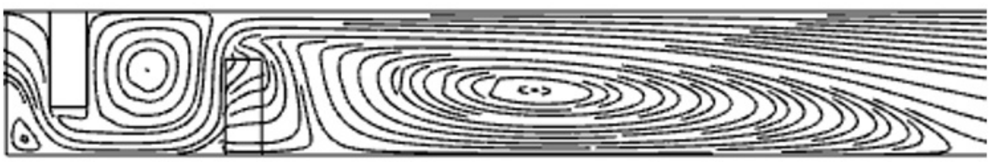
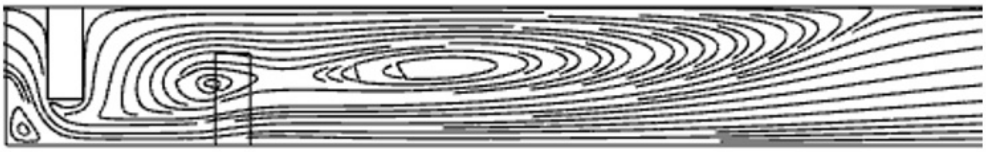
Permeability (m^2)	**Streamlines**
8.50E-11	
8.50E-10	
8.50E-09	

Figure 2 : Figure 2: Streamlines in the test section for different permeability values at 0o inclination and Re=10000.

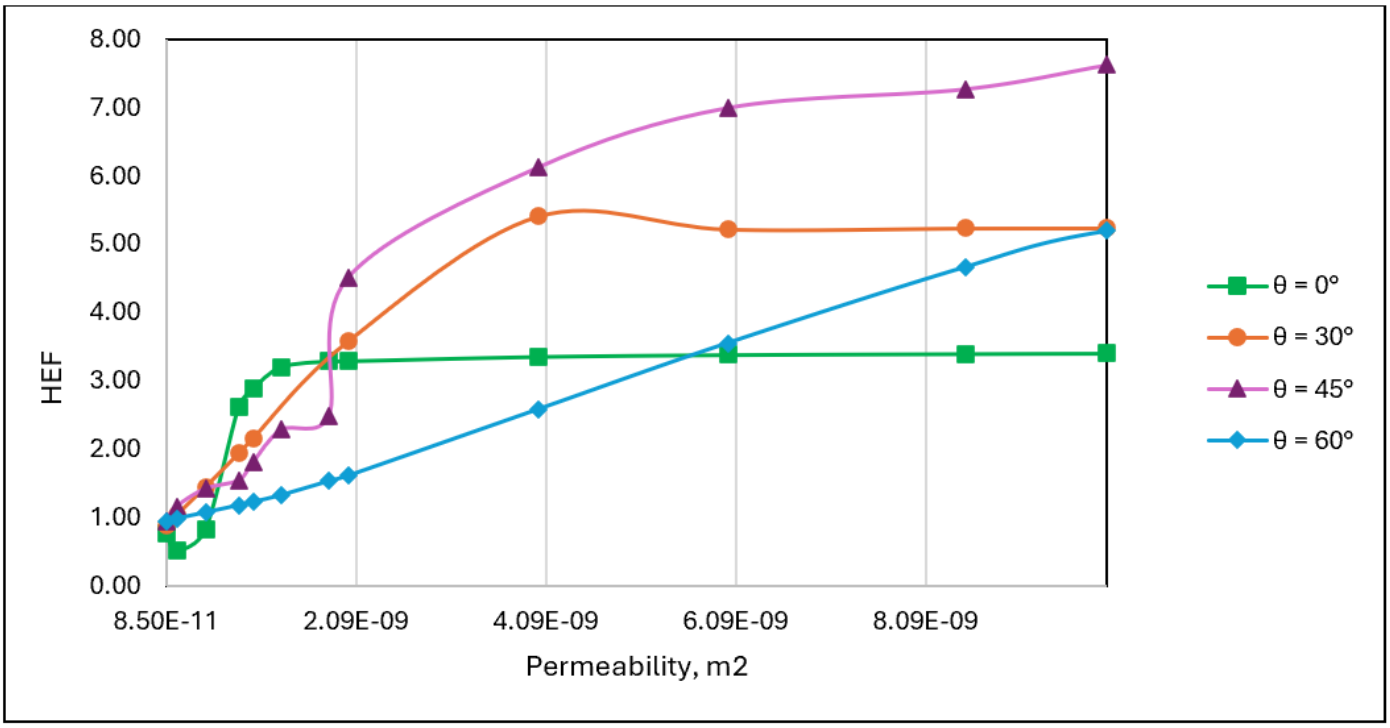


Figure 3 : Figure 3: Heat transfer enhancement factor, HEF, as function of inclination angel and second baffle permeability at Re = 10000.