NUMERICAL STUDY EFFECT OF THE ADDITION OF RECTANGULAR OBSTACLE FOR FLOW CHARACTERISTICS AND HEAT TRANSFER IN STAGGERED TUBE BANKS WITH \( \ell / D = 0.2 \)

“A case study for obstacle’s angle (\( \alpha \)) at 30°, 45° and 60°”

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ABSTRACT

Many researches has been done to improve the performance of compact heat exchanger on the external side, one of the research is installing the obstacle on the surface of the fin. Installation of obstacle can increase the external heat transfer due to the swirl of fluid flow that can transfer heat more quickly and effectively.

The study is concerning of varying the position’s angle of the rectangular obstacle (\( \alpha \)) about 30°, 45° and 60° with size of \( \ell / D = 0.20 \). Working fluid is air with constant velocity value of 2 m/s modeled as an ideal gas flowing on the external side of tube banks with temperature conditions of 308 K and the tubes’ temperature of 325.77 K. The study is conducted in 2-dimensional steady flow conditions with the principles of Computational Fluid Dynamic (CFD) using GAMBIT 2.4.6 for build the domain and will be simulated in FLUENT 6.3.26. Turbulence models used is the renormalization group (RNG) \( k-\varepsilon \). The study aims to determine the flow and heat transfer phenomena in tube banks with varying the position of rectangular obstacle, qualitatively by using visualization of temperature and velocity contours, and quantitatively by analyzing the local velocity, local Nusselt number and pressure drop graphs.
The results of this study showed that compared to the baseline model, the value for model with $\alpha$ for $30^0$ shows decreasing of local velocity value by 0.584% and the decrease in heat transfer is 1.053%. Models with $\alpha$ equal to $45^0$ have increasing the local velocity of 4.140% and an increase in heat transfer at 0.502% compared to the baseline model. Models with $\alpha$ for $60^0$ increased by 34.709% at local velocity and heat transfer increases by 10.107% compared with the baseline model. Pressure drop occurs in all models, with the value for the model without the rectangular obstacle is 10.13 Pa, $\alpha$ for $30^0$ is 11.02 Pa, $\alpha$ for $45^0$ is 15.96 Pa, and $\alpha$ for $60^0$ is 23.73 Pa. For the model with $\alpha$ equal to $60^0$ gives the best enhancement based on the characteristics of the flow, heat transfer and pressure drop. Modification of tube banks with $\alpha$ for $30^0$ does not produce a better heat transfer compared with the baseline model and the other modified model.

Keyword : Compact Heat Exchanger, Rectangular Obstacle, angle of Obstacle, heat transfer