

EXPERIMENTAL STUDY OF ENHANCED LAMINAR NATURAL CONVECTION HEAT TRANSFER FROM STAGGERED CYLINDERS ARRANGED IN AN INCLINED ARRAY

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Received: 18 Jun 2019

Accepted: 08 Jul 2019

Published: 24 Jul 2019

ABSTRACT

An experimental investigation to a laminar natural convection heat transfer from an inclined array of the circular cylinder was presented in this study. Inclined cylinders were subjected to constant heat flux and were arranged in staggered in a bank. The apparatus of investigation consists of five identical in dimension cylinders and the staggered arrangement with longitudinal (flow direction) and traversing spacing distances of $5 D$ and $2.5 D$, respectively. The study cover $Ra_{L,D}$ range varies from 50600 to 108000 and five inclination angles 0° , 30° , 45° , 60° and 90° (vertical). The local surface temperature T_x , local heat transfer coefficient h_x and average heat transfer coefficient h_L variation with cylinder length are presented for all bank inclination angles. Variations of average Nusselt number $Nu_{L,D}$ with the Rayleigh number $Ra_{L,D}$ are also correlated for all array inclination angles and for each individual cylinder in the array. With exception of the vertical orientation, results show an increasing rate of heat transfer from two cylinders located in the upper corners of the array in comparison with two cylinders located in the lower corners cylinders and the cylinder located at arrays center. The natural convection current interference shows no effect on the two lower corner cylinders and array central cylinder. This process enhancement shows a significant heat transfer decreasing rate for array inclination angle between horizontal to 30° ranges than with a constant rate between 30° and 60° and another decreasing rate as the bundle moves toward a vertical orientation which reveals the lowest heat transfer rate. In general, for each individual cylinder in bank, heat transfer process improved as the bank moves from vertical to horizontal. A good agreement with a previous work results obtained for single horizontal cylinder but a contradictory agreement with a previous work results obtained for a single vertical cylinder. Comparison for the upper cylinders in the bank with available experimental and analytical previous work reveals a good agreement.

KEYWORDS: Heat Transfer, Natural Convection, Inclined Cylinders, Staggered Array