

## EFFECT OF DIFFERENT INTAKE SHAPES ON THE FLUID FLOW CHARACTERISTICS OF A RIBBED RECTANGULAR DUCT

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### ABSTRACT

The developing region was investigated experimentally in this paper for smooth and ribbed duct to enhance the heat transfer coefficient at equal pumping power constraint through the flow passage. The mean velocity of air stream varies from about 4 to 18 m/s corresponding to a range of Reynolds number from  $1.62 \times 10^4$  to  $7.2 \times 10^4$ , the rib pitch-to-height ratio ( $P/e$ ) varies from 10 to 20, the rib height-to channel hydraulic diameter ratio ( $e/D_e$ ) is fixed at 0.081, and the channel length to hydraulic diameter ratio ( $L/D_e$ ) is fixed at 18.75. A rectangular channel with an aspect ratio ( $W/H$ ) of 4:1 ribbed with square ribs is investigated at different intake shapes (bellmouth, plenum box, and abrupt intakes). The effects of the different investigated parameters on the local and average static pressure, and friction factor are studied. For smooth duct with abrupt and plenum intakes, the maximum static pressure coefficient was found at the reattachment point at about  $X/D_e=0.95$ , while it was found at  $X/D_e=0.17$  for bellmouth intake. For ribbed duct the effect of the intake shape becomes more significant at the entrance region ( $X/D_e < 0.69$ ). For the ribbed duct with the abrupt intake it was found that the static pressure coefficient ( $C_p$ ) is lower than that of plenum and bellmouth ribbed ducts. These may be attributed to that the abrupt intakes improve the flow pattern (turbulent and acceleration) in the entrance region more than that for plenum and bellmouth. The average static pressure coefficients ( $C_{p_{average}}$ ) for abrupt and plenum intakes are lower than that for bellmouth intake for smooth and ribbed wall and it were independent of Reynolds number for  $Re > 40,000$ . Good agreement was found between the experimental results and [Liou, et. Al., 1992] data for direct comparison of static pressure for ribbed duct with plenum intake. The experimental correlations of the average static pressure coefficient ( $C_{p_{average}}$ ) for the developing region of a ribbed duct with different intake shapes are obtained.

$$C_{p_{average}} = a Re^b (P/e)^c \quad (1)$$

The constant coefficients (a, b, c) and the relative error are listed in table 2. Flow visualization results were carried out to support the measured results and illustrate the flow characteristics around the intake and the ribs.

**KEYWORDS:** Entrance region, Intake shape, Ribbed duct, Fluid Flow, Flow visualization.