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AN EXPERIMENTAL STUDY OF TURBULENT SEPARATION FLOW AND HEAT TRANSFER IN A CIRCULAR CONCENTRIC ANNULUS

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ABSTRACT

The step height effect of radially inward expanded air flow stream on the heat transfer process in a concentric circular annular passage is studied experimentally. The air flow separation, reattachment and redevelopment took place in the test section which its inner tube subjected to a constant heat flux boundary condition. The experimental apparatus comprised of concentric tubes to form an annular passage with a sudden enlargement in the passage cross-section created by increasing the outer tube diameter of the annular inner tube at the entrance section prior to the test section. The inner tube of the test section was made of aluminium having 25 mm outside diameter and 350 mm heated lengths, which was subjected to a constant wall heat flux boundary condition.The investigation was performed to cover a Re range of 3000 – 11000, inner tube heat flux varied from 800 W/m^2 to 1750 W/m^2 and the enhancement of step heights were S = 0 (without step), 6.5 mm, 12.5 mm, and 18.5 mm which refer to D_i/d = 1, 1.5, 2 and 2.5, respectively.

Results reveal for all cases, that the local heat transfer coefficient increased against increasing the heat flux and/or Re. The step height has an eminent effect on heat transfer in the separation region which decreases with the raise of the step height. The passage without step (S=0) results were correlated and compared with the availableturbulentforced convectionentry length correlations for same geometry and boundary conditions. The step height effects show, for S= 6.5 mm a 25% on the average improvement in heat transfer for a full Reynolds number tested while for another two step heights the results show a limited improvement in low Reynolds number to a 16.5% reduction in heat transfer due to separation zone effect. The velocity profiles demonstrate that the position of reattached point behind the step increases with the rise of step height.The present results show a good agreement with the available previous works and have followed similar trends.

KEYWORDS: *Turbulent Forced Convection, Internal Flow Separation, Concentric Annular Passage*

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