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A Computational Study of Very High Turbulent Flow and Heat Transfer Characteristics in Circular Duct with Hemispherical Inline Baffles

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Abstract : This paper presents a computational study of steady state three dimensional very high turbulent flow and heat transfer characteristics in a constant temperature-surfaced circular duct fitted with 900 hemispherical inline baffles. The computations are based on realizable k-ε model with standard wall function considering the finite volume method, and the SIMPLE algorithm has been implemented. Computational Study are carried out for Reynolds number, Re ranging from 80000 to 120000, Prandtl Number, Pr of 0.73, Pitch Ratios, PR of 1,2,3,4,5 based on the hydraulic diameter of the channel, hydrodynamic entry length, thermal entry length and the test section. Ansys Fluent 15.0 software has been used to solve the flow field. Study reveals that circular pipe having baffles has a higher Nusselt number and friction factor compared to the smooth circular pipe without baffles. Maximum Nusselt number and friction factor are obtained for the PR=5 and PR=1 respectively. Nusselt number increases while pitch ratio increases in the range of study; however, friction factor also decreases up to PR 3 and after which it becomes almost constant up to PR 5. Thermal enhancement factor increases with increasing pitch ratio but with slightly decreasing Reynolds number in the range of study and becomes almost constant at higher Reynolds number. The computational results reveal that optimum thermal enhancement factor of 900 inline hemispherical baffle is about 1.23 for pitch ratio 5 at Reynolds number 120000.It also shows that the optimum pitch ratio for which the baffles can be installed in such very high turbulent flows should be 5. Results show that pitch ratio and Reynolds number play an important role on both fluid flow and heat transfer characteristics.

Keywords : friction factor, heat transfer, turbulent flow, circular duct, baffle, pitch ratio
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