SECONDARY FLOW IN ROTATING DUCTS

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Abstract

A simulation study is performed on laminar flow of an incompressible viscous fluid through rotating ducts. The ducts considered were rectangular straight, rectangular curved and circular curved. Simulations were carried out at two Reynolds numbers, three rotation numbers and five radii of curvature. Secondary flow is induced due to the rotation as well as the curvature of the duct independently, and this can be observed by the presence of double vortex in the bend region and in the downstream region of the rotating duct. Secondary flow creates unwanted losses in the flow. In the present study, the variation of the losses is estimated by plotting the secondary flow kinetic energy and the total pressure loss coefficient for different radii of curvature and rotation speeds. It was observed that both the coefficients increase rapidly in the curved region. The total pressure loss coefficient keeps increasing along the length, while the secondary kinetic energy coefficient decreases after peaking in the curved portion and converges to a constant value. This flow phenomenon, especially in turbines and rotating coolant channels are of practical interest in such applications as heat exchangers, rotors of electrical machinery, cooling channels of gas turbine rotor blades. Therefore it is important to understand the underlying physics, which could help in the design of turbomachines and in optimizing heat transfer rate in the relevant applications.

Keywords*: Secondary flow, Rotating ducts, Curved ducts, Coriolis force, Centrifugal force, Laminar, Secondary kinetic energy, Total pressure loss coefficient*

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