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NUMERICAL INVESTIGATION ON CONVECTIVE HEAT TRANSFER IN HIGH TEMPERATURE SOLAR RECEIVER

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Abstract

In recent years, solar receivers have been employed in several applications where high temperature fluids are involved, such as power plants and solar thermal reactor. The possible presence of high temperature gradients could determine reduced receiver efficiency and a short life of the material. Thermal and fluid dynamic analysis of the receiver allows to highlight possible presence of temperature gradients and to evaluate their values and the more critical zone of the material. Compressibility effects are encountered in gas flows at high velocity and/or in which there are large pressure variations. In the present paper a numerical study on forced convection in the solar receiver vessel is carried out. In particular, the investigation is accomplished to evaluate the convective heat transfer behaviour in a non-straight rectangular channel as a function of hydraulic diameter and mass flow rate. The investigation is obtained in three-dimensional steady state turbulent forced convection in channels with Reynolds number ranging between 6600 and 13200. The fluid is carbon dioxide and its properties are assumed to be temperature dependent. A comparison between incompressible and compressible flows is also carried out. Results are presented in terms of temperature, pressure and velocity fields, average heat transfer coefficients, and pressure drops. It is observed that higher temperature values are reached near the inclined channel walls in correspondence of the stagnation regions. In addition a Von Karman wake with swirling vortexes are present downstream the duct corners.

Key words: concentrated solar power, forced convection, thermal design

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