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传递现象

封闭腔内水自然对流换热数值模拟

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摘要

为了揭示封闭腔内非Boussinesq流体在浮力驱动下所特有的流动换热现象和形成机理，采用CFD软件Fluent对封闭腔内水的自然对流进行数值模拟，得到矩形封闭腔高宽比、Rayleigh数、倾斜角度、壁面温度差对流动和传热的影响规律。研究结果表明：由于水的密度在3.98℃达到最大，两竖壁面温度跨越这一点时会引起流动图像反转；具有流动反转的双涡结构降低了对流换热平均Nusselt数；相同Rayleigh数下,高宽比为1对应对流换热平均Nusselt数最大值；倾斜角度对平均Nusselt数影响与Rayleigh数和温度边界条件有关。

关键词 自然对流 流动反转 高宽比 倾斜角

分类号

Numerical simulation of natural convection and heat transfer of water in cavities

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Abstract

To reveal the features of flow structure and heat transfer and the mechanism of the non-Boussinesq liquid flow driven by thermal buoyancy in cavities, the natural convection of water in square and rectangular enclosures was numerically simulated with CFD software of Fluent.The effects of aspect ratio of the cavity, Rayleigh number, inclination angle and temperature difference between the two walls of the cavity on the flow and heat transfer were investigated.The results show that the flow pattern inverses if the two walls temperature of the cavity was greater and less than 3.98℃, respectively, at which the water density is maximum.The flow pattern inversion has a double vortex structure and decreases the average Nusselt number of natural convective heat transfer.At a fixed Rayleigh number, the average Nusselt number reaches a maximum in the square cavity at the aspect ratio of 1.The inclination of the square cavity has more complex influence on the average Nusselt number which depends not only on the Rayleigh number but also on the thermal boundary conditions.

Key words

natural convection flow pattern inversion aspect ratio inclination angle

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