

虚拟边界法研究正交双圆柱及串列双圆球绕流

邓见, 邹建锋, 任安禄, 邵雪明

浙江大学力学系流体工程研究所

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摘要 把Goldstein等人提出的虚拟边界法推广到三维情况, 研究了 $Re=150$ 时不同间距下正交双圆柱绕流, 和 $Re=250$ 时不同间距下串列双圆球绕流流场. 对于正交双圆柱绕流, 当间距比大于3, 下游圆柱对上游圆柱尾流的影响只限定在下游圆柱的尾流所扫过的范围之内; 当间距比小于等于3, 下游圆柱对上游圆柱尾流的影响扩大, 下游圆柱尾流扫过区上下出现两排三维流向二次涡结构. 对于串列圆球绕流, 研究发现, 在小间距比 ($L/D \approx 1.5$) 的情况下, 由于上下游圆球尾流区的相互抑制消除了压力不稳定性, 整个流场呈现稳态轴对称特征; 间距比为2.0时, 周向压力梯度诱发出流体的周向输运, 流场呈现稳态非对称性, 但流场中存在特定的对称面; 间距比增大到2.5后, 绕流场开始周期振荡, 原有的对称面依旧存在; 在间距比3.5时下游圆球下表面的涡结构强度有所减弱, 导致占优频率发生交替; 间距比增至7.0时, 整个流场恢复稳态特征, 两圆球尾部同时出现双线涡, 这时流场对称面的位置发生了变动.

关键词 [虚拟边界法, 正交双圆柱, 串列双圆球, 三维涡结构](#)

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Numerical simulations of flow around two circular cylinders in cruciform arrangement and two spheres in tandem arrangement by virtual boundary method

浙江大学力学系流体工程研究所

Abstract

The virtual boundary method was applied to simulate the flow passing around two circular cylinders in cruciform arrangement at $Re=150$. Spatial structures of the flow wake are different at various spacing ratio. When the spacing ratio is greater than 3, for upstream cylinder, the influence of downstream cylinder is restricted in the region that the wake of downstream cylinder coexists, and out of this region the wake of upstream cylinder maintains a regular Karman vortex street. When the spacing ratio is smaller than or equal to 3, for upstream cylinder, the influence of downstream cylinder is expanded to the whole spanwise of the upstream cylinder wake, and obvious three-dimensional structures can be observed. In the case that spacing ratio smaller than or equal to 3, in the plane in near wake of downstream cylinder, four symmetrical vortices come into being. Other detailed parts of the flow field are addressed in this paper, and some macro-variables such as vortex shedding frequency, lift and drag coefficients are also calculated in this paper.

Key words

DOI:

通讯作者 zjudengjian@zju.edu.cn

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