

环形液池内中等Pr数流体的浮力-热毛细对流

彭岚, 李友荣, 曾丹苓, 今石宣之

重庆大学动力工程学院, 重庆 400044

收稿日期 修回日期 网络版发布日期 接受日期

摘要 为了解水平温度梯度作用时环形液池内的浮力-热毛细对流特性, 利用有限差分法进行了非稳态三维数值模拟, 环形液池外壁被加热, 半径为40 mm, 内壁被冷却, 半径为20 mm, 液池深度为3~17 mm, 液池内流体为0.65cSt的硅油, 其Pr数为6.7. 模拟结果表明, 当水平温度梯度较小时, 流动为轴对称稳态流动, 随着温度梯度的增加, 流动将会失去其稳定性, 在浅的液池内($d=3\text{mm}$), 转化成三维振荡流动, 在深的液池内($d\geq 6\text{mm}$), 转化成三维稳定流动; 模拟计算的临界温差及表面温度分布图像与实验结果基本吻合.

关键词 [数值模拟](#), [浮力-热毛细对流](#), [轮型](#), [硅油](#), [环形浅池](#)

分类号 [O363.2](#), [TK124](#)

Buoyant-thermocapillary convection of moderate prandtl number fluid

...

重庆大学动力工程学院, 重庆 400044

Abstract

In order to understand the nature of buoyant-thermocapillary convection in an annular pool with the outer heated container of radius $r_o=40\text{ mm}$ and the inner cooled cylinder of $r_i=20\text{ mm}$, and an adjustable depth $d=3\sim 17\text{ mm}$, we conducted a series of unsteady three-dimensional numerical simulations with the finite difference method. The pool was filled with the 0.65cSt silicone oil (Prandtl number $Pr=6.7$). Results show that a small temperature difference in the radial direction generates steady roll-cell buoyant-thermocapillary flow. With large temperature difference, the simulations can predict two types of flow instability. In a shallow pool ($d=3\text{ mm}$), the hydrothermal wave characterized by curved spokes traveling in the azimuthal direction is dominant while in deep pools ($d\geq 6\text{ mm}$), the three-dimensional stationary instability appears. The critical conditions for the onset of the instability flows and the free surface temperature fluctuation are determined and compared with the experimental results.

Key words [computer simulation](#) [buoyant-thermocapillary convection](#) [spoke pattern](#) [silicon oil](#) [annular pool](#)

DOI:

通讯作者 penglan@cqu.edu.cn

扩展功能

本文信息

- ▶ [Supporting info](#)
- ▶ [PDF\(1279KB\)](#)
- ▶ [\[HTML全文\]\(0KB\)](#)
- ▶ [参考文献](#)

服务与反馈

- ▶ [把本文推荐给朋友](#)
- ▶ [加入我的书架](#)
- ▶ [加入引用管理器](#)
- ▶ [复制索引](#)
- ▶ [Email Alert](#)
- ▶ [文章反馈](#)
- ▶ [浏览反馈信息](#)

相关信息

- ▶ [本刊中 包含“数值模拟,浮力-热毛细对流,轮型,硅油,环形浅池”的相关文章](#)
- ▶ [本文作者相关文章](#)

- [彭岚](#)
- [李友荣](#)
- [曾丹苓](#)
- [今石宣之](#)