

传递现象

## 黏性耗散效应对微石英管内部对流换热的影响

刘志刚, 赵孝保, 张承武

山东省科学院能源研究所; 南京师范大学动力工程学院

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摘要

以去离子水为工质, 对流过内径分别为45  $\mu\text{m}$ 、92  $\mu\text{m}$ 及141  $\mu\text{m}$ 的微石英管内的黏性耗散对换热特性的影响进行了实验研究。通过对紧密缠绕在管外的细铜丝通电以加热管外壁, 得到了Reynolds数在100~2000之间变化时的Nusselt数, 同时在考虑到电双层效应的基础上计算出黏性耗散所产生的热量。实验结果表明,  $Re$ 较低时, 黏性耗散效应对微管内部对流换热的影响较小; 随着 $Re$ 的增加, 黏性耗散对对流换热的影响增大, 并随着微管直径的减小而明显增强。对于内径为45  $\mu\text{m}$ 的管, 当 $Re$ 达到2000左右时, 黏性耗散效应对对流换热的影响超过14.1%; 对于内径为141  $\mu\text{m}$ 的管, 层流黏性耗散效应对微管内部对流换热的影响较小, 基本可以忽略。

关键词

[微管](#) [Nusselt数](#) [电双层](#) [黏性耗散](#)

分类号

## Influence of viscous dissipation on convective heat transfer in quartz glass microtube

LIU Zhigang, ZHAO Xiaobao, ZHANG Chengwu

Abstract

Deionized water, used as working fluid, flowed through the quartz glass microtubes with inner diameters of 45  $\mu\text{m}$ , 92  $\mu\text{m}$  and 141  $\mu\text{m}$ , respectively, and the influence of viscous dissipation on convective heat transfer was experimentally studied. The microtube was heated by an electrified brass wire that was coiled evenly up around the microtube. As the Reynolds number varied in the range from 100 to 2000 in the experiments the corresponding Nusselt number was obtained. The quantity of heat generated by viscous dissipation was calculated by considering electrical double layer (EDL) effect. The experimental results showed that the influence of viscous dissipation on convective heat transfer was small at a low Reynolds number. With the increase of Reynolds number and the decrease of microtube inner diameter, viscous dissipation apparently affected convective heat transfer. For the microtube with an inner diameter of 45  $\mu\text{m}$ , the quantity of heat generated by the viscous dissipation could account for about 14.1% of the quantity of convective heat transfer when Reynolds number reached 2000. The influence of viscous dissipation on convective heat transfer was so small that it could be neglected for microtube with an inner diameter of 141  $\mu\text{m}$  when the flow was laminar.

Key words

[microtube](#) [Nusselt number](#) [electrical double layer](#) [viscous dissipation](#)

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