

多相流和计算流体力学

## 水基纳米流体在水平毛细管中的气液两相流流型特性

高亦普, 刘振华

上海交通大学机械与动力工程学院

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摘要

研究了在内径为1.6 mm的水平玻璃毛细管圆管内的氮气-氧化铜水基纳米流体的两相流流型分布图, 实验气体是氮气, 实验液体是由去离子水、氧化铜纳米颗粒和十二烷基苯磺酸钠(SDBS)组成的悬浮液。首先对氮气-去离子水在水平毛细管内的两相流流型图进行了实验研究, 将实验结果与前人提出的应用于常规管的半理论半经验公式进行了比较。然后在水中添加不同比容积的SDBS和氧化铜纳米颗粒制备成纳米流体, 对纳米流体在水平毛细管内气液两相流的流型图进行了研究。结果表明, 使用纳米流体后, 毛细管内的分层波动流区域显著增加。纳米流体对两相流流型的影响主要是由添加表面扩散剂和纳米颗粒后降低了溶液表面张力产生的。纳米流体中的纳米颗粒和表面扩散剂浓度对流型图几乎无影响。

关键词 [两相流](#) [流型图](#) [纳米流体](#) [毛细管](#)

分类号

## Flow pattern map of two-phase flow of nitrogen and water based nano-liquids in horizontal capillary tube

GAO Yipu, LIU Zhenhua

### Abstract

The flow pattern map of the two-phase flow of nitrogen and water based CuO nano-liquid in a horizontal capillary tube was investigated experimentally. The nano-liquid was a suspension consisting of water, CuO nano-particles and sodium dodecyl benzol sulphate solution (SDBS). The flow pattern map of nitrogen-water in a horizontal capillary tube was firstly investigated and the result was compared with previously published models for the conventional tubes. Then, different specific volumes of SDBS and CuO nano-particles were added into water to make a series of water based CuO nano-liquids. The flow pattern characteristics of the gas-nanoliquids in a horizontal capillary tube were investigated. The experimental result showed that the flow pattern maps of gas-liquid two-phase flow for capillary tube differed significantly from those for the conventional tubes. For the gas-nanoliquids flow in the capillary tube, the flow pattern transitions for gas-liquid two-phase flow occurred at lower flow gas velocities compared with the gas-water flow in the same capillary tube. The effect of the gas-nanoliquids on the two-phase flow pattern resulted mainly from the change of surface tension. Since the surfactant and nano-particles decreased the surface tension of the nano-liquid, the flow pattern transitions for gas-nanoliquids occurred at much lower velocities compared with the case of gas-water. The concentrations of the nano-particles and SDBS had no effect on the flow pattern map of the gas-nanoliquids.

**Key words** [two-phase flow](#) [flow pattern map](#) [nano-liquid](#) [capillary tube](#)

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通讯作者 刘振华 [liuzhenh@sjtu.edu.cn](mailto:liuzhenh@sjtu.edu.cn)

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