Accepted Manuscript

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Yun-long Zhou, He Chang, Tianyu Qi

PII: S1004-9541(16)30618-8
DOI: doi:10.1016/j.cjche.2016.10.006
Reference: CJCHE 690

To appear in:

Received date: 27 June 2016
Revised date: 11 October 2016
Accepted date: 12 October 2016

Please cite this article as: Yun-long Zhou, He Chang, Tianyu Qi, Gas–liquid two-phase flow in serpentine micro channel with different wall wettabililty, (2016), doi:10.1016/j.cjche.2016.10.006

Gas-liquid two-phase flow in serpentine micro channel with different wall wettabililty

ZHOU Yun-long(周云龙) [1]，CHANG He(常赫) [1]，QI Tianyu(齐天宇) [2]

1.Energy and Power Engineering College, Northeast Dianli University, Jilin 132012, China

2.Institute of Energy, Environment, and Economy, Tsinghua University.Beijing, 100084, China

Abstract Gas-liquid flow in serpentine micro channel with different surface properties exhibits drastically different flow behavior. With water and air as working fluids, the method of numerical simulation was adopted in this paper based on CLSVOF (coupled level set and volume of fluid method) multiphase model. After verifying the reasonability of the model through experiment, by changing wall properties and *Re* number (*Re*<1500), the influences of contact angle and surface roughness on flow regime and *Po* number were discussed. Moreover, the difference of pressure drop between curve and straight micro channel was also calculated. Beyond that, the combined effect of curve channel and wall properties on flow resistance was analyzed. This paper finds that wall properties have great influence on gas-liquid flow in micro channels not only on flow regime but also flow characteristics. Meanwhile, the pressure drop in curve micro channels is larger than straight. It is more beneficial for fluid flowing when the straight part of micro channel is hydrophilic smooth wall and curve part is hydrophobic with large roughness.

Key Words Serpentine micro channel; Computational Fluid Dynamics; Gas-liquid flow; Microfluidics

1 INTRODUCTION

Micro channel has great application prospect in the fields of natural science and chemical engineering, and kept high speed development. Meanwhile, micro chemical technology which is increasingly attract attention of scholars has become one of the important development directions of chemical engineering [1-2]. According to the statics in literature, due to excellent heat and mass transfer ability, many reactions that cannot be achieved in conventional channel can be implemented in a micro reactor [3]. At present, micro reactor has been widely used in chemical researches, and the application of it in commercial production is also increasing day by day. Especially for gas-liquid two-phase flow which is widely applied in the chemical industry [4], petroleum industry [5] and photochemical reactions [6]. As basic transport, it determines the performance and efficiency of micro devices to a great extent. Up to now, domestic and foreign academic circles have carried out extensive researches and owned a better understanding of fluid flow characteristics. However, there are still many technical difficulties in the manufacture of micro devices including wall load of the catalyst and automatic control of the system [7]. It is necessary to carry out deep and integrated researches on wall surface of micro channel and interfacial phenomena. Among various issues calling for further study, wall properties have attracted our interests a lot.

As an important part of micro chemical technology, gas-liquid micro contact system has been widely studied both by experiment and in theory [3-5, 8]. A common conclusion has been drawn: wall properties (roughness and wettability) are one of the reasons that cause heat transfer and flow characteristics of microchannel different from conventional ones. On the basis of experiment and detailed numerical simulation, we adopted a Y type convergence serpentine micro channel with two curve channels which is different from traditional micro channel to explore two-phase flow. The present research is mainly focused