

多相流和计算流体力学

基于图像纹理分析的两相流流型时空演化特性

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摘要 为了研究气液两相流流动结构时空演化特征, 在水流量为 $0.02\sim 0.4\text{ m}\cdot\text{s}^{-1}$ 及气流量为 $0.005\sim 2.7\text{ m}\cdot\text{s}^{-1}$ 的流动范围内, 对垂直及倾斜 30° 上升的气液两相管流中的七种典型流型采集了动态图像信息。在流型图像特征分析中采用了灰度共生矩阵法对图像局部邻域内的二维信息进行量化表征, 提取了六种反映不同流型动态图像纹理结构的时变特征参数, 对流型生长过程中流动结构变化进行了分析。研究表明: 流型图像纹理结构特征动态参数演化趋势刻画了不同流型流动结构差异及动力学复杂性, 该分析方法有助于理解气液两相流流动结构时空演化特征, 也是气液两相流流型辨识的有效手段。

关键词

[气液两相流](#) [流型时空演化](#) [灰度共生矩阵](#) [图像纹理分析](#)

分类号

Temporal and spatial evolution characteristics of two-phase flow pattern based on image texture analysis

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Abstract

In order to study the temporal and spatial evolution characteristics of gas-liquid two-phase flow structure, a high-speed dynamic camera was utilized to acquire the dynamic image information of seven typical gas-liquid two-phase flow patterns in vertical and inclined 30° upward pipes with the testing ranges of superficial water velocity $0.02\text{--}0.4\text{ m}\cdot\text{s}^{-1}$ and superficial gas velocity $0.005\text{--}2.7\text{ m}\cdot\text{s}^{-1}$. The gray level co-occurrence matrix (GLCM) was used to quantitatively characterize 2D information in the local neighborhood of image for analyzing flow pattern image features and the four time-varying characteristic parameter indices which represented image texture structures of different flow patterns were extracted. Then the transition of flow structure in the development process of flow patterns and calculated Lempel-Ziv sequence complexity of the four time-varying characteristic parameter indices were analyzed, and compared with the complexity measurement, fractal scale and recurrence plot determinism calculated by conductance fluctuating signals. The study showed that the dynamic parameter evolution trends of flow pattern image texture structure characteristics described the variation of different flow pattern structures and dynamics complexity, and the correlation index (COR) was more effective to reflect the complexity of flow pattern dynamics than others. It indicated that the proposed dynamic image analysis method was helpful to understanding the flow pattern temporal and spatial evolution characteristics and also was an effective approach to identifying the gas-liquid two-phase flow patterns.

Key words

[gas-liquid two-phase flow](#) [flow pattern temporal and spatial evolution](#) [gray level co-occurrence matrix](#) [image texture analysis](#)

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