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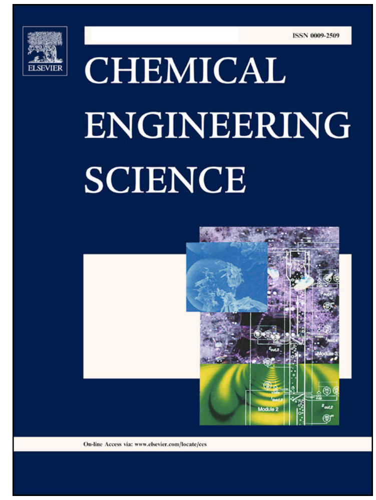

Image processing techniques for the measurement of two-phase bubbly pipe flows using particle image and tracking velocimetry (PIV/PTV)

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Image processing techniques for the measurement of two-phase bubbly pipe flows using particle image and tracking velocimetry (PIV/PTV)

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Abstract

Particle Image Velocimetry (PIV) measurement in gas-liquid bubbly flows is a challenging task, mainly due to the dispersion of the laser light caused by the gas-liquid interfaces. A common solution adopted is the use of fluorescent seeding particles associated with a bandpass filter for the laser light. Therefore, the camera captures only the light fluoresced by the seeding particles, filtering the laser light dispersed by the gas-liquid interfaces and measuring a velocity field which corresponds to the liquid phase, seeded with the particles. However, even for relatively low gas fractions, the fluoresced light reflected by the interfaces distorts the measurements, as it illuminates particles out from the laser plane. In addition, the fluoresced light also reflects at the interfaces, distorting the measurements and trending to overshoot the measured liquid velocities In this work, PIV measurements of air-water bubbly flows in a small diameter pipe (D=26.2 mm) are performed with fluorescent tracer particles (PIV/LIF). A new method for the phase discrimination in PIV was developed to overcome the problems caused by the presence of bubbles in the flow, which uses the pixels intensity information of each interrogation window, to identify if that window corresponds to liquid or bubble region. To validate the PIV procedure, a Particle Tracking Velocimetry (PTV) algorithm was also developed to measure the bubbles velocities, based on similar implementations found in literature, but some corrections were also proposed to overcome the bubble overlap phenomena which arises in bubbly pipe flows, when backward illumination is used. The PIV and the PTV methods were tested and validated by a series of distinct gas void fraction and bubble diameters experimental cases, confirming the accuracy and reliability of both methods. The proposed method was used to analyze a set of upward laminar and turbulent bubbly flows, showing that the averaged axial velocity and the dispersed gas bubbles modify the turbulence intensity profiles.

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