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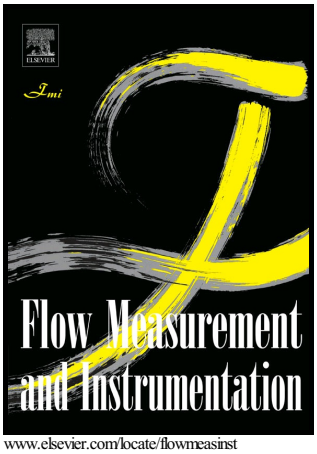

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Development of a dual optical fiber probe for the hydrodynamic investigation of a horizontal annular drive gas/liquid ejector

Aliyu Musa Aliyu[1], Yoon Kee Kim[1], Seong Hwan Choi[1], Joo Ha Ahn[2], Kyung Chun Kim[1*]

[1]School of Mechanical Engineering, Pusan National University, San 30, Jangjeon-dong, 609-735, Busan, Republic of Korea

[2]Technical Research Department, Tanktech Co. LTD., Busan, 618-817, Korea

[*]Corresponding author: Tel.: +82 51 510 2324; Fax: +82 51 515 7866. kckim@pusan.ac.kr

Abstract

A dual-channel optical fiber probe was developed to quantify the bubble characteristics (void fraction, velocity, and bubble size) in a gas–liquid annular ejector system. Water is pumped upstream of the ejector contraction. Since a low pressure region exists downstream in the ejector diffuser, this permits air to be sucked into the flowing liquid by jet pump action and the inlet air volumetric flow rate is measured by a flow meter. Verification of the void fraction (range 0.15 – 0.5) measured by the optical fiber probe was then possible and deviations were generally around ± 5 %. Also, bubble velocity was measured using the optical probe by cross-correlating signals from the two fibers whose tips are separated by a known distance. Alternatively measuring bubble velocity using a particle image velocimetry method provided validation for the optical fiber probe system where a high speed camera was used to capture instantaneous bubble images at time intervals of 0.125 ms. Excellent agreement between the velocities using both methods is reported. For bubble size measurements, analyzing the temporal signals from a single probe enabled estimation of the size of a bubble. Bubble sizes measured ranged between 1.5 and 6.0 mm and size distributions were constructed for different ejector water volumetric flow rates ranging from 0.0022 to 0.0063 m^3/s. LabVIEW provided a convenient platform for coding the algorithms for estimating the void fraction, bubble velocity and bubble size. For further comparison, a CFD study of the ejector system was done, and the vertical radial profiles of the void fraction were compared with those obtained by the optical fiber system and these showed good agreement.

Keywords: Fiber optic probe, Fresnel reflection, bubbly flow, annular ejector, void fraction, CFD.