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LETTERS

Comments on "Fiber optic reflectometer for velocity and fraction ratio measurements in multiphase flows" [Rev. Sci. Instrum. 74, 3559 (2003)]

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The writers presented a challenging and detailed technique to deduce velocity measurements from a single-tip optical fiber probe in air–water flows. The discusser congratulates them for this major advance and he wishes to add some pertinent comments on air–water flow velocity measurements with single- and double-tip probe systems.

Phase-detection intrusive probes have been used for more than four decades. Since the needle probe was developed by Bankoff,[1,2] the designs have been refined. Although the first designs were resistivity probes, both optical fiber and resistivity probe systems are commonly used today. Figure 1(A) shows a double-tip resistivity probe with an inner electrode (platinum) of 0.15 mm diam used for field measurements, while Fig. 1(B) presents a laboratory probe with a 0.025 mm diam inner electrode. The latter design [Fig. 1(B)] has been used successfully for more than ten years with flow velocities up to 9 m/s.[3–6] As such, resistivity probe sensors can be much smaller than optical fiber probe tips.

With phase-detection intrusive probes, velocity measurements may be performed using the writers' technique or using a double-tip probe system. Note that double-tip probe system signals may be analyzed using two methods: the analysis of individual bubbles successively impacting both sensors, or a cross-correlation analysis.[7,8] Table I summarizes the comparative advantages of each technique. In summary, the writers' technique has the main advantage of probe simplicity, while dual-tip probe measurement techniques require the simplest data acquisition system and the least postprocessing. The latter was recently extended to include turbulence intensity, bubble size and bubble cluster outputs.[6]

Finally, two studies attempted unsuccessfully to measure interfacial velocity from the signal rise time with single-tip resistivity probes.[9,10] It was suggested that the drying process on the probe sensor was strongly affected by the presence of

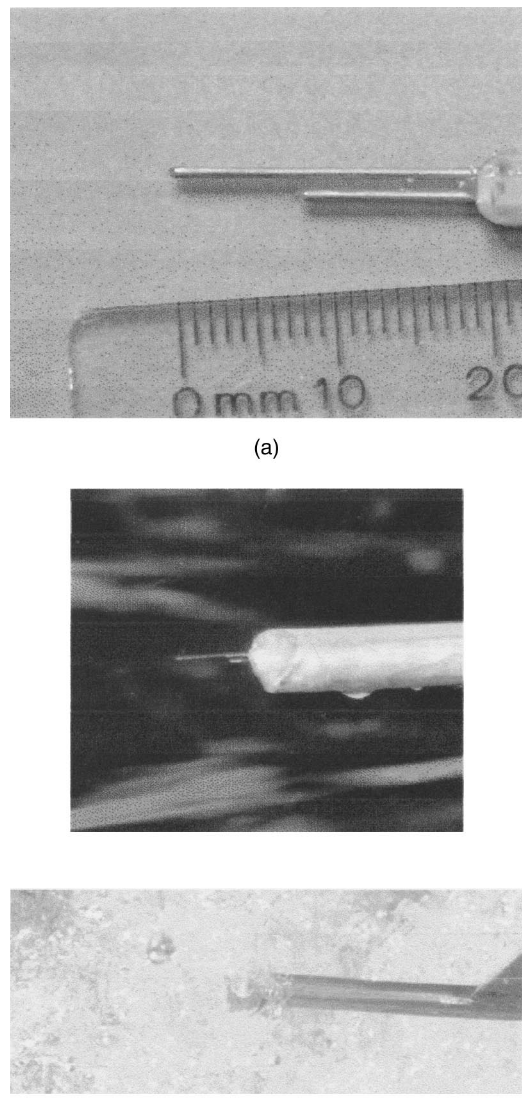

FIG. 1. Photographs of double-tip resistivity probes: (a) Probe for field measurements (inner electrode ∅=0.15 mm); and (b) probe for laboratory measurements (inner electrode ∅=0.025 mm). (Top) above water; (bottom) in air–water flows (flow from left to right, V∼3.5 m/s).

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TABLE I. Comparison of velocity measurement techniques.

Feature (1)	Chang *et al.*[a] (2)	Double-tip probe design: Single event analysis (3)	Double-tip probe design: Cross-correlation analysis (4)	Remarks (5)
Probe	Single-tip optical fibre probe	double-tip resistivity/optical fibre probe	double-tip resistivity/optical fibre probe	
Scan rate	10 MHz	10 kHz	10 kHz	Typical values.
Velocity measurement calculation	Time series analysis of individual bubble event	Individual bubble event analysis	Cross correlation	
Post-processing calculations	Very complicated	Complicated	Simple	
Remarks		Void fraction less than 20%	Void fractions between 0 and 1	

[a]Reference 12.

water impurities and by sensor shape irregularities, yielding a wide scatter of the calibration data.[11] It would be interesting to have the writers' thoughts on a possible application of their technique to resistivity probe measurements.[12]

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