DIRECTIONAL SENSITIVITY & PERFORMANCE COMPARISON OF DANTEC DYNAMICS TRIPLE SENSOR HOTWIRE PROBES

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Triple-sensor hotwire probes are important point measurement sensors during turbulent flow investigations. Coupled with high-performance constant-temperature anemometers they can provide high-bandwidth information on turbulence quantities such as normal stress, Reynolds stress, turbulent kinetic energy, production terms and dissipation terms [1]. An accurate measurement depends on the correct conversion of the measured voltage to instantaneous velocity. Variations in prong / sensor geometry, directional calibration model (f. ex. the effective cooling velocity [2]), type of sensor (wire or fiber-film), and temperature variations affect the conversion. Furthermore, the measurement system is often calibrated within a limited velocity range and the sensor often has a limited acceptance angle for the incoming flow vector. It has been reported that the accuracy decreases with increasing incidence angle [3].

With the development of a new automated directional calibration tool, we aim to report and compare the directional sensitivity and performance of Dantec Dynamics-manufactured triple sensor probes in a subsonic velocity range; from 5m/s to 50m/s, and within an incidence angle of up to 40deg with respect to the probe axis. A total of five probes are included in the calibration campaign in air. Four of these are for parallel flows: 55P91, 55R91 (wire and fiber sensors on legendary claw-type prong geometry), 55P95 (Fig. 1a), 55R95 (wire and fiber sensors on new straight prong geometry); and one is for cross-flows: 55R97 (fiber sensors on special cross-flow prong geometry). Each probe has been subject to multiple directional calibrations; at different constant velocity and yaw angle settings in order to establish the directional dependence to calibration velocity and incidence angle. The aim is to calculate the true error (Fig. 1b) from the calibration data for a wide range of velocity and incidence angles, and this will allow different comparisons among the five sensors: (i) sensor type: wire vs. fiber sensors (ii) prong shape: claw vs. straight prongs and (iii) placement of sensor: parallel vs. cross-flow. The results form a reference database for researchers who plan to undertake triple-sensor hotwire anemometry experiments, and provide the expected measurement error for a given flow speed.

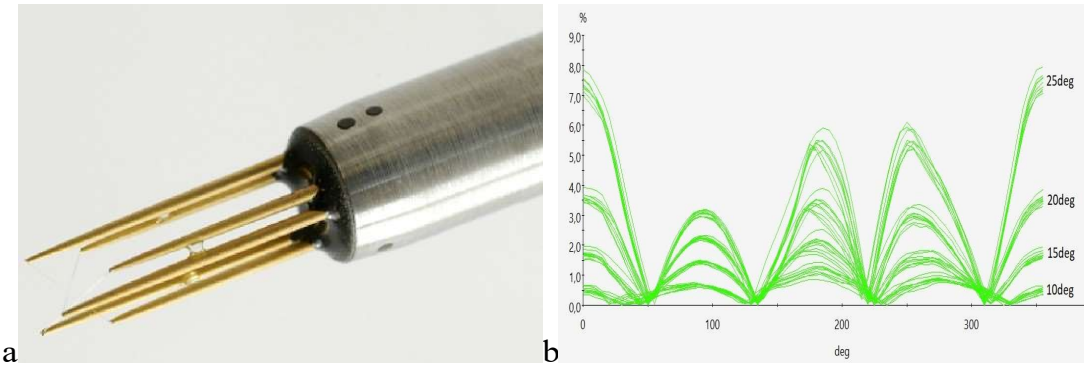

Figure 1. (a) 55P95 triple-wire probe with straight prongs. (b) %Error variation in V vs roll angle using 55P95. Velocity range 10-50 m/s, incidence angle range 10-25deg.

References

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