DEVELOPMENT OF TWO-SENSOR HOT-WIRE PROBES FOR MEASUREMENT OF THE VELOCITY AND THE TEMPERATURE

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1. Introduction

The paper describes characteristics of a new two-sensor HWA probe designed for simultaneous measurement of the velocity and the flow temperature. A comparison with previously developed probe is given. Both tested probes were developed and manufactured at Fluid dynamics laboratory of the Institute of Thermomechanics.

2. Directional characteristics measurement

Both examined probes have two parallel wires. The first probe (P711) was designed as a "miniature" probe, which means that the whole wire length is active. The second one (P712), called "long-wire" probe, has sensors with plated ends. Only the middle part of sensors is active in this case.

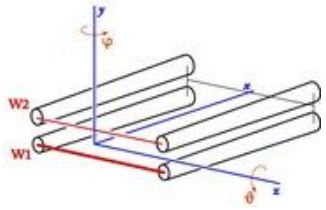


Fig. 1: Scheme of parallel-sensor probe geometry

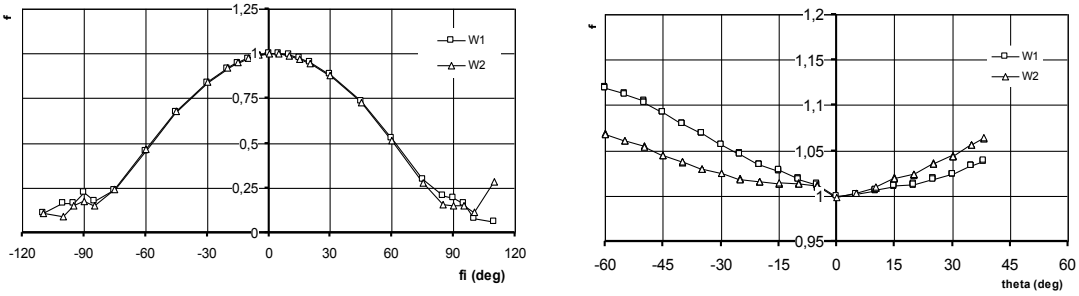
Directional function $f(\alpha)$ is defined as follows:

$$f_i(\alpha)=\left[\frac{u_{ef_i}(\alpha)}{u}\right]^2=\left[\frac{K_i E_i^2(\alpha)}{\lambda_{mi}(T_{wi}-T)}\left(\frac{T_{mi}}{T}\right)^{m_i}-A_i\right]^{\frac{2}{n_i}}\left[\frac{K_i E_i^2(\pi/2)}{\lambda_{mi}(T_{wi}-T)}\left(\frac{T_{mi}}{T}\right)^{m_i}-A_i\right]^{-\frac{2}{n_i}}$$

Comparison of directional characteristics of both types is given.

a) Miniature parallel-sensor probe P711

Heated elements are placed perpendicular to the probe axis and parallel to each other (d_1=1e-5 m; l_1=l_2=1,25e-3 m, d_2=5e-6 m). Measured directional characteristics are shown in Graph 1.



Graph 1a and 1b: Directional characteristics of probe P711 - *x*-axis is parallel to the flow

b) Long-wire parallel-sensor probe P712

A new long-wire probe P712 looks similar to previous one (P711), but the distance between prongs is bigger. Heated elements have overall length of 5e-3 m. First sensor is made of a tungsten wire with gold-plated ends (d_1=5e-6 m; l_1=1,25e-3 m). Second sensor is made of cooper-plated platinum-alloy (Pt-Rh) wire of Wollaston type (d_2=2e-6 m, l_2=1,51e-3 m).

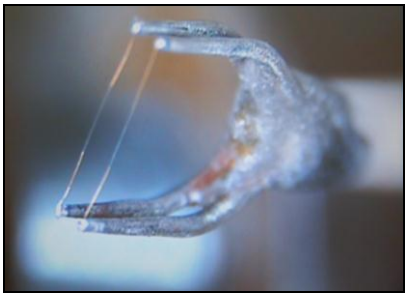
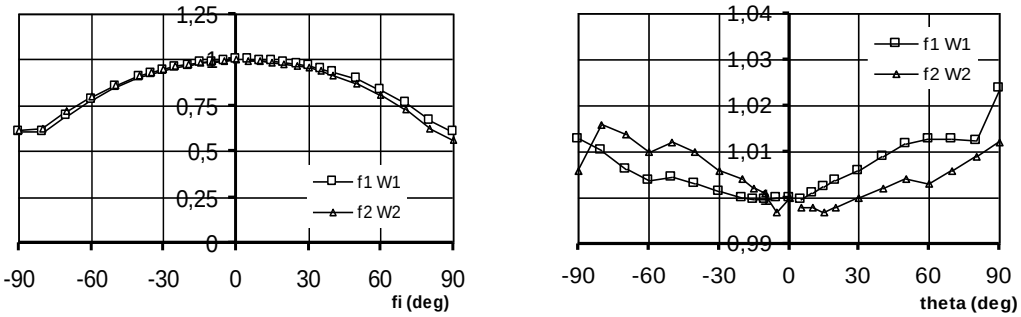


Fig.2: Photo of long-wire parallel-sensor probe



Graph 2a and 2b: Directional characteristics of probe P712 - *x*-axis is parallel to the flow

3. Conclusion

For simultaneous measurement of velocity and scalar quantity is essential to keep equality of directional functions of both sensors in wide range of angles. This is fulfilled in *xz*-plane (φ angle) for both probes (±60°). It can be seen an improvement in *xy*-plane (ϑ angle); range of use is only ±10° in case of miniature probe, whereas for long-wire probe is the difference in *f* less then 1% in the whole range.

Characteristics of new long-wire parallel-sensor probe P712 seem to be better then of a miniature type. It is more suitable for simultaneous measurement of velocity and scalar quantity.

4. Acknowledgement

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5. References

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