ON THE SHEAR STRESS MEASUREMENT OF THE COMPRESSIBLE FLUID FLOW IN STRAIGHT NARROW CHANNEL

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ABSTRACT

The ability to predict shear stress in narrow channels is of the utmost interest in the design of various machines such as screw type compressors, gas and steam turbines in which the narrow channels are formed in seals and in the clearance gaps. Since the value of shear stress depends mostly on whether the flow is turbulent or laminar the aim of our research is to obtain reliable data of the nature of the flow for possible calibration of turbulence models which are mostly based on the flow about flat plate and thus might not give correct results for internal flow.

Among the usual methods to measure the shear stress we can include hot film measurements using flush mounted films, pneumatic measurements using Preston or Stanton tube or surface fence probes, liquid crystal methods and methods based on the direct measurement of forces – so called floating elements. This contribution aims to introduce our experience of measurements using hot films and surface fence probes in the simple test geometry consisting of straight channel of the length 1.5 m and rectangular cross-section of the width 0.2 m and height 0.01 m under wide ranges of back pressure to stagnation pressure ratio. The two selected methods were chosen because of its relatively good availability and also due to previous experience of measuring with these in our laboratory, however, only in the incompressible fluid flow [1], [2].

For the hot film measurements The Dantec 55R45 flush mounted hot film probe was used in the CTA mode. The probe was inserted in the measuring plug made of stainless steel which can be placed in prepared locations along the channel length. The plug was instrumented with three fast response thermometers one of which was located at the wall and two others inside the plug allowing us to calibrate the probe for different wall and fluid temperature; however, the temperature dependence turned out to be still what makes it difficult to calibrate the probe in compressible flow. Prior the measurements the distributions of static and total pressure were measured for a wide range of back pressure to stagnation pressure ratios. The first attempts to calibrate the hot wire probe to shear stress obtained from pneumatic measurements and subsequently from Fanno flow model appeared to be highly inaccurate, particularly in the vicinity of channel outlet. Therefore the measurements were completed by surface fence probe measurements. The surface fence probe was manufactured according the design, that has already been used in our laboratory and the calibration curve was known.

Results of the hot film probe calibration are to be used for a measurement of the compressible fluid flow in a channel of dimensions with a height of only few millimeters, where any other intrusive methods would fail.

REFERENCES

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[2] Jonáš, P.; Řehák, V. (1994); *Some Observations on the Universal Features of an Array of Heated Films for the Skin Friction Measurements*, In: 12th Symposium on Measuring Techniques in Transonic and Supersonic Flow in Cascades and Turbomachines, Prague, Czech Republic.