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EXPERIMENTAL RESEARCH ON VELOCITY PROFILES IN SELECTED FLOW SYSTEMS

Mirosław KABACIŃSKI
Opole University of Technology, Opole, Poland;
E-mail: m.kabacinski@po.opole.pl

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Velocity profiles of a flowing fluid play an important role during the selection of the installation place of a flowmeter. Depending on the configuration of a flow system the literature refers to various locations for flowmeter installation [1, 2]. Particular role in this respect is given to the local obstacles which cause reversal of the flow direction (e.g. elbows, valves, throttles, changes in pipeline cross-section, tee joints) as they lead to disturbance in the velocity profiles. Flowmeters which are sensitive to the deformation of the velocity profile have to be installed in a relatively large distance from the obstacle (i.e. 20D and more) [1, 2]. However, often in metrological practice we have to do with the need to shorten the distance between the obstacle and the flowmeter due to specific characteristics of an installation. In the case when the application of a flow straightener is unjustified due to economic or metrological considerations, the measurements of velocity profiles can be undertaken in selected installation locations with an aim of assessing the effect of flow deformation due to the installation of a flowmeter [3]. Due to the unexpected distribution of the fluid velocity it is necessary to undertake measurements in considerably larger number of places than it is stipulated in the standard [4]. Such studies are possible on an automated and original laboratory stand (Fig. 1).

a) b)

Fig. 1. An integral part of automated test stand for velocity profile measurement: a) pipeline tests, b) wind tunnel tests (flow around a body).

It was prepared in a manner to enable measurements on various diameters of pipelines (DN 110 to DN 315) with an arbitrary angle in relation to the axis of the pipeline. Due to the installed measurement equipment and various alternatives of software use it is possible to assess the inlet effect and distribution of velocities in the vicinity of the averaging Pitot tubes in order to determine the phenomena occurring in their vicinity (recirculation, direction of the main stream) and verification of the numerical models of the turbulence. Due to recirculation

of the stream in the vicinity of the probes tested in the wind tunnel, two-way probe with the diameter of 2 mm was used instead of the Pitot tube. It is also possible to determine the mean velocity on the basis of a program that accounts for the number of measurement points, their location in relation to the axis and the local velocities. The measurement system was installed with a system of variable ambient condition compensation (measurement of temperature and absolute pressure). Due to the compact structure it was possible to realize measurements not only in laboratory conditions, but in real industrial facility as well. A linear module with a stepper motor (Fig. 1) formed an integral part of the measurement system, which makes it possible to determine the position of the measurement probe (Pitot tube or two-way probe) during measurements with the precision of 0.1 mm. The location of the measuring anemometer, the possibility of adjusting stream mean velocities and data acquisition was undertaken by means of an original program (independently for each case), one that operates in the LabVIEW environment (Fig. 2).

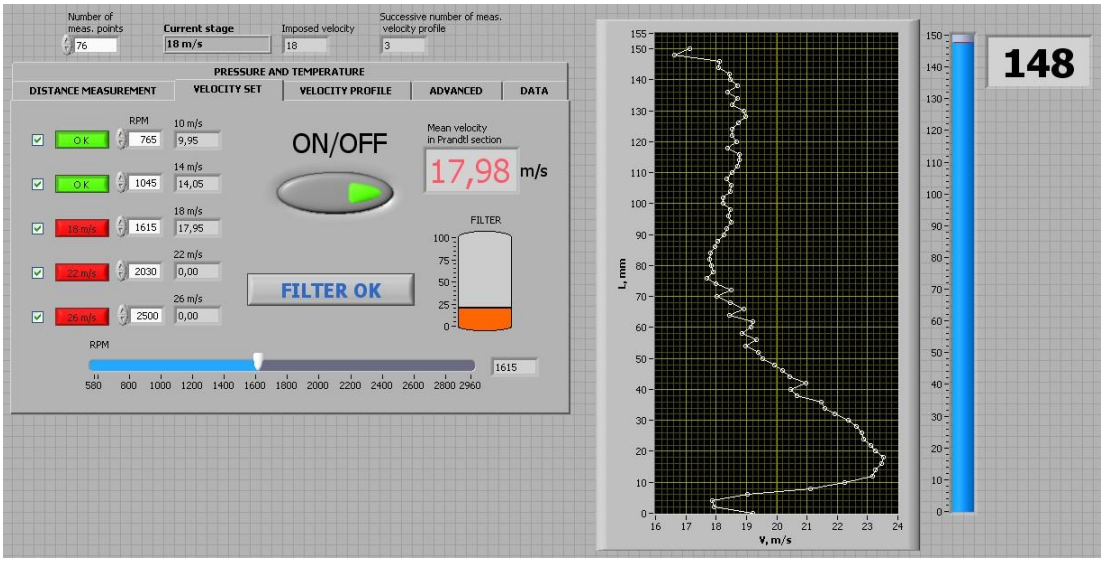

Fig.2. An exemplary computer program controlled velocity profile behind the segment elbow (DN 160).

This paper also presents exemplary velocity profiles for selected research problems:

a) Measurements in pipelines (in the vertical and horizontal planes) – inlet effect accounting for the components at the inlet (mesh, fabric filter, inlet nozzle), flow behind the segment single and double elbow, flow behind the throttle,
b) Measurements in a wind tunnel – flow around a two-profile probe, circular, streamlined, quadratic and double circular.

For the case of research in pipelines – the resulting characteristics make it possible to precisely determine uncertainty of the measurement, which should be accounted for during determination of air fluxes in the locations which are not included in technical documentation of a flowmeter.

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