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Title of the thesis: "Metrological analysis of the application of the ultrasonic flow meter in the pipeline in the place behind the valve"

Abstract of the manuscript

The dissertation concerns the issue of performing flow measurements using the ultrasound technique. The main scope of research is the metrological approach to tests performed in non-standard measurement conditions, i.e. without maintaining the sections of straight pipelines required by the standards. Measurements of the stream flow are one of the most important measurements in engineering practice. We deal with the necessity to measure the mass or volume flow in the energy, chemical and petrochemical industries, as well as in many other engineering fields such as construction and environmental engineering. Determining the flow rate of the fluid plays a fundamental role in the preparation of the mass balance and the energy balance of the system. The measurements of the speed and flow rate are supposed to be conducted with the greatest possible accuracy, because this information is usually widely used in the calculation process or in the operation of the control system of a flow installation.

The most desirable features of measuring devices are high accuracy, reliability and non-invasiveness. The ultrasonic method meets these standards. Ultrasonic flowmeters with clamp-on sensors are very universal, because their installation on the outer surface of the pipeline does not interfere with the functioning of the installation and does not force it to stop. Moreover, these devices ensure high measurement accuracy. The limit error of ultrasonic transit-time flowmeters with clamp-on sensors, depending on the flowmeter model, is in the range of 1% - 2% of the measured value. [1] [2]

However, there are limitations to the use of the ultrasonic flow measurement method. Ultrasonic flow meters are sensitive to flow disturbances, which, as previously stated, may be caused by hydraulic fittings or sediment on the walls of the pipeline. The consequence of this is the necessity to keep straight sections of the pipeline in front of and behind the obstacle i.e. the source of disturbances. The required straight sections of the pipeline are strictly defined for each type of obstacle in the standards and manuals for a given device. Recommended straight sections of the pipeline are from 15D to 40D, depending on the type of obstacle. The most common elements disturbing the flow are: measuring orifice, diffuser, confusor , hydraulic elbow, throttle, knife gate valve or other types of valves. [3] [4]

It is very difficult to maintain the straight sections in front of and behind the source of the disturbance in the case of large installations and pipelines with large diameters. For example in the energy industry, pipelines with a diameter of more than 1m are used, e.g. cooling water

pipelines in steam turbine condensers. In such cases, it is problematic to find straight sections of the pipeline with a length equal to a dozen or several dozen times the diameter of the pipeline. In the doctoral dissertation, the topic concerning the metrological analysis of measurements performed without maintaining the required straight sections behind the knife gate valve, which is an element used to regulate the flow, very common in industrial installations, was brought up. Performing a measurement using an ultrasonic flowmeter is in such cases often the only solution to perform tests without stopping the work of the installation. In order to compensate the measurement error caused by the flow disturbances, it is necessary to introduce the correction coefficient K. [1]

The performed tests of the flow behind the knife gate valve, at distances from the gate valve smaller than specified in the standards (in the range of 3D-15D), allowed to determine the correction factor in the form of the velocity distribution shape factor K. An analogous factor was determined for the velocity distribution equations describing flows with a distorted velocity profile. [1] [5] [6] In order to find out the actual speed distribution behind the obstacle in the form of a knife gate valve, tests were carried out with the use of a laser anemometer (LDA). They allowed for the adjustment of the velocity distribution model to the actual flow.

Literature:

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