Head of Doctoral Studies
at the Faculty of Mechanical and Power Engineering
prof. dr hab. inż. Henryk Kudela

mgr inż. Piotr Synowiec

Title of the prepared doctoral dissertation:

"The influence of flow disturbances on the characteristics of ultrasonic flow meters with clamp-on sensors on pipeline"

Promoter: **dr hab. inż. Artur Andruszkiewicz prof. PWr**

Auxiliary promoter: **dr inż. Wiesław Wędrychowicz**

In balance tests of power machines and devices, e.g. boilers, steam turbines or pumps, it is necessary to measure the water stream in the flow pipelines of a given device. Measurements of flow streams necessary to carry out the balance are usually carried out during continuous operation of the devices, which does not allow any interference in the pipelines. Therefore, non-contact ultrasonic flow meters are most often used to make them, which do not disturb the flow and do not cause additional pressure drop. The limit error of such a flow meter, according to the declaration of the measuring apparatus manufacturers, does not exceed 2% of the value indicated by the device. Meeting the accuracy of the flow meter during measurements requires an appropriate length of straight pipeline sections, both before and behind the obstacle. However, very often these conditions cannot be met and the measurement is carried out on straight sections that do not meet the requirements. In this case, an additional factor to eliminate measurement errors should be entered into the processing equation of a given flow meter. The values of this factor were determined in the work depending on the distance of flow measurement behind the selected disturbance, which was the Hamburg bend - an element of almost every flow installation. The calculated values were given in tabular as well as graphical form, which clearly showed that the lengths of straight sections necessary to perform the measurement after the disturbance, and exceeding more than 15 pipeline diameters, are too large and can be reduced. Based on the measurements it was found that in the area of disturbed flow on the perimeter of the pipeline, in a given cross-section, there are places where the error in measuring the flow stream is the smallest - in the case of the analyzed disturbance these were angles of 60 ° and 240 °.

This confirmed the goals of the doctoral dissertation.

The paper compares the actual velocity profiles determined in individual planes using the LDA method with numerical simulations using the k-ε turbulence model. It showed the similarity of the speed profiles in each of the planes, which showed that a mathematical model can be used to determine such a place on the periphery of the pipeline, in the area of disturbed flow in which the error of flux measurement will be the smallest.

To achieve the set goals, an original test stand was built, which allowed the measurement of the flow stream to maximum Reynolds numbers of about 100,000. Its characteristic feature was to install, in addition to the Doppler laser anemometer, several flow meters whose purpose was to check the correct and constant setting of the water flow in the installation, as the measurements were time consuming and took place over a longer period of time. Also installed in the installation flow meters were used to check the correctness of the indications of ultrasonic flow meters, which were used to continuously measure flow.

Piotr Synowiec