WORKING PARAMETERS EVALUATION OF THE STAND OF HYDRODYNAMIC PERFORMANCES OF VALVES

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The paper presents the working parameters of the hydrodynamic performances stand of industrial process control valves. The stand could test industrial butterfly valves or gate valve with the dimensional size of 600 to 300 mm. Flow coefficient, K_v and velocity head loss coefficient of the valve, ζ, could be measured in the stand in accordance with international standard CEI/IEC 60534-2-1:1998. The stand of testing has a constant level tank which assures the permanent flow to a practical rate of 2.1 m^3/s and the discharge by a head of 6.95 m.

Hydraulic and hydraulic machinery Department of University Politehnica of Bucharest wants to respond to the European norm 97/23/EC regarding the pressure equipment.

Keywords: flow coefficient, velocity head loss coefficient, check valve, test procedure, Reynolds number, incompressible fluid.

1. Introduction

The working process of the industrial process control valves depends of the valves hydrodynamic performances: flow coefficient, K_v, velocity head loss coefficient, ζ and the cavitation coefficient or Thoma coefficient, σ.

In the Gas-hydrodynamic of machineries and installations Laboratory of the Hydraulic and Hydraulic Machineries Department a stand was build to measure the hydrodynamic performances of the valves in accordance with the international standard CEI/IEC 60534-2-1: 1998 and CEI/IEC 60534-2-3: 1997. The purpose of the paper is to describe the stand and to specify the working parameters of the stand for the nominal size of the valve, nominal diameter, DN, 600, 500, 400, 300 mm.

The stand was designed in accordance to the demands of the Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 concerning pressure equipment.

The stand is in the process of conformity assessment procedures regarding the measurements of flow coefficient and velocity head loss coefficient.

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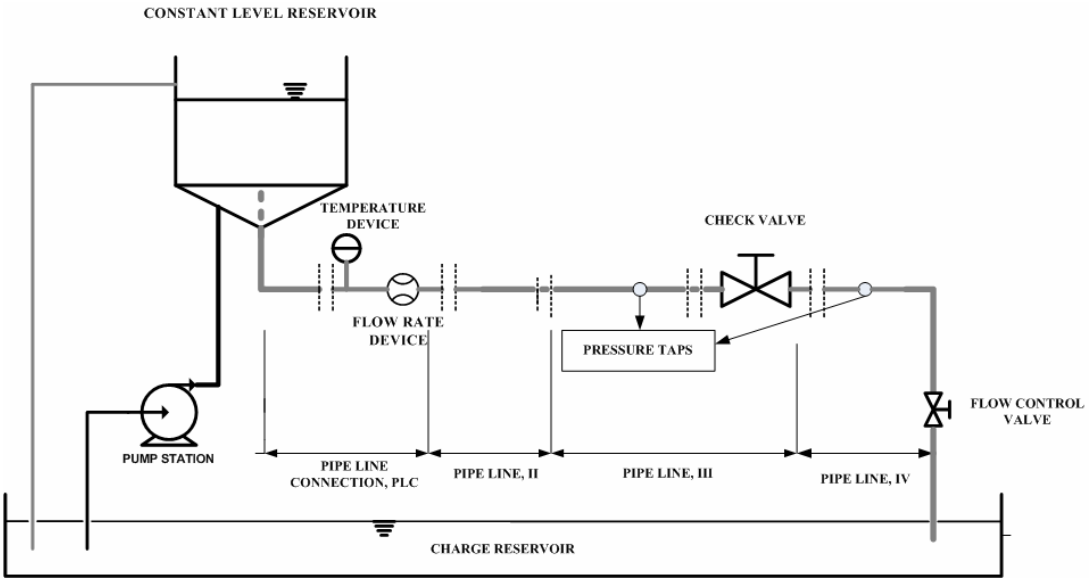
2. Description of the stand

The stand of hydrodynamic performances of industrial valves consists in a constant level reservoir [3] which supplies by gravity a pipe line connection of 600 mm nominal diameter and length of 16.00 m which is able to connect the pipe line of measurements for each nominal size check valve of 600 mm, 500 mm, 400 mm or 300 mm. Each pipe line of measurements is equipped with temperature measuring device mounted upstream the test valve and the flow rate device, the flow rate device and the pressure taps mounted upstream and downstream the test valve. At the end of the pipe line of measurements a control valve is mounted to control and change the flow rate in the stand. Figure 1 is a sketch of the stand in a standard configuration for nominal diameter of 600 mm. The passing between diameters from one line to another is made with convergent cones of 10^0 degrees angle at the peak.



Nominal Diameter (mm)	Pipe line connection	Pipe line II	Pipe line III	Pipe line IV
600	16.00 m	3.60 m	14.20 m	4.8 m
500	16.00 m	4.50 m	14.20 m	4.8 m
400	16.00 m	10.80 m	4.00 m	4.8 m
300	16.00 m	8.10 m	3.00 m	4.8 m

Fig. 1. Stand of hydrodynamic performances of industrial valves.

Constant level reservoir has a practical flow rate of 2.10 m^3/s (theoretical flow rate of 3.43 m^3/s) and a constant free water level of 7.5 m from the laboratory's ground, figure 2. The reservoir has a flow edge of 300.00 m and which provide a flow rate variation of maximum 6.00 ‰.

The stand of hydrodynamic performances of industrial valves is supplied by two axial pumps type DV 5-35, manufactured by S.A.AVERSA S.C.

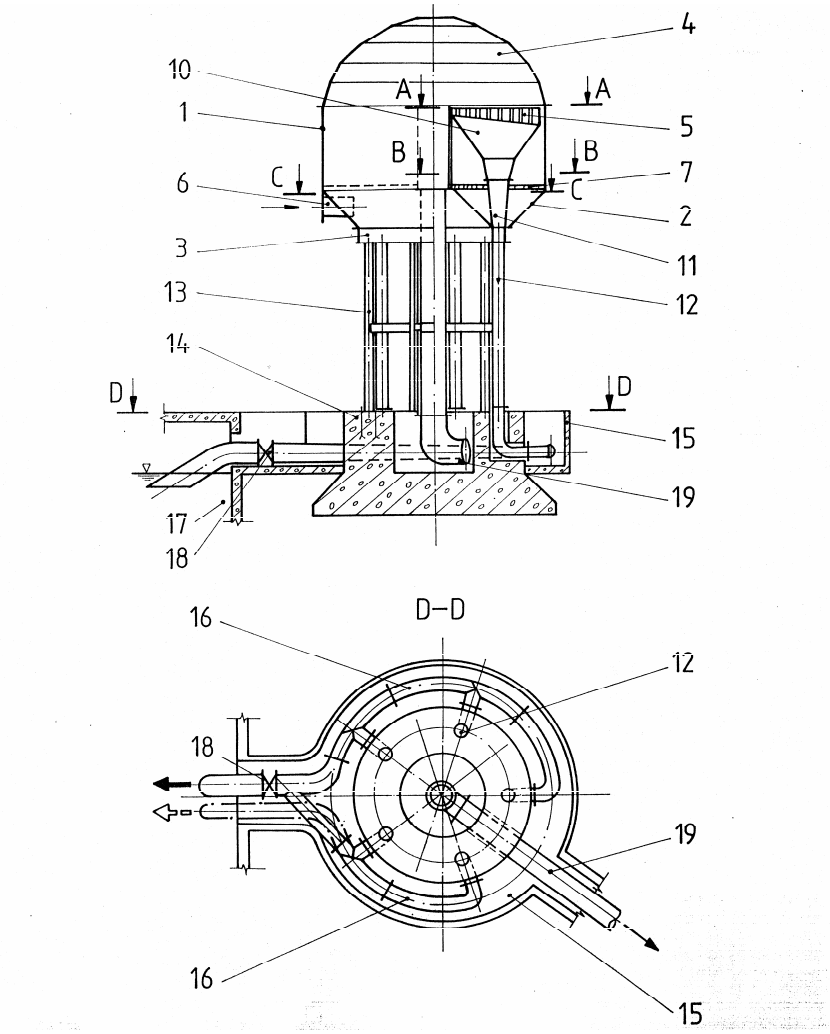


Fig. 2. Constant level reservoir: 1. cylinder, 2. cone, 3.connecting device, 4. pressurized calotte (was specified in the project but in the reality the reservoir is with free surface), 5. flow device, 6. water supply device, 7. soothing device, 10. funnel collector, 11. pipe, 12. pipe for constant level, 13. uphold supports, 16. exit pipeline collector, 17. supply reservoir of 2,000.00 m^3, 18. exit valves, 19. exit pipeline of 600.00 mm.

3. Working parameters of the stand

The stand of hydrodynamic performances of industrial valves could measured the flow rate in installation and the pressures in order to calculate the flow rate coefficient and the velocity head loss coefficient of an industrial valve, [8, 9].

First at all, the measurements accuracy is given by the accuracy of the measurement device and the accuracy of the method of measurement. In table 1 are the accuracy values of the measured parameters for different comparative standards.

Table 1

Accuracy values

Standard	Flow rate	Pressure	Temperature	K_v
[4]	± 3%	6 ÷ 15%	-	5 ÷ 10%
[6]	± 1%	± 1%	-	1 ÷1,5%
[5]	± 2%	± 2%	± 3K	5%
In stand	**±1%**	**±1%**	**±1K**	**1 ÷1,5%**

In the stand the flow rate is measured with an electromagnetic flow rate device with the accuracy of 0.5% so that the flow rate accuracy will be under ± 1%, [6]. Comparative with the standards the last line of Table 1 display the accuracy of measurements that it will be expected in the stand.

The flow rate, that is available for each pipeline of measurements with the check valves of 600 to 300 mm nominal diameter size, is listed in table 2 and was calculated as:

$$Q = \sqrt{\frac{H}{0.0826 \cdot \left[1 + \left(\lambda \frac{L}{D} + \sum_{i=1}^{n} \zeta_i\right)\right] \cdot \frac{1}{D^4}}} \tag{1}$$

where:- H is the static head of the stand as the difference between the static head of the constant level reservoir of 7.50 m and the axe position of the horizontal pipeline of the stand of 0.55 m from the same reference system, the laboratory's ground;

- λ, is the Darcy coefficient (friction coefficient) of distributed head losses in the pipeline with D diameter and L, the length;
- ζ_i, are the local resistance coefficient of the local head losses for different local hydraulic resistances as the direction-changing fittings, section-changing fittings (convergent cone), test valve and flow control valve.

The flow rate was calculated in the case of an opened flow control valve when the head losses on the entire pipeline are minor. A gate valve is used as flow control valve.

Table 2

Flow rate values

Nominal Diameter, (mm)	600	500	400	300
Q_{max} (m^3/s)	1.48	1.35	0.76	0.18

Calculated values of the flow rate are plotted in Figure 3.

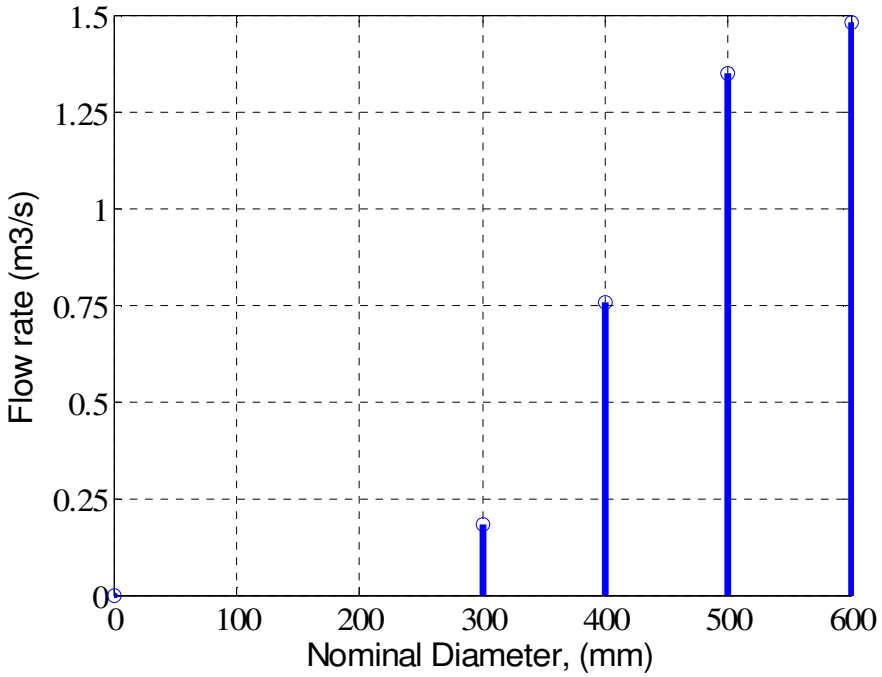


Fig. 3 Flow rate capacity of the stand

4. Conclusions

The stand could test industrial butterfly valves or gate valve with the dimensional size of 600 to 300 mm. Flow coefficient, K_v and velocity head loss coefficient of the valve, ζ, could be measured in the stand in accordance with international standard CEI/IEC 60534-2-1:1998.

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Acknowledgements

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