for the pressure ranges on the valve inlet and outlet by which the valve could be operable. Also there was a di erence between overall dimensions of both actuators: APA® had $140 \times 70 \times 10$ mm, while cylindrical actuator – 66 mm longitude and 10 mm diameter.

3. Mass flow rates of the gas flowing through the valve

Measurements of mass flow rates of the gas passing the valve were performed by various inlet and outlet pressures. They were done with the stand consisting of two containers connected to the valve inlet and outlet respectively (Fig. 2).

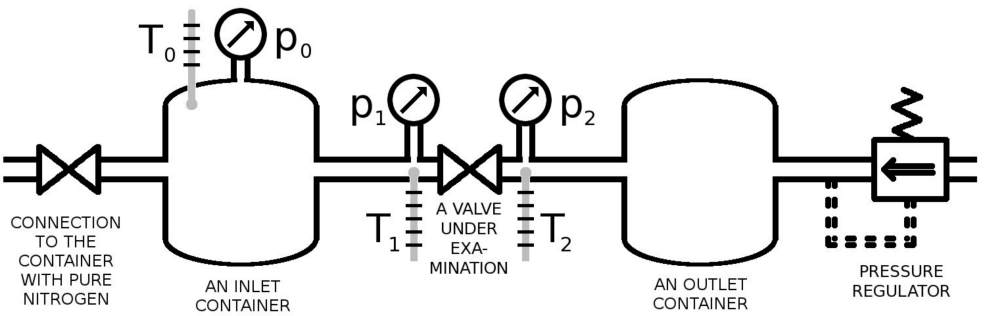

Fig. 2. Schematic of the setup used for obtaining vale characteristics.

During the conducted research there were performed series of experiments in which the gas flew between two containers through the investigated valve. By each test inlet pressure drop from initial value to the value kept on the valve outlet by the use of pressure regulator and outlet container. Measurement of the pressure and temperature in the inlet container allowed to estimate the mass of the gas present inside this container in each time instant and – as well – mass flow rate of the gas passing the investigated valve by various inlet and outlet pressures.

4. Results and conclusions

The comparison between mass flow rates of a gas passing two investigated valves led to conclusion that the multiplication of the actuator stroke by use of APA® gave no significant advantage from the point of view of maximum achievable mass flow rates of the gas. It exceeded 30 g/s by 1.2 MPa inlet pressure and 290 K inlet temperature. Replacing the poppet with Hörbiger plates ensured to achieve the same flow characteristics by two times shorter actuator strokes performed by cylindrical actuator.

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References

1. R. Wiszowaty, J. Biczyk (2013). Piezoelectric Valve for Controlled Pneumatic Shock Absorber, *IPPT Reports on Fundamental Technological Research*, **47**, 4, 43–47.
2. G. Mikułowski, R. Wiszowaty, J. Holnicki-Szulc (2013). Characterization of a piezoelectric valve for an adaptive pneumatic shock absorber, *Smart Materials & Structures*, **22**, 12, 1250011-1-12.
3. CeramTec. Advanced Ceramics in Piezo Applications, Multifunctional Ceramics Division [Online]. Available: http://www.ceramtec.de/files/mf_broschure-piezoapplications_en_de.pdf.