39th Solid Mechanics Conference
Zakopane, Poland, September 1–5, 2014

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APPLICATION OF PIEZOELECTRIC ACTUATORS FOR THE GAS VALVE OPENING CONTROL

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1. Introduction

In many cases during designing various technical installations arises a problem of choosing a proper gas valve that can meet the requirements following from distinct tasks. Imposed limitations concerning outline dimensions, flow capacity, opening/closing time, etc. could bring the designer to apply the valve actuated with piezoelectric actuators.

The presented paper concerns the topic of suitability piezoelectric actuators for the gas valve opening control. The valves' performance was considered in connection with the piezoactuators' motive properties that follow from the piezoelectric materials characteristics. The valves manufactured according to two structure concepts were investigated and compared. The former one was the poppet valve driven with Amplified Piezoelectric Actuator (APA®, Cedrat Technologies; Fig. 1. left) [1]. That solution was chosen due to relatively high stroke of the actuator. In the latter structure solution (Fig. 1 right) a cylindrical actuator was utilized for opening the valve by moving a plate having a matrix of overflow orifices apart from another plate with such a orifices located in different places than in the case of the first plate (the plates manufactured in this a way are called Hörbiger plates) [2].

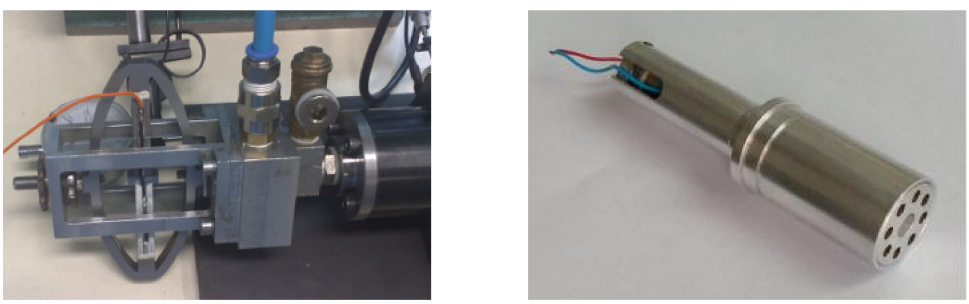

Fig. 1. Valve actuated by APA® (left) and by cylindrical actuator (right).

2. Piezoelectric actuator performance

Multilayer ceramic stacks, made of SONOX® P505 [3], were applied in both tested actuators and they operated by nominal driving signal voltages 150 and 200 V respectively. The eliptic stroke multiplicator which belongs to the APA® structure enabled to achieve maximum stroke of 150 µm and ensured required piezostack preload[1)]. On the other hand, the cylindrical actuator performed maximum elongation of 80 µm. That parameter is significant from the point of view of maximum achievable gas mass flow rates on the valve. Blocking force of APA® equalled 1 kN, and 2.5 kN of cylindrical actuator initially preloaded with 750 N by the use of a external plate spring stack. This feature is crucial

[1)]Original device constructed by Cedrat was modified by replacing piezostacks with actuators made by CeramTec.

for the pressure ranges on the valve inlet and outlet by which the valve could be operable. Also there was a difference 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).

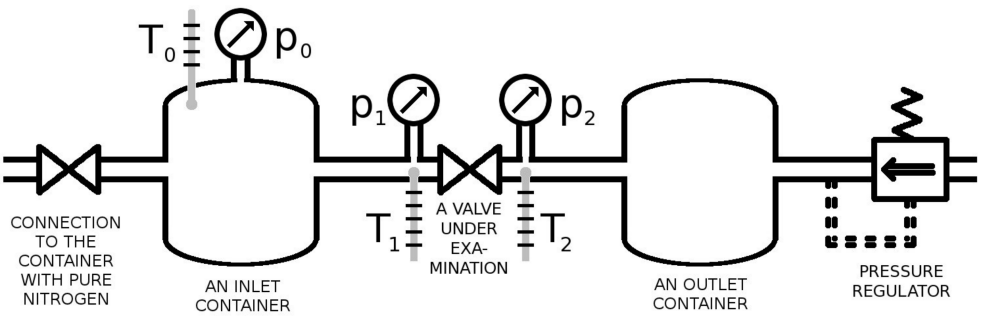

Fig. 2. Schematic of the setup used for obtaining vale characteristics.

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.

Acknowledgments

Financial support of Structural Funds in the Operational Programme – Innovative Economy (IE OP) financed from the European Regional Development Fund – Project "Modern material technologies in aerospace industry", No. POIG.01.01.02-00-015/08-00 and Polish National Science Centre Project 'AIA' (DEC–2012/05/B/ST8/02971) are gratefully acknowledged.

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