STUDY OF STABILITY REPRODUCTION GAS FLOW RATE UNIT BY THE PRIMARY STANDARD

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During experimental research in SE Ivano-Frankivskstandardmetrology to ensure the stability of reproduction gas volume flow rate unit by the national state primary standard gas volume and volume flow rate units on gaseous medium at pressures up to 1.6 MPa NDETU M-02-2018 found, that the main influential factor and destabilizing element is the insufficient rigidity of the metal structure of the frame of the piston prover.

The node providing reciprocating movement of the rods complete with piston separators is covered by a mechanical connection by means of a solid shaft, which is located horizontally in a direction perpendicular to the movement of the rods [1]. The design of the box, in which the fixed shaft is a figure in the shape of a parallelepiped, through the geometric center of which along the long axis is a solid shaft. Fixation of a shaft is carried out in a box through remote centering plugs which radius on 1 mm exceeds a shaft radius. In turn, the shaft is located perpendicular to the rods of the piston sections.

In fig. 1 shows a schematic representation of the coordinate axes and, accordingly, the degrees of freedom, which, in this case, may have a drive nut of the ball-screw pair (BSP), which in turn provides the movement of the box. Thus the BSP nut can have 6 theoretical degrees of freedom (3 translational, 3 rotary).

Fig. 1. Visualization of the degrees of freedom of the drive element
We will conduct a detailed analysis of each of the axes in terms of the implementation of degrees of freedom:

1. X-axis - the longitudinal axis of the prover, which is the reciprocating movement of the piston separators, this movement is realized by the translational degree of freedom (1.1) using the screw BSP; rotational movement - the rotational degree of freedom (2.2) is limited by fixing the nut in the housing, which is attached to the box of the prover.

2. The Y axis is the transverse (short) axis of the prover. The translational degree of freedom (2.1) is realized when there is a force that moves the box along the short axis of the prover or if during the movement along the X axis the width of the prover changes. The rotational degree of freedom (2.2) is realized when the box rotates around a solid shaft.

3. The Z axis is the vertical axis of the installation. The translational degree of freedom (3.1) is realized by the vertical movement of the piston sections during movement along the X axis. The rotating axis (3.2) can be realized at non-synchronous speed of rotation of screws BSP or at various change of a step of screws BSP.

During the movement in the forward and reverse directions during the research, periodic damping oscillations were observed, which are associated with the vertical movement of the pistons of the piston sections, as a result of which oscillations were observed in some areas of the movement. This, in turn, manifested itself in the form of pulsations in the value of the pressure drop in the process of measuring the control displaced gas volume. After the analysis, clear peak areas were established, in which the effect was manifested in a significant pulsation of the initial value of excess pressure. To solve this problem, it is proposed to divide the solid shaft into four separate parts in order to implement a conditionally independent suspension for each piston section. Thus, during the reciprocating movement of the cylinder rods obtained an additional degree of freedom along the Y axis (Fig. 1), which in turn significantly reduced the oscillations during the movement of the piston sections and increased the stability of reproduction gas volume flow rate unit by the national state primary standard gas volume and volume flow rate units on gaseous medium at pressures up to 1.6 MPa NDETU M-02-2018.

In fig. 2 shows a view of the separating separators with oval grooves, which provides vertical compensatory movement during the reciprocating movement of the rods.
References:

[1] Bas O.A. (2014). Конструкторні та метрологічні аспекти газовимірювальних установок поршневого типу. Технологічний аудит та резерви виробництва, (1/4 (15), 11 – 13. (1. Bas O.A. (2014). Konstruktyvni ta metrolohichni aspekty hazovymiriuvalkh ustanovok porshnevoho typu. Tekhnolohichnyi audyt ta rezenvy vyrobnytstva, (1/4 (15), 11 – 13. (ukrainska).