DEVELOPMENT OF AUTOMATED QUALITY CONTROL SYSTEMS AND METHOD FOR ABSOLUTE PRESSURE SENSORS

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Abstract: *The article reviews concept of quality control systems of absolute gas pressure measuring instruments. Structure of quality control system is proposed. Development ways of method for control validity improvement of absolute pressure measuring instruments are overviewed.*

Keywords: QUALITY CONTROL SYSTEM, CONTROL AUTOMATION, CONTROL VALIDITY, ABSOLUTE PRESSURE SENSOR.

1. Introduction

Current practice of absolute pressure measurement is making higher requirements to accuracy, automation and productivity of quality control systems. It is noteworthy that in most of the cases these requirements are conflicting in such a way that improvement of some characteristics is achieved by decreasing of others. For example, increasing of system functional capabilities, accompanied by it complexity growth, decrease reliability caused by increase of element failure rate. That is why development of quality control system should be supported by continuous searching of compromise between implemented properties, technical capabilities and economic efficiency.

Development of measurement techniques, continuous improvement of constructive, technological and functional characteristics of measuring equipment, large-scale implementation of information technology leads to change of control operations content, increase of it complexity and responsibility and as a consequence leads to new heightened requirements to quality control systems.

Main metrological problem of absolute pressure sensors control system development was and remains problem of it systematic accuracy improvement with keeping high productivity of control operations.

2. System structure

Analysis of requirements to absolute pressure sensors quality control system structure was done based on the assumption that it main quality parameters are: metrological characteristics (range, accuracy, speed), stability of indications, measuring- equipment reliability. Analysis indicated that achieving of acceptable accuracy and productivity should include several standard instruments of pressure measuring, than can provide precise and reliable joint measuring by various methods [1, 2]. Based on requirements to accuracy and reliability of measurement, structure of automated system for absolute pressure sensors quality control should consist of [3, 4]: automated system of air pressure values setting (ASPS), containing automated pressure control unit and reference frequency pressure sensor; receiver; reference deadweight manometer (Fig. 1). By ASPS in the working cavity of receiver and controlled instrument, absolute pressure is set with limit of error 20 Pa in the range of 0,7 to 100kPa and 0,015% in the range of 100 to 285 kPa. This allows to use ASPS as a precision instrument for absolute pressure sensor quality control. Reference frequency pressure sensor needs in periodical verification. For this purpose in the structure of automated system for absolute pressure sensors quality control included reference deadweight manometer with the following limit of error: 7 Pa in the range of 0,7 to 100kPa and 0,005% in the range of 100 to 720 kPa.

3. Control method

Practical application of proposed structure of absolute pressure sensors quality control system require improve of control method. The reason for this is that existing methods and guidelines are not always taking into account automated character of control and also requirements to accuracy of controlled instruments quite difficult to provide by enough accurate reference measuring instruments included into automated quality control system. Validity of control instruments have to be ensured by complication of control operations organization, by introduction of strict acceptance limits, by complication of technical means [5, 6].

It is important to note that lack of accuracy of reference measuring instruments reflected in the verification methods of working pressure measuring instruments MM (measurement method) 2124-90 SSEUM (state system for ensuring the uniformity of measurements) «Manometers, vacuum meters, mano-vacuum meters, pressure gauges, draught meters and draught and pressure gauges indicating and recording. Verification method». Regulatory documents are proposing to use stricter acceptance limit than measurement error in technical passport of controlled instrument. Value of acceptance limit is calculated based on statistical model that provides require control validity with error ratio between reference and controlled instruments $\alpha_p \leq 0{,}5$ in accordance with MM 187-86 SSEUM «Validity and requirements to measurement instruments verification method» and MM 188-86 SSEUM «Measurements instruments. Setting of parameters values for verification methods».

It is proposed to adhere following condition during periodical calibration of pressure sensor ASPS and control of absolute pressure sensor:

$$(\Delta_0/D)100 \leq \alpha_p \gamma, \qquad (1)$$

where Δ_0 – limit of absolute permissible error of reference instrument; D – scale range of calibratable (controlled) absolute pressure measurement instrument; α_p – ratio between limit of permissible error of reference instrument and limit of intrinsic permissible error of calibratable (controlled) absolute pressure measurement instrument; γ – limit of intrinsic permissible error of instrument as a percentage of standardized value. This changes statistical approach to reference measure selection in the quality of ASPS during control of pressure sensor allowing selection of α_p with higher value ($\alpha_p \leq 0{,}5$). Herewith high quality of control is provided by introduction of so-called acceptance limit $\Delta_{ac.}$, which is less than limit of intrinsic permissible error $\Delta_{max.}$ of calibratable (controlled) absolute pressure measurement instrument.

$$\Delta_{ac.} < \Delta_{max.}. \qquad (2)$$

Absolute pressure sensors quality control systems of proposed in the article structure include two reference instruments with different principles of measurement. ASPS simulate air pressure which is measured by control instruments. Availability of deadweight manometer which implements direct method of pressure measurement allows to provide high validity of metrological characteristics of graduated and calibrated absolute pressure measurement instruments.

Within proposed concept automated and high-productivity precision systems for absolute pressure measurements instruments quality control can be created. These systems allow collection of mass data, comparison of results of periodical verification and control of measurement instruments, analysis of failure root causes, calculation of metrological validity value and prompt correction of verification intervals.

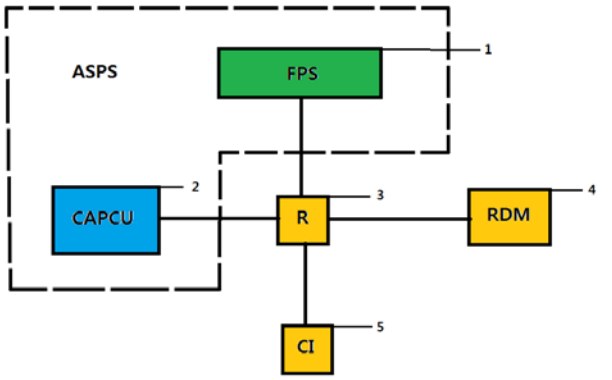

Fig. 1*. System structure: 1 - frequency pressure sensor; 2 - containing automated pressure control unit; 3 – receiver; 4 - reference deadweight manometer; 5 - controlled instrument*

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