Test algorithm to confirm the type of modern measuring devices for low absolute pressures and vacuum

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Abstract. The article provides information on the normative documentation applicable in the Russian Federation on the approval procedure of measuring devices, explains the procedure for carrying out tests for approval of the type of vacuum measuring devices at D. I. Mendeleyev Institute for Metrology VNIIM, summarized information about modern high-precision thermal (measuring range (1·10²...1.08·10⁵) Pa, maximum permissible error of a measuring ±(10...50) %) and ionization (specified measuring range (1·10²...1.3) Pa, maximum permissible error of a measuring ±(20...50) %) of vacuum gauges that have been tested for type approval since 2016. The information on the vacuum gauges contained in this article was published in the Federal Information Fund for Ensuring the Uniformity of Measurements.

1. Introduction

Based on the information in [1] we can conclude that the number of calibrated vacuum gauges increased sharply in the period 2018-2019, which in turn indicates an increasing demand for vacuum gauges in the field of government regulation - vacuum gauges of the approved type.

From the information in [2] it can be concluded that the greatest demand in the field of state regulation is modern high-precision thermal (according to [3] - devices in which heat transfer methods for measuring low pressures; the functional principle according to [4] is based on the Dependence of the heat transfer through a gas on the pressure) and ionization (according to [3] - devices with a very wide pressure range - from (10¹⁰...10⁹) Pa to (10⁵...10⁶) Pa, their effect is based on the dependence of the number of molecules ionized in the volume of the corresponding converter on the gas pressure, the functional principle according to [4] is based on the proportionality between pressure and ion current, which is created as a result of the ionization of gas molecules; In the Federal Information Fund for Ensuring the Uniformity of Measurements (hereinafter: FIF) according to [2], there is no information on domestically manufactured vacuum gauges.

According to the results of the report [2] at the All-Russian Scientific Conference with international participation "Vacuum Equipment and Technologies – 2020", most of the questions did not relate to the technical component of the article (e.g. functional principle, metrological properties), but to the method used Testing of vacuum gauges for the purpose of type approval.

In this context, this article aims to:

- to inform manufacturers and consumers of vacuum gauges about the current status in the Russian Federation regulatory documents for the procedure for type-approval of measuring devices;
to explain manufacturers and consumers of vacuum gauges the procedure for carrying out tests for the approval of the measuring device type at the D. I. Mendeleyev Institute for Metrology VNIIM;

to summarize information on the approved types of vacuum gauges, to reduce this information in an easy-to-read table in order to provide complete information for manufacturers and consumers of vacuum gauges.

2. Results and discussion

According to [2], the approval of the type of measuring tool (hereinafter: MT) according to Article 11 of Chapter 3 of document [5] is one of the forms of state regulation in the field of ensuring the uniformity of measurements. The decision on the approval of the MT type is made by federal executive bodies (hereinafter - Rosstandart) based on the positive results of the test of the MT for the purpose of type approval in accordance with Article 12, Paragraph 2 of Chapter 3 of the document [5]. Information on the permitted MT types according to the document [6] is entered in the FIF. The type approval of MT according to Paragraph 15 of Appendix 2 of document [6] and list k of Paragraph 5, Paragraphs 20 and 21 of document [7] is carried out by an entry in FIF and according to Appendix 3 of the document [6] - a type approval certificate. The validity period of the approved type is usually 5 years from the date of signing the Rosstandart order for approval of the measuring tool type. A compulsory test step for approving the type of measuring instruments referred to in paragraph 22 of document [6] is the development or selection of a method for checking the measuring tools and its testing. The test method is specified in accordance with Appendix 2 of document [8].

Tests of vacuum gauges for the purpose of type approval (hereinafter - tests) at D. I. Mendeleyev Institute for Metrology VNIIM at the research department for state standards in the field of pressure measurements, two laboratories are involved: the laboratory for further developments and tests in the field of pressure and the research laboratory for state standards and scientific research in the field of measurements of low absolute vacuum pressure. The entire test spectrum is carried out in these laboratories, including the analysis of a test application, the development of a test program, testing, the development or selection and testing of a procedure for the calibration of vacuum gauges, the creation of protocols and an action based on the results of the test of Vacuum gauges for type approval purposes. The general algorithm and a list of the stages of testing vacuum gauges for type approval purposes are shown in figures 1 and 2.

Based on the information in [2] and the analysis of current information on vacuum gauges entered in FIF, tables 1 and 2 summarize information on vacuum gauges that have been tested for type approval since 2016 and can be used in the field of government regulation. Information on type-tested vacuum gauges from 2008 to 2018 can be found in [9].

Table 1. Approved types of thermal vacuum gauges.

| № | Type designation | Measurement range, Pa | Relative error, % | Manufacturer | № FIF |
|---|------------------|-----------------------|-------------------|--------------|-------|
| 1 | TPR, TPG 201, PPT 200 | from $1 \cdot 10^{-2}$ to $1 \cdot 10^3$ | $\pm (30...50)$ | Pfeiffer Vacuum GmbH, Germany | 63031-16 |
| 2 | ERSTEVAK (MTP4D type) | from $2 \cdot 10^{-1}$ to $1 \cdot 10^5$ | $\pm (10...30)$ | "Thyracont Vacuum Instruments GmbH", Germany | 64910-16 |
| 3 | THERMOVAС | from $5 \cdot 10^{-2}$ to $1.5 \cdot 10^5$ | $\pm (10...50)$ | "Leybold GmbH", Germany | 68784-17 |
| 4 | VSP 3000, VACUU VIEW extended | from $1 \cdot 10^{-1}$ to $1.08 \cdot 10^5$ | $\pm (15...30)$ | "VACUUBRAND GMBH + CO KG", Germany | 80636-20 |
Figure 1. General algorithm and list of test stages.
Figure 2. General algorithm and list of test stages.
Table 2. Approved types of ionization vacuum gauges.

| №   | Type designation | Measurement range, Pa | Relative error, % | Manufacturer                          | № FIF    |
|-----|------------------|-----------------------|-------------------|---------------------------------------|----------|
| 1   | CCM              | from 1.3⋅10^{-7} to 1.3 | ±30               | "InstruTech, Inc.", USA               | 66042-16 |
| 2   | Ionivac IE414,   | from 2⋅10^{-7} to 1    | ±20               | Leybold GmbH, Germany                 | 78832-20 |
|     | Ionivac IE514    |                       |                   |                                       |          |
| 3   | IKR              | from 1⋅10^{-7} to 1⋅10^{-1} | ±50               | Pfeiffer Vacuum GmbH, Germany         | 80739-20 |

3. Conclusions
As a result of the work in this article:

- the information on the regulatory documents in force in the Russian Federation on the procedure for the approval of vacuum gauges as measuring devices was provided;
- the procedure for carrying out tests for approval of the measuring device type was explained on the example of testing vacuum gauges in the pre-development laboratory and tests in the field of pressure and research laboratory for state standards and scientific research in the field of measurements of low absolute vacuum pressure of the research department of state standards in the field of pressure measurements of D. I. Mendeleeyev Institute for Metrology VNIIM;
- information on the types of vacuum gauges approved since 2016 have been summarized in tables 1 and 2.

References
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