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MEASURING THE PRESSURE IN DYNAMIC MODE

Abstract. The subject study of the article is to measure the pressure in the dynamic mode used in parts of the regional center of standardization and metrology during the verification and calibration of measuring equipment and during their operation. The article is research process of measuring the pressure in the dynamic mode and the principles of perspective on device verification and calibration of pressure. The problem to be solved is justification of technical solutions and their implementation in practice. It will improve measurement accuracy pressure measurement used for verification and calibration of the device on checking and calibration of pressure by applying a generalized block diagram of pressure offered. The article shows the Dynamic mode of pressure; dependence of dynamic properties of measurement tools on the nature of changes in the value measured; research of dynamic characteristics of pressure; the input error measuring pressure in dynamic mode; block diagram and principle of the prospective device on checking and calibration of pressure which are being developed. **Conclusion:** The proposed technical solutions should be used as the modernization of existing pressure meters, and in the creation of promising samples of pressure meters.

Keywords: pressure; pressure meter; dynamic mode.

Introduction

Formulation of the problem. Recently, need to control the technical parameters of samples of industrial machinery and control their metrological characteristics have raised due to increased of useful life by the State Center specialists of Standardization and Metrology State. Existing measuring instruments are constantly in need of improvement of metrological characteristics undertaken to improve the reliability of the control parameters of industrial equipment designs. One of the parameters is the pressure. One of the requirements for verification and calibration of measuring pressure is to increase the quality of verification and calibration of measuring pressure. For this purpose, methods for analog-digital conversion, which to describe the control scheme of the device for pressure measuring, work both in statistical and dynamic modes.

During verification and calibration of pressure measurement it is necessary to measure in a rather precise way and get more rational measure of this parameter. Thus the relevance of the scientific and applied problems is caused with the constant increase in requirements as a means of pressure measuring in metrological agencies.

Analysis of the literature. Principles and organizational framework of metrological software and the role and place metrological support in Ukraine, are set out in the Law of Ukraine "About metrology and metrological activity" [1] "ISO 2681-94. Metrology, Terms and Definitions" [2], the ISO [3, 4] in [5, 6], in the literature [7 - 19].

Mathematical models determine the number of orders for the guaranteed metrological service of armament and military equipment taking into consideration their importance described in [5]. The process of forecasting capabilities of Metrology repair of damaged units of measurement devices, military described in [6]. Operating Basics of measuring instruments are outlined in the literature [7].

Survey questions concerning measuring pressure are thoroughly discussed in [8] It also discusses theoretical information on means of measuring pressure. At the same time questions related to the measurement of the pressure in the dynamic mode remain open.

The goal of article is an analysis of pressure measuring in the dynamic mode and the principles of perspective on device of verification and calibration of pressure.

Main material

The change in time of the measured value $X(t)$ results in a dynamic mode of operation of pressure. In this mode, the measurement accuracy much depends on the dynamic characteristics of measuring instruments and the nature of the change in the value measured.

In order to get an accurate value $X(t)$ of output signal over time which is measured regardless of the nature of the changes it is necessary to comply:

$$Y(t) = k_{ном} X(t), \quad (1)$$

where $k_{ном}$ - nominal rate conversion.

To simplify the analysis of dynamic mode assume that the pressure meter is not static error, so the actual conversion rate $k_p = k_{ном}$ is the entire range of measurement input $X(t)$.

Actual measurement tools have a dynamic quality due to the presence of elements which have a mass of elastic elements in electrical appliances, capacitance and inductance in measuring circuits, etc., which leads to greater relationship between $X(t)$ and $Y(t)$.

There is different ways to describe the dynamic characteristics of measuring instruments and assessment of errors that occur in dynamic mode, the most complete of these qualities can be described by differential equations, transient and shifting pulse characteristics, frequency response and transfer function.

Dynamic mode among a broad class of pressure can be described by the differential expression of linear inhomogeneous with constant coefficients:

$$A_n Y^{(n)}(t) + A_{n1} Y^{(n1)}(t) + \\ + A_1 Y'(t) + Y(t) = k_{ном} X(t), \quad (2)$$

where $k_{ном}$ – nominal conversion factor.

Accuracy of the input measuring pressure in the dynamic mode is given by:

$$ДУ(t) = Y(t) - Y_u(t), \quad (3)$$

where $Y(t)$ – real input signal; $Y_u(t)$ – ideal output signal.

Definition of error $ДУ(t)$ and fundamentally possible, but in practice there are difficulties, because the analytical expression for $Y(t)$ Unknown and determination $Y(t)$ registered in the output signal from a graph (Fig. 1) can be carried out with the necessary accuracy.

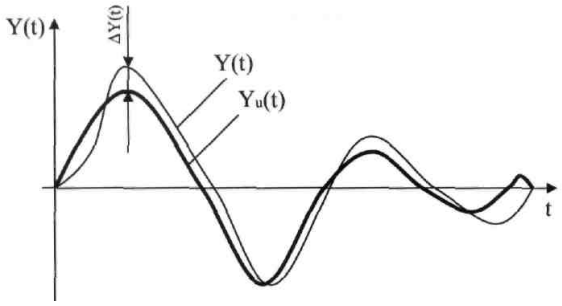

Fig. 1. Meter error in input pressure in dynamic mode

To study the dynamic properties of pressure commonly used dynamic range of first and second order. So often use some dynamic error estimation, describing the result of measurement values $Y(t)$ which changes over time.

Dynamic range is described by second-order equations:

$$A_2 Y''(t) + A_1 Y'(t) + Y(t) = k_{ном} X(t), \quad (4)$$

or $$\frac{1}{u_0^2} Y''(t) + \frac{2в}{u_0} Y'(t) + Y(t) = k_{ном} X(t), \quad (5)$$

where u_0 – the frequency of oscillation personal circle;

$в$ – damping factor, the degree of sedation.

The degree of calm – characteristic value range which significantly affects the parameters of the dynamic processes that take place in that circle.

Using (2) and inequality:

$$max\left(Y''(t)\right) \le u_m^2\left(Y_m\right) \quad (6)$$

You can write the expression for dynamic range of input error by second order:

$$ДХ(t) = -\frac{Y''(t)}{\left(u_0^2 k_{ном}\right)} - \frac{2в Y'(t)}{\left(u_0 k_{ном}\right)} \quad (7)$$

Factor of A_m corresponding to maximum deviation Y_m is also not known. Moreover circle for the second order in general, $k_{ном}$ can be both less and more than nominal.

If accepted assumptions on the maximum frequency range of input signals for frequency response possible to determine the maximum value $k_{ном}$ in a given frequency range.

This device, developed, to be used both in static and in dynamic mode. Occurs during measurement dynamic error to determine which to use the expression (6). When choosing a block diagram that stipulates compensation scheme should be used type. In this scheme the result of the measurement is independent of errors, made each block separately, which improves accuracy pressure measurement. The device, developed appropriate to accomplish by combining all the blocks in the general case. Generalized block diagram pressure measuring device on checking and calibration of pressure, which is being developed is shown in Fig. 2.

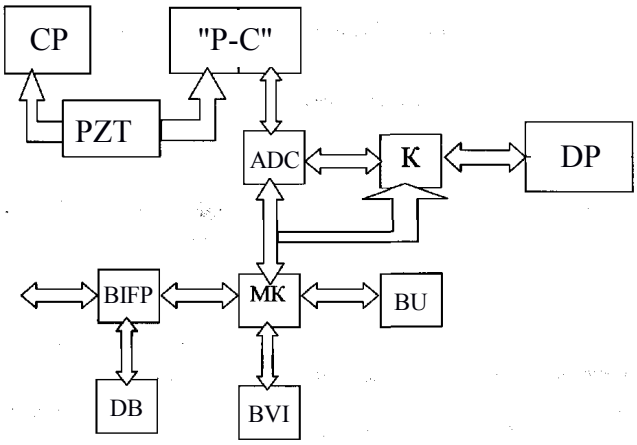

Fig. 2. Generalized block diagram of pressure on unit testing and calibration of pressure

Appointment blocks:

"P-C" - collection "piston-cylinder" is used as a working standard pressure;

DC - intended to reflect the position of the piston relative to the original;

PZT - designed to create excessive pressure;

ADC - used to convert DC to instantaneous;

K - designed for the distribution of information coming from the sensors;

D - is designed to convert the value of t c; cp% y in electricity value;

MK - is a special class computer technology and is designed to receive, process values coming from the ADC;

BU - keyboard controller display device input-output information;

BIFN - designed to connect ADC BU from the microprocessor has access to CPT and communication interface with computers;

BVI - designed to display information in a form suitable for the operator;

DB- designed for printing.

Principles of installation are as follows. When creating pressure with PZT, he also acts on the gear that calibrated and a collection of "P-C." At the core of differential pressure depending on the applied force and the cross-sectional area:

$$P = \frac{F}{S}, \quad (8)$$

where P – pressure; F – applied force; S – cross-sectional area.

The piston assembly "P-C" is to remove the provision that meets the value created pressure. This situation is controlled by the SE, which is used as a guidance converter. DP signal from entering the ADC, and then are converted into the appropriate form, enters the MC. This information is processed and the pressure appears on the display that allows the operator to monitor the value of the set pressure. At the same time, MK compares the pressure values set by the CP and pressure values, which are calculated in the MC.

A computer calculation error compared with the allowable values of error that are inherent in the program for this type of gauge calibration.

Select the type of gauge and calibration values of its properties must be entered by the operator before calibration, using BU. Installation is also temperature sensors, humidity and atmospheric pressure environment. Information from these sensors comes through K ADC, and then in a modified form in the MC, which is processed and taken into account when calculating the calibration error. MK fixes all errors throughout the calibration cycle, gives value to the BVI, as well as the database, where printed report and certificate of calibration. The unit operates in two modes: Mode "pressure" mode and "mass".

In the "pressure" setting is used for measuring the pressure generated in the pressure line and measurement result appears on the BVI and database.

In the "weight" setting is used for calibration manometers, pressure working standards.

Selecting the work carried out on the BU selecting the appropriate button.

In course of measurement on BVI installation is displayed as the position of the piston in the book "P-C" rate dipping piston temperature, atmospheric pressure and humidity. Also provides for the possibility of introducing amendments to reduce the local gravitational acceleration, if it is not provided loads used. Principles of installation are explained in the description of the block.

Conclusions

1. In the article the block diagrams and properties of pressure in the dynamic mode were examined.

2. In the article the block diagram and principle of the prospective device on checking and calibration of pressure were examined.

3. These technical solutions should be used as the modernization of existing pressure meters, and in the creation of promising samples of pressure meters.

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Вимірювання тиску в динамічному режимі

В. Б. Кононов, А. О. Чорна, М. А. Азізова

Анотація. Предметом вивчення в статті є вимірювання тиску в динамічному режимі, що використовується в відділах регіональних центрів стандартизації та метрології при проведенні повірки та калібрування засобів вимірювальної техніки та в процесі їх експлуатації. **Метою статті** є дослідження процесу вимірювання тиску в динамічному режимі та принципів дії перспективного пристрою щодо повірки та калібрування приладів тиску. **Задача, що вирішується, –** обгрунтування технічних рішень, впровадження яких в практику вимірювання дозволить підвищити точність вимірювання тиску, що використовується при повірці та калібруванні пристрою щодо повірки та калібрування приладів тиску шляхом застосування узагальненої структурної схеми вимірювача тиску, що пропонується. В статті розглядається: динамічний режим роботи вимірювачів тиску; залежність динамічних якостей засобів вимірювання від характеру зміни величини, яка вимірюється; дослідження динамічних якостей вимірювачів тиску; похибка по входу вимірювача тиску в динамічному режимі; структурна схема та принцип дії перспективного пристрою щодо повірки та калібрування приладів тиску, що розробляється. **Висновки:** запропоновані технічні рішення доцільно використовувати як при модернізації існуючих вимірювачів тиску, так і при створенні перспективних зразків вимірювачів тиску.

Ключові слова: тиск; вимірювач тиску; динамічний режим.

Измерение давления в динамическом режиме

В. Б. Кононов, А. А. Черная, М. А. Азизова

Аннотация. Предметом изучения статьи является измерение давления в динамическом режиме, что используется в отделах региональных центров стандартизации и метрологии. **Целью статьи** является исследование процесса измерения давления в динамическом режиме и принципов действия перспективного устройства поверки и калибровки приборов давления. **Задачей** является обоснование технических решений, внедрение которых в практику измерений позволит повысить точность измерения давления, используемых при поверке и калибровке приборов давления при помощи использования обобщенной структурной схемы предлагаемого измерителя давления. В статье рассматривается динамический режим работы измерителя давления; зависимость динамического качества средств измерения от характера изменения измеряемой величины; исследование динамических качеств измерителей давления; погрешность по входу измерителя давления в динамическом режиме; структурная схема и принцип действия перспективного устройства по поверке и калибровке разрабатываемых устройств давления. **Выводы:** предложенные технические решения целесообразно использовать как при модернизации существующих измерителей давления, так и при разработке перспективных образцов измерителей давления.

Ключевые слова: давление; динамический режим; измеритель давления.