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Metrological Support Of Moisture Measurements Of Agricultural Materials

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Abstract: The following issues are considered in the published article: features of measuring the humidity of agricultural materials; the role and place of metrological support in ensuring the uniformity of measurement in this area; the state of the scientific, regulatory, technical and organizational basis of metrological support in this area.
The article describes the regulatory framework and the basis for creating and operating in the Republic of Uzbekistan the State system for ensuring the uniformity of moisture measurements of agricultural materials, the economic significance of the humidity characteristics, which defines the priority tasks in the development of humidity control devices: the development of a single method and an exemplary installation for measuring humidity for cotton, cotton materials, grain and products of their industrial processing, providing verification and calibration of working moisture meters with an error of about 0.5%; recommendations for the development of sample preparation conditions and methods for transferring humidity units from the sample unit to working moisture meters with minimal loss of accuracy.

Keywords: humidity, metrological support, ensuring the uniformity of measurements, transmission of the dimensions of units of physical quantities, state tests of moisture meters, state verification, calibration of moisture meters, measuring instruments, normalized metrological characteristics of measuring instruments.

1. INTRODUCTION

Materials of the agro-industrial complex have a complex structure and usually almost all types of agricultural products include organic and mineral weed impurities. For example, raw cotton consists of seeds, fiber and lint, contains such weed impurities as stems, boxes, green leaf, and the quantitative ratio of these components is not constant and can vary widely depending on industrial and breeding varieties. Grain products, oilseeds, mulberry cocoons, animal products, various types of feed are also multicomponent [1].

The physical properties of the components of these materials (F_{ki}) differ significantly and depend on a number of factors (W_{ki}), including their humidity temperature (T_{ki}), macro - and microstructure features (S_{ki}), degree of maturity (Z_{ki}), storage and processing conditions (X_{ki}).

$$F_{ki} = f(W_{ki}, T_{ki}, S_{ki}, Z_{ki}, X_{ki}). \quad (1)$$

It is obvious that the actual properties of the material (F_M) depend on the properties of its components (F_{ki}), their quantitative ratio (M_{ij}), their relative position (R_{ij}), the number (N) and volume V of air inclusions between them:

$$F_M = Q(F_{ki}, M_{ij}, R_{ij}, N, V). \quad (2)$$

The moisture content of the material (W) is defined as the ratio of the total mass of water in the controlled volume (M_B) and the dry mass of this volume (M):

$$W = \frac{M_B}{M} = \frac{\sum_1^n W_{ki} \cdot M_{ki}}{\sum_1^n M_{ki}}. \quad (3)$$

Where (M_{ki}) is the mass of the component;

n - the number of components of the material.

Metrological support of measurements always includes a number of regulatory operations, including:

- Setting requirements for the reliability of measurement results; planning measurements in the development of measurement methods; selection of measuring instruments and measuring equipment taking into account the specified indicators of the reliability of measurement results;
- Statistical processing of measurement results and evaluation of the reliability of their results; organization and control of indicators of the reliability of measurement results, in particular, organization and conduct of measurements in other places.

The theoretical basis of metrological support covers the following works: transfer of the sizes of units of physical quantities (humidity) from standards to working measuring instruments;

- Development, production and release into circulation of moisture meters;
- State tests of moisture meters; state verification and calibration of moisture meters;
- Standard samples of the composition and properties of substances and materials; standard reference data on physical constants and properties of substances and materials.

2. METHOD AND MATERIALS

The choice and justification of the optimal method and device of a specific material for humidity control is one of the main tasks of metrological maintenance of moisture measurement. In practice, the thermogravmetric method remains the main methods for assessing the moisture content of agricultural materials. It provides high accuracy in determining humidity (the error is tenths and even hundredths of a percent) and, apparently, will serve as an exemplary method for checking and certifying moisture meters based on

indirect methods of measuring humidity for a long time. Theoretical and experimental studies have shown that the high-frequency dielkometric method meets their specifics most fully. The research results show that 60% of the produced moisture meters work by dielkometric methods [2].

An important feature of the metrological support of measurements is its normative basis. The State System of Ensuring the Uniformity of Measurements (GSI) has been established and operates in the Republic of Uzbekistan, which is a set of regulatory documents that establish rules, norms, requirements aimed at achieving and maintaining the uniformity of measurements in the country. A number of provisions of the State System for ensuring the uniformity of measurements is established in O'z DSt 8.001:2010-The State System for ensuring the uniformity of Measurements of the Republic of Uzbekistan. Ensuring the uniformity of measurements. The main provisions [3]. Currently, there are a number of regulatory and technical documents regulating the procedure for measuring the humidity of certain agricultural products: O'z DSt 644:2006 [4], O'z DSt 634:1995 [5], O'z DSt 600: 2008 [6].

Currently, the current regulatory and technical documents (GOST, O'z DST) for methods of measuring the humidity of various agricultural materials formally establishes several non-destructive and destructive methods: dielkometric and resistive [7], vacuum-thermal [8], thermogravimetric [9]. As an exemplary method for determining humidity, only the thermogravmetric method is regulated, which is implemented, for example, for cotton and cotton materials in such installations as drying cabinets Uz-7M, Uz-8. The state standard allows the use of other drying cabinets with similar metrological characteristics.

The following methods of measuring the humidity of substances are given in RMG 75-2004: gravimetric; evaporative-gravimetric; thermogravimetric; vacuum-gravimetric; vacuum-thermal method; sorption-gravimetric; condensation-gravimetric; coulometric; psychrometric; condensation; equilibrium; dielkometric; Fisher's method; optical; neutron; resistive; capacitive, etc. [10].

3. RESULTS

The most important condition for improving the quality of products is to obtain reliable measurement information about the parameters, characteristics and properties of finished products, components, technological processes, raw materials and materials. Ensuring the uniformity of measurements serves as a guarantee of the reliability of measurement information. A set of measures, called metrological support, is aimed at maintaining it. High economic efficiency the introduction of modern methods and technical means of humidity control and metrological support in the agro-industrial complex is provided by many factors. A number of factors are due to the "direct" economic effect that the introduction of new measurement tools gives. These include: improving the technical and economic indicators of technological processes for which humidity is the main value or one of the most important technological parameters; better use of raw materials by reducing waste, losses and waste in production; improving the quality and yield of marketable products.

The quality of storage and processing of agricultural products largely depends on the correct use of moisture meters, on the reliability and reliability of the measurement results obtained. In the interests of the agro-industrial complex, it is required that the measurement results, wherever they are performed, are within the permissible measurement error. Achieving and maintaining the permissible error of working moisture meters is possible only with metrological maintenance and providing them with exemplary measuring instruments. The need for exemplary measuring instruments is due to the fact that most of the existing and newly

developed modern electronic working moisture meters are based on indirect measurement methods and need primary calibration and periodic verification for compliance with standardized metrological characteristics according to GOST 8.009-84. The interstate standard contains a general nomenclature of metrological characteristics subject to standardization, methods of standardization and forms of presentation of standardized metrological characteristics.

4. DISCUSSION

Currently, there are some important issues in the field of metrological support of moisture measurements of agricultural materials, which is related to theoretical research, the development of methodological and regulatory documents, the development of modern moisture meters and their technical basis [11].

Taking into account the actual position of humidity measurements of agricultural materials, the economic value of the humidity characteristic, the priority tasks of moisture measurement are determined: to develop a single method and an exemplary installation for measuring humidity for a specific agricultural product to ensure verification and calibration of working moisture meters with an error of about 0,5%; to develop conditions for sample preparation and methods for transferring humidity units from the model installation to working moisture meters with minimal loss of accuracy.

In the theory and practice of moisture measurement, it is well known that researchers and specialists recommend different methods and means of measuring humidity for the same agricultural product. Under these conditions, the unity of measurements and obtaining reliable results can be obtained only by the unity of methods and techniques, instruments and equipment, and scientifically based methods used in measurements.

A substance humidity simulator is a measure of the humidity of a substance in the form of a sample of another substance that reproduces some physical quantity associated with the humidity of the first substance, intended for calibration and verification of moisture meters, the principle of operation of which is based on the measurement of this physical quantity [9]. Standard samples (SS) for checking dielkometric and microwave moisture meters should simulate the permittivity and the tangent of the dielectric loss angle of a wet substance at different values of the moisture content of the substance in the measured range. Thus, the developed simulator for checking microwave moisture meters of cotton imitates its properties at a humidity of 5-18% [10-21], and another simulator for checking capacitive grain moisture meters at a humidity of 8-35%, [11, 12] as well as for solving the technology of polymetallic ore enrichment [13]. To determine the systematic and random components of the basic error of dielkometric moisture meters, it is performed when they are checked using standard samples that simulate certain physical properties of the material under study and are certified at sample installations. Standard samples are intended for moisture meters of the same type and for certain materials under study.

One of the important stages of metrological support of a moisture meter is the testing and approval of the type of measuring instruments (SI). The type of measuring instruments is approved based on the results of tests of samples of measuring instruments, during which a comprehensive study of the characteristics of samples (copies) of measuring instruments is carried out and the compliance of these characteristics with the requirements of regulatory documents that apply to this type of SI is determined. Tests for the purpose of SI type approval are carried out in accordance with the test program and methodology approved by the head of the authorized body for SI type tests. Requirements for the content and construction of the test

program and methodology for the purpose of SI type approval-according to RD Uz 51-036. Tests for the purpose of approval of the SI type are allowed to be carried out according to standard SI test programs. To date, standard programs have been developed for some moisture meters of agricultural materials. For example, "The standard program of state acceptance tests of moisture measuring instruments of raw cotton and cotton materials" and "The standard program of state acceptance tests of moisture meters of grain and its processed products". Scientific and technical progress, the achievement of modern moisture measurement, and most importantly-the requirements of the current fundamental standards of the State system for ensuring the uniformity of measurements requires updating the above regulatory documents [14].

During the state acceptance tests of moisture meters, the most difficult moment in the experimental work is to check the metrological characteristics of the moisture meter. From the metrological characteristics regulated by GOST 8.009-84 "GSI. Normalized metrological characteristics of measuring instruments" most often check the basic error of the moisture meter, its systematic and random components and the measurement error of the value functionally related to humidity [15].

5. CONCLUSION

In conclusion, it should be noted that the level of metrological support of humidity measuring instruments for agricultural materials in the conditions of their production and operation significantly lags behind the level of development of modern moisture meters [16-17]. Therefore, the creation of scientific, technical, regulatory and organizational bases for metrological support corresponding to the modern level of moisture measurement of agricultural materials in this area is an urgent task, the solution of which largely depends on ensuring the unity and reliability of moisture measurements, which is one of the normalized indicators of the quality of agricultural materials [18-19]. A necessary condition for the further development and improvement of moisture measurement of agricultural products is the creation of metrological support that meets the requirements of international standards (ISO, OIML) and covers methods and technical means of verification and calibration of moisture meters, a set of standards, standardization and regulatory documentation [20-21].

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