Ways of transforming chemical analysis into specific kinds of measurements, creation of standard and normative bases, development of a metrological infrastructure, and formation of an international system for comparing results of analytical measurements are considered. The importance of considering the specific nature of analytical measurements in legislation is emphasized.

Key words: quantitative chemical analysis, analytical measurements, standard, certification system, standard specimen, key comparison, calibration and measurement resources, measurement uncertainty.

Quantitative chemical analysis (QCA) is the experimental determination of an object of analysis (substance, material) containing one or several components [1]. Measurement (the broad interpretation adopted in [1, 2]) is finding the value of a quantity by testing using technical means. Comparison of the concepts points to the possibility of considering analysis as measurement with presence of technical means of a physical quantity and its unit. However, this formal and logical approach is inadequate. In the generally accepted opinion, use in this respect of any recognized procedure of the term “measurement” is accepted as the primary basis for believing a representative result. This perception is connected with knowledge (or feeling) that measurement is performed with observation of some special rules, and the use of technical means and a procedure is controlled in accordance with some special order, and measurement accuracy is evaluated.

The idea of converting QCA to a specific form of analysis was born in the 1930s, but its translation into life at a state level started in the 1970s. The stimulus was a growing requirement for reliable analytical information in a number of branches of industry with ecological control and monitoring. At that time in the country there was creation of a powerful infrastructure for providing measurement unification and its connection to solving new problems appeared to be entirely natural. The task of metrological institutes became the creation of the required standard base, and also development of the corresponding documents of the state system for provision of measurement unification (GSI) or inclusion of new conditions in existing documents. Measurements of quantities specifying chemical composition were called analytical (more rarely chemically-analytical or chemical).

It should be noted that not everyone shared this opinion. Many leading chemists and analysts were disturbed by the fact that metrology could not consider the specific nature of QCA. In this connection, they also pointed to such features of it as special terminology, exclusive variety of analytical tasks, methods, and versions of their equipment formulation, existence in an analytical procedure of a stage of sample selection and preparation, a requirement for identifying a specific component of a sample, extensive use of analytical instruments for general purposes, graded by analysts, use for calibration and monitoring the accuracy of consumable specimens, pure substances as bench marks, corresponding extreme points the scale of values for the content of a component (0%) or (100%), a marked dependence of analytical information quality on the qualification of personnel and organization of work in an analytical laboratory.

Another group of opponents are metrologists rejoicing in the “purity” of metrology. They feared that inclusion in the sphere of metrology of QCA would give rise to dilution of its hypotheses, require introduction of new terms, and disturb the orderly construction of teaching courses.

D. I. Mendeleev All-Russia Research Institute of Metrology; e-mail: lkonop@b10.vniiim.ru. Translated from Izmeritel’naya Tekhnika, No. 11, pp. 66–71, November, 2007. Original article submitted August 14, 2007.
Development of the process went in two directions. Automation of industrial analytical monitoring led to development of a significant range of automatic analyzers whose scales were calibrated in units of the content of a specific component. At the start of the 1970s in the country more than 800 thousand automatic gas analyzers were in operation. There were many moisture meters (for air, gases, oil, organic liquids), salt meters, instruments for determining dissolved oxygen and petroleum products in water. In external appearance, they differed little from other monitoring and measuring instruments subjected to primary and periodic verification. Unification of measurements, carried out by means of automatic analyzers, would be provided logically on the basis of approved hierarchical standard systems in classical metrology described by verification schemes. An enormous contribution to the substantiation of this field was made by D. K. Kollerov, who led the section of physicochemical measurements of VNIIM in 1960–1976 [4, 5]. Another trend was active participation of metrologists in creating chemical measures of standard substances and materials. Initially this was standard specimens required for spectral analysis of metals. Metrology promoted expansion of this experience to other objects and methods of analysis drawing on centralized planning work for creation of standard specimens, classification was developed, accounting was organized, etc. A standard was introduced into operation [6] developed by VNIIM and its Sverdlovsk branch (now UNIIM). The procedural basis of this subject is presented in [7, 8].

Metrologists were less strong in analytical procedures. In educational and normative documents for metrology methods are considered for evaluating the accuracy of an individually taken measurement experiment, whereas chemists are interested to a considerable extent in the problem of establishing the accuracy of analyses carried out in accordance with procedures. Work of specialists for mathematical statistics was earmarked specially for chemists [9–11]. It was also directed at standardization of analysis methods for a widespread group of objects. In other cases for many chemists a feeling of inadequacy arose. Statistics do not always make it possible to reveal the constant systematic errors and standardization helps little in combating them. Therefore, in studying analytical procedures interest arose in cooperation with professional metrologists and striving towards a systematic approach and support for generally recognized scales.

Convergence of these positions was expressed in the agreed definition included in a publication in 1975 of the recommendations of the scientific council for analytical chemistry of the Academy of Sciences of the USSR [12]: “Quantitative analysis is the experimental determination (measurement) of concentration (amount) of chemical elements (compounds) or their form in an analytical substance.”

For the past thirty years, in all the subjects mentioned above (verification schemes, standard specimens procedures) marked results have been achieved. We only dwell on that activity connected with the state metrological service, including metrological institutes and territorial centers.

In Russia, several hierarchical systems function providing transfer of the size of a unit from state standards to an extensive group of analytical institutes. These are state verification schemes for measurement facilities for the content of components in gas atmospheres, electrically conducting liquids, dispersion parameters of aerosols, suspensions and powder materials, the relative moisture content of gases, volumetric moisture content of petroleum and petroleum products, weight concentration of particles in aerodispersed media, and pH. State primary (GPÉ) and special (GSÉ) standards are distributed with respect to metrological institutes as follows:

**D. I. Mendeleev VNIIM (St. Petersburg)**
- GPÉ of units of molar fraction weigh concentration of components in gas atmospheres;
- GSÉ of the unit of weight concentration of particles for aerodispersed media with prescribed parameters;
- GPÉ of electric conductivity of liquids in the range 0.1–50 S/m.

**VNIIFTRI (Moscow region)**
- GPÉ for pH scale;
- GPÉ for electrical conductivity of liquids in the range 0.001–10 S/m;
- GPÉ for units of dispersed parameters of aerosols, suspensions and powder materials.

**VS VNIIFTRI (Irkutsk)**
- GPÉ for the unit of relative moisture content of gases.

**VNIIR (Kazan)**
- GSÉ for the unit of volumetric moisture content.