Remarks to Calibration in Chemistry

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ABSTRACT

Calibration is the operation establishing metrological traceability of values of calibrated measuring instrument scale (or reference material) to stated reference. In the case of indirect measurement it is necessary to know the relationship between determined quantity values and corresponding measurand values. If mathematic form of this relationship is unknown, it is substituted by its approximation. In this process a real situation is simplified by neglecting of influence quantities to a relation of two variables – independent versus dependent. Metrological traceability of certified reference materials (CRM) values intended for calibration purposes and characterised by means of a method working on the base of approximative function could be questionable. If a measurement method based on original relationship already exists, it should be strongly preferred in the process of CRM certification to methods based on approximation of original relationship.

Keywords: Approximation, Calibration, Indirect Measurement, Metrological Traceability, Metrology in Chemistry, Reference Materials

INTRODUCTION

Basic attribute of civilisation progress is cognition effort. The epistemic process is once again connected with generalisation and formulation of mutual dependencies of interacting systems. These dependencies in natural sciences usually have a form of some mathematical function. Validity confirmation of such relationships is performed via special classes of experiment called measurement. The fundamental problem of measurement is obtaining of accurate results.

Metrological traceability assurance of measured values is one of the basic assumptions for obtaining accurate results in chemical analysis. Metrological traceability is defined by International Vocabulary of Basic and General Terms in Metrology as “property of a measurement result whereby the result can be related to stated references through a documented unbroken chain of comparisons, each contributing to the measurement uncertainty.” These comparisons of values reproduced by measuring instrument to values realised by standard are denoted as calibrations. Metrological traceability concept is based on three basic pillars. The first of them is idea of the most perfect realisation of unit value (or scale values) of particular physical quantity by means of a standard – sophisticated equipment or artefact of relatively high stability, as a carrier of particular quantity value, conventionally considered to be unit or reference value (Figure 1). The second pillar presents idea of international compatibility of such values and
the third one is the idea of the most accurate transfer of a value realised by the standard to practical measurement (measuring instruments) via comparison of this standard value to value of measuring instrument scale. This method or process of transfer, called calibration, should be detailly described and evaluated (validated). The biggest problem of traceability establishment consists in the first pillar. In metrology units of individual basic quantities are defined. However, their realisation according to relevant definition is very difficult. These definitions are generally based on various abstractions. Probably the most appropriate case should be definition of quantity value (unit) resulting from definition of relevant physical quantity, best of all based on natural law formulation. However, definitions of basic quantities are absent. The definitions should be sufficiently universal and formulated in an appropriate quantifiable way.

CALIBRATION

Calibration enables interconnection of quantity value given by a standard into measurement results in practice. It is a measurement process that assigns values to the property of an artefact or to the response of an instrument relatively to reference standard. The purpose of calibration is to eliminate or reduce bias in the users’ measurement system relatively to reference. Within a calibration procedure an “unknown” value of calibrated item or measuring instrument is compared with reference value represented by standard according to specific algorithm.

Calibration is generally performed in one of the two following ways (Subaric-Leitis, 1994) [in spite of the fact, that some authors (Woschi, 1994; Cropley, 1998) recognise some additional ways like transposition method, differential method...]:

- **By comparative method** (reference and compared equipment under calibration are operating simultaneously or alternately during the calibration cycle, in which values of quantity realised by both equipments are directly compared with possibility to install corrections of quantity value displayed by compared equipment; both equipments may operate on the basis of different physical principles).
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