Discussion on the Gaussian assumption in flow rate measurements using a primary weighing method

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ABSTRACT

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Flow rate measurement is a common task in many hydraulic infrastructures included in systems with a large impact on the economy. The quality requirements that such measurement must fulfil imply the best knowledge of the measurement results (estimates and measurement uncertainties). Methods such as those given by the Guide for the Expression of Uncertainty in Measurement (GUM) have been widely used as tools to evaluate measurement uncertainties. However, such methods have implicit assumptions on the nature of the mathematical models and the applicability conditions, which are not often taken into account by their users, who apply them regardless of the specific nature of the actual metrological problems. One such assumption is that the output probability function is Gaussian, which is true only if some input conditions are met. In practice, many metrological problems are described by mathematical models with non-ideal conditions, the measurement uncertainty solutions thus being quite different from those predicted by the GUM method. The development of metrological studies has shown that the Monte Carlo method is suitable to deal with non-ideal problems and has several advantages. One such advantage is particularly useful for the specific problem of flow rate measurement using a primary weighing method: the ability to give information on the output quantity probability function. In this way, it is possible not only to obtain the output quantity estimate but also to test the normality of the output measurement uncertainty interval, which in fact has a non-Gaussian shape.

Key words | flow rate, measurement uncertainty, Monte Carlo method