What is Measurement Uncertainty and its usefulness?

The purpose of measurement in a laboratory is to determine *a* value of a quantity of interest (also known as the measurand). The very basic requirements of a test method are to have a high degree of specificity and accuracy, low limit of detection, rapid and economical, if possible.

But, no matter how precise and accurate is a test method, all measurements but physical counting are subjected to imperfections or errors.

It is a well known fact that in a series of replicate measurements, we seldom obtain all the results to have exactly the same value. These results in fact tend to scatter about the mean of these results. The scattering of results tends to be even more so when the measurements are made near the detection limit of the test method. A relative standard deviation of 30 – 40% is quite common in trace analysis. These scattering effects are mainly due to the random errors occurred during the analysis due to controllable instrument signals and environmental conditions.

Therefore, we can never be absolutely sure that any test result found in a laboratory is 100% accurate with zero error. We have indeed to look for a range or dispersion of results around the final test result obtained. With some statistical applications, it is hoped that the range of measurements due to the uncertainty would have covered the 'true' value that we are trying to estimate, with a certain degree of confidence.

Given such inherent variability of measurement, a statement of a measurement result is incomplete (perhaps even meaningless) without an accompanying statement of the estimated uncertainty of measurement (a parameter characterizing the range of values within which the value of the measurand can be said to lie within a specified level of confidence).

Such knowledge of the uncertainty associated with measurement results is essential to the interpretation of the results. And, there is also a risk of misinterpretation of results if the uncertainty information is not there. Such incorrect decisions may lead to incorrect prosecution, non-compliance to specification, adverse health or social consequences.

Hence, we have to demonstrate to the data users the quality of our test results by giving a measure of confidence or credibility placed on those data. Such confidence that can be attached to a test result and the degree of confidence to which the result is expected to agree with other results is provided by the measurement uncertainty.

Measurement uncertainty concepts are well developed in metrology and calibration sectors but not so in chemical analysis. The ISO/IEC 17025 accreditation standards has placed greater emphasis and demands on testing laboratories to estimate and report the uncertainties of their test results produced.

Hence, measurement uncertainty is useful and need for:

- to estimate the reliability of the measurement
- to compare test result with allowable values, e.g. tolerance limits or specification
- to decide whether there is a difference between results given by different laboratories, or results from the same analyst carried out at different times
- to establish traceability
- to thoroughly analyze the test method
- to obtain information for validating or improving the test method.