EVALUATION OF UNCERTAINTY OF DOSED VOLUME WITH ONE-CHANNEL PIPETTOR

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Uncertainty is a parameter associated with the result of a measurement that characterises the dispersion of the values that could reasonably be attributed to the measurand. In practice the uncertainty on the result may arise from many possible sources, including examples such as incomplete definition of the measurand, sampling, environmental conditions, uncertainties of masses and volumetric equipment, approximations and assumptions incorporated in the measurement method and procedure, and random variation.

The factors that affect the volume of dispensing (2 ml and 10 ml) by the ULAB pipettor had identifies in the article. The relevant uncertainty sources were shown in the cause and effect diagram and had provided a procedure for assessing the standard uncertainty of the underlying factors.

Some of these components may be evaluated from the statistical distribution of the results of series of measurements and can be characterised by standard deviations. In our case, the standard uncertainty of the convergence of the weighing results were calculated.

The other components, which also can be characterised by standard deviations, are evaluated from assumed probability distributions based on experience or other information. In our case, the standard uncertainty of the effect of temperature on the volume of water and the standard uncertainty of calibration the pipette by manufacturer were calculated.

For example, according to the manufacturer the pipette has been calibrated at a temperature of 25 °C, whereas the laboratory temperature varies between the limits of ±5 °C. The uncertainty from this effect can be calculated from the estimate of the temperature range and the coefficient of the volume expansion. The coefficient of volume expansion for water is 2.1×10^{-4} $°C^{-1}$, which leads to a volume variation of $\pm(2000\ 5\ 2.1\ 10^{-4})=2{,}1$ μl and $\pm(10000\ 5\ 2.1\ 10^{-4})=10{,}5$ μl.

The standard uncertainty is calculated using the assumption of a rectangular distribution for the temperature variation i.e. $\frac{2{,}1}{\sqrt{3}}=1{,}21$ μl and $\frac{10{,}5}{\sqrt{3}}=6{,}06$ μl.

After quantification of the standard uncertainty of the considered factors, determine the combined standard uncertainty

$$u_c(2\mu l)=\sqrt{3{,}2^2+2{,}1^2+0{,}01811^2}=3{,}8276\ \mu l;$$

$$u_c(10\mu l) = \sqrt{16^2 + 10{,}5^2 + 0{,}02067^2} = 19{,}1377\ \mu l.$$

If there are not a large number of components, then those that less than a third of the largest, do not need to be evaluated in detail. The preliminary assessment of the contribution of each component to the uncertainty should be made, and those that are not essential are eliminated. Checking the size of each contribution, the calibration is by far the largest.

The expanded uncertainty U(V) is obtained by multiplying the combined standard uncertainty by a coverage factor of 2, giving.

$$U(2\ ml) = k\cdot u_c(2\ ml) = 2\cdot 3{,}8276\ \mu l = 7{,}6554\ \mu l;$$

$$U(10\ ml) = k\cdot u_c(10\ ml) = 2\cdot 19{,}1377\ \mu l = 38{,}2754\ \mu l.$$

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