

Uncertainty of 10 ml pipette volume

The following components of uncertainty are taken into account:

1. Tolerance of the volume as specified by the manufacturer
2. Uncertainty due to the repeatability of pipetting
3. Uncertainty of the volume due to temperature difference from 20 °C

The calculation assumes that the pipette has been decently cleaned, that is no droplets are formed on the inner surface of the pipette after draining the liquid.

Model Equation:

{ Volume of the pipette

The volume is expressed as sum of three components. The V_{tol} carries the value together with calibration uncertainty.

The two other components carry only uncertainties, their values are set to zero.

}

$$V = V_{tol} + V_{repeat} + V_{temp};$$

{ Uncertainty of the pipette volume due to temperature difference from 20 °C }

$$V_{temp} = V_{tol} * \gamma * \Delta t;$$

List of Quantities:

Quantity	Unit	Definition
V	ml	Volume of the 10 ml pipette
V_{tol}	ml	Value of the volume together with tolerance uncertainty
V_{repeat}	ml	Repeatability uncertainty component of the volume
V_{temp}	ml	Temperature component of the uncertainty of the volume (Uncertainty of the volume due to temperature difference from 20 °C)
γ	1/°C	Thermal expansion coefficient of water
Δt	°C	Difference of the liquid temperature from 20 °C

V: Result

V_{tol} : Type B rectangular distribution
Value: 10.000 ml
Halfwidth of Limits: 0.03 ml

V_{repeat} : Type A summarized
Mean: 0 ml
Standard Uncertainty: 0.04 ml
Degrees of Freedom: 50

We estimate here that the repeatability standard uncertainty of pipetting is 0.4% of the pipette volume. We have found in our lab that this is a safe estimate. The users are recommended to substitute this estimate by real data obtained in their labs.

V_{temp} : Interim Result
 γ : Constant
 Value: 0.00021 1/°C
 Δt : Type B rectangular distribution
 Value: 0 °C
 Halfwidth of Limits: 4 °C

In our lab it is reasonable to assume that the temperature does not differ from 20 °C by more than 4 degrees. The users are advised to substitute this estimate by one that is obtained in their lab.

Uncertainty Budget:

Quantity	Value	Standard Uncertainty	Distribution	Sensitivity Coefficient	Uncertainty Contribution	Index
V_{tol}	10.0000 ml	0.0173 ml	rectangular	1.0	0.017 ml	15.6 %
V_{repeat}	0.0 ml	0.0400 ml	normal	1.0	0.040 ml	83.2 %
γ	0.00021 1/°C					
Δt	0.0 °C	2.31 °C	rectangular	0.0021	0.0048 ml	1.2 %
V	10.0000 ml	0.0439 ml				

Result: Quantity: V
 Value: 10.000 ml
 Expanded Uncertainty: ±0.088 ml
 Coverage Factor: 2.00
 Coverage: manual