

Uncertainty of 50 ml volumetric flask volume

The following components of uncertainty are taken into account:

1. Tolerance of the volume as specified by the manufacturer (Type B)
2. Uncertainty due to the filling repeatability (Type A)
3. Uncertainty of the volume due to temperature difference from 20 °C

Model Equation:

{ Volume of the flask

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 flask 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 50 ml flask
V_{tol}	ml	Value of the volume together with tolerance uncertainty contribution
V_{repeat}	ml	Uncertainty contribution of the volume due to repeatability
V_{temp}	ml	Uncertainty contribution of the volume due to temperature difference from 20 °C
γ	1/°C	Thermal expansion coefficient of water
Δt	°C	Difference of liquid temperature from 20 °C

V_{tol} : Type B rectangular distribution
 Value: 50.00 ml
 Halfwidth of Limits: 0.06 ml

V_{repeat} : Type B rectangular distribution
 Value: 0 ml
 Halfwidth of Limits: 0.09 ml

The uncertainty of ± 0.09 corresponds to the uncertainty of plus minus 3 drops. With 50 ml volumetric flask this is a reasonable filling uncertainty estimate. With larger volumetric flasks that have thicker necks, the filling uncertainty can be even larger. Also this depends very much on the worker.

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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.

Interim Results:

Quantity	Value	Standard Uncertainty
V_{temp}	0.0 ml	0.0242 ml

Uncertainty Budgets:

V: Volume of the 50 ml flask

Quantity	Value	Standard Uncertainty	Distribution	Sensitivity Coefficient	Uncertainty Contribution	Index
V_{tol}	50.0000 ml	0.0346 ml	rectangular	1.0	0.035 ml	26.7 %
V_{repeat}	0.0 ml	0.0520 ml	rectangular	1.0	0.052 ml	60.2 %
V_{temp}	0.0 ml	0.0242 ml				
γ	$210.0 \cdot 10^{-6}$ 1/°C					
Δt	0.0 °C	2.31 °C	rectangular	0.011	0.024 ml	13.1 %
V	50.0000 ml	0.0670 ml				

Results:

Quantity	Value	Expanded Uncertainty	Coverage factor	Coverage
V	50.00 ml	0.13 ml	2.00	manual