

Specific heat

The specific heat capacity c_p is a characteristic material property of a substance. It describes the amount of heat required to increase the temperature (at constant

pressure) and is thus an important property for the calculation of thermal processes in the chemical industry. With the aid of this option, the c_p temperature function of a substance can be determined quickly and simply using DSC or SDTA measurements.

This software option offers a choice of various c_p evaluations:

- **Specific heat:** Quick and simple determination of the c_p temperature function with or without a blank curve correction for screening measurements.
- **c_p sapphire measurement (DIN 51007):** This method is advisable when more exacting demands are placed on the accuracy of the results.

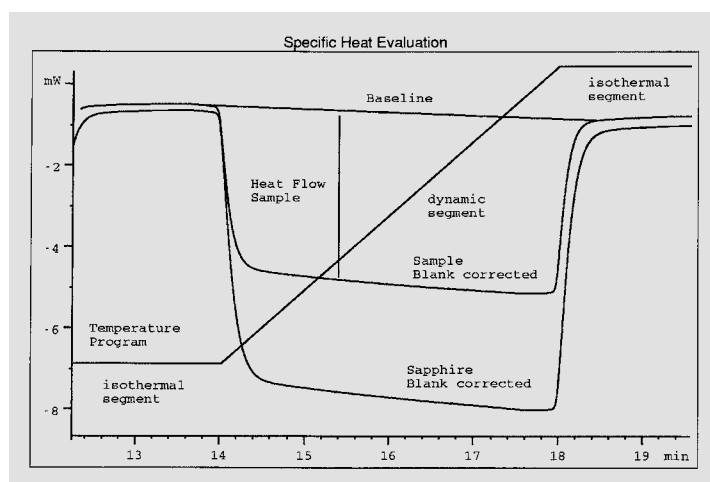
In addition to the actual sample and blank curve, for the sapphire method a sapphire measurement must be performed. The known heat capacity of sapphire is used in the calculations. Even more accurate results are obtained when the temperature range under investigation is not simply scanned linearly, but divided into short dynamic segments with isothermal pauses.

Definition:

$$\text{Equation } c_p = \frac{dH}{dt} \cdot \frac{1}{\beta_s \cdot m_o}$$

where dH/dt = heat flow to the sample (corrected by blank curve)
 β_s = heating rate in the sample
 m_o = sample mass

c_p as a function of the sample temperature is obtained as the result in J/g·K or, if the molecular weight of the sample is known, also in J/mol·K.



According to DIN 51007, the deflection of the DSC curve of the sample is compared with that of sapphire and c_p determined from this. If an isothermal step has been measured before and after the dynamic segment, correction for the isothermal drift is done.

Fig. 1: Schematic representation of the c_p evaluations. Temperature program (isothermal, dynamic, isothermal), sapphire measurement, sample, baseline (Isothermal drift).

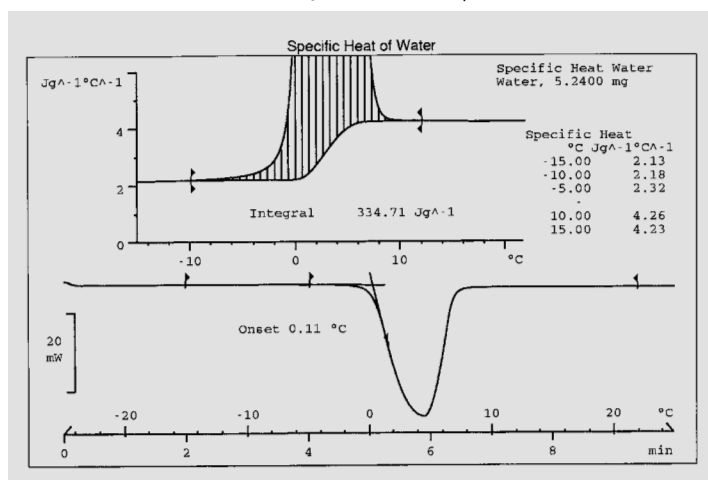
Application examples

Specific heat capacity of water

The example shows the c_p determination of water measured in a hermetically sealed Al crucible over a temperature range

–25°C to +25°C and at a heating rate of 5 K/min. The experimental curves have been blank corrected and were evaluated in the range –15 to 20°C by the „Specific heat“ method.

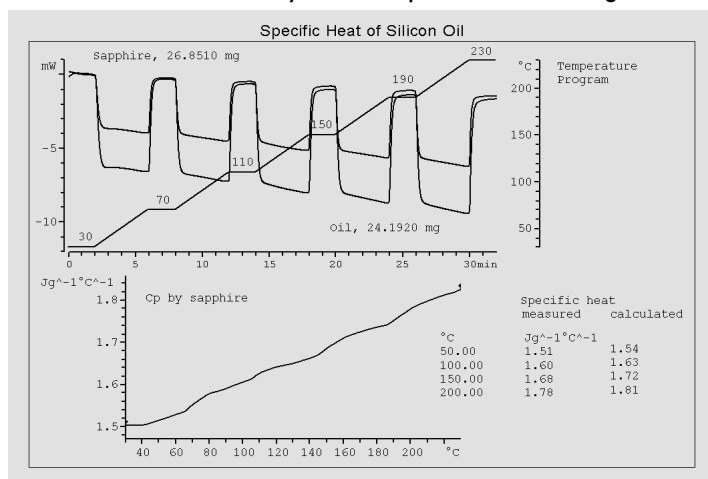
The specific heat capacity calculated in this manner is shown in both tabular and graphical form, but only the values outside the melting peak are realistic. The results are in good agreement with the literature values (–10°C: approx. 2.0 J/g·K, 10°C: 4.19 J/g·K). From the c_p temperature curve, integration over temperature also allows calculation of the heat of fusion, which is very close to the literature value of 334 J/g.



Specific heat capacity of silicon oil

In many technical processes knowledge of the heat capacity is very important as it may enter into the calculations

of a chemical process. The c_p value of a heat transfer oil is therefore important. This example shows the use of an extended DIN 51007 method which is particularly suitable if relatively wide temperature ranges have to be covered. The temperature program is an extension of DIN 51007 and comprises several dynamic and isothermal segments. This compensates the drift (interpolated isothermal baselines) better as several isothermal segments are used as interpolation points. As the direct c_p curve shows peaks as a result of the isothermal segments, the interpolated curve is used for the table. An approximation formula supplied by the producer for calculation of the heat capacity ($c_p = 1.453 + 1.8 \cdot 10^{-3}T$) shows only slight differences compared with the measurement results.



Specific heat capacity of polystyrene

c_p measurements can also be used for the validation of methods. The example shows the curve of a polystyrene standard (NIST SR705a), which was measured at a heating rate of 10 K/min. The experimental curve corrected by the blank curve is a mean value of 10 single measurements and was evaluated by the „Specific heat“ method. The value of 104.15 was used for the molar mass. A comparison of the measured values with the literature values demonstrates the quality of the measurement.

