Physikalisch-Technische Bundesanstalt

Braunschweig und Berlin

Working Group 3.32 ”Properties of Liquids“

Secondary basic liquid SN 01 for the calibration of standard viscometers of the highest precision

Standard capillary viscometers of the highest precision as they are used, for example, by national metrology institutes to realise the unit of viscosity, are traced back to the kinematic viscosity of water at 20°C and atmospheric pressure, ν_W = 1.0034 mm^2/s (internationally agreed value in accordance with ISO/TR 3666-1998, and subject to ITS-90). For this purpose, the viscometer constants of the "basic group" (i. e. of the viscometers, whose measuring range includes the viscosity of water) are determined from the flow time of water. These constants are, however, exactly valid only for liquids for which the ratio of the surface tension, σ, to the density, ρ, is equal to that of water, i. e. σ_W/ρ_W = 72.9 cm^3/s^2.

For both the link-up up of additional viscometers to the basic group and the determination of the kinetic energy correction, liquids are used the ratio σ_F/ρ_F of which is of the order of magnitude of 30 cm^3/s^2 and thus considerably smaller than that of water. The influence of the surface tension must, therefore, be corrected.

No correction of the surface tension is necessary if, instead of water, the **SN 01 secondary basic liquid** is used to determine the viscometer constant. Another point is that the problems due to the high and by smallest impurities most susceptible surface tension of water are no longer encountered, which makes it difficult to achieve a sufficiently small scatter of the flow times.

SN 01 is commercial n-nonane with a degree of purity of > 99%. The kinematic viscosity, ν_N, of SN 01 was determined in special U-tube viscometers by direct comparison of the flow time, t_N, with that of water, t_W, at 20°C.

The approximate value of the **kinematic viscosity of SN 01** is 0.989 mm^2/s, that of the **dynamic viscosity** 0.710 mPa·s. The exact values can slightly depend on the batch and are stated in the calibration certificate with an **uncertainty of 0,05%**, related to the viscosity of water and valid for a confidence level of 95%.

The ratio σ_N/ρ_N is 31.9 cm^3/s^2 and is thus of the order of magnitude of the oils and solvents used for viscometer calibration and most liquids to be measured. The viscometer constant C_N calculated from the flow time of SN 01 therefore requires **no correction of the surface tension**.

If it should be necessary in a special field of application, SN 01 also allows individual surface tension correction factors, κ, needed for each viscometer to be calculated from the flow times of SN 01 and water at 20°C (DIN 51 562, part 3). The surface tension correction c_σ by which the constant C_N of the viscometer equation

$$\nu = K_N \cdot c_\sigma \cdot c_B \cdot \left(t - t_H\right)$$

is to be multiplied is defined as

$$c_\sigma = 1 - \kappa\left(\frac{\sigma_N}{\rho_N} - \frac{\sigma_F}{\rho_F}\right), \qquad c_B = \frac{1 - \frac{\rho_L}{\rho_F}}{1 - \frac{\rho_L}{\rho_N}},$$

where σ_N/ρ_N is the surface tension/density ratio of SN 01 (to be taken from the calibration certificate) and t_H the kinetic energy correction. With $\sigma_F/\rho_F = \sigma_W/\rho_W$ the equation is obtained which allows κ for each individual viscometer to be calculated from the flow times of SN 01 and water:

$$\kappa = \frac{1 - \frac{\nu_W}{\nu_N} \cdot \frac{1}{c_B} \cdot \frac{t_N}{t_W}}{\frac{\sigma_N}{\rho_N} - \frac{\sigma_W}{\rho_W}}, \qquad c_B = \frac{1 - \frac{\rho_L}{\rho_W}}{1 - \frac{\rho_L}{\rho_N}},$$

where c_B is the buoyancy correction for the difference between the densities of SN 01 and water, and ρ_L is the air density.

As the difference between the kinematic viscosities of water and SN 01 is small, the difference between the kinetic energy corrections is negligible so that they must not be known for the above calculation.

The SN 01 secondary basic liquid is delivered in quantities of 100 ml and 250 ml. It can be obtained from:

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Working Group 3.32 "Properties of Liquids"
Postfach 33 45
38023 Braunschweig
Germany

Phone: +49 531 592-3320 (Dr. Henning Wolf)
Fax: +49 531 592-693320 +49 531 592-3305
E-Mail: Henning.Wolf@PTB.DE

The fee is for 100 ml approx. 738 €
for 250 ml approx. 861 €

It is calculated according to the working time necessary for the determination of the viscosity and density of the reference liquid, its preparation and delivery. The fee is charged in accordance with the »Regulations Governing the Charges for Services Supplied by the Physikalisch-Technische Bundesanstalt« and is subject to change.

n-Nonan will only be shipped carriage forward with the parcel service suggested by the customer.