Temperature effect on NO_2 Sampler

Theoretical considerations

The migration of molecules through a static air layer can be described by Fick's law of diffusion:

$$J = \frac{D \quad \Delta C}{L} \qquad (1)$$

J: diffusive flux [g/sec]
D: coefficient of diffusion [cm2/sec]
Δc concentration gradient

After integration and rearrangement the following equation can be used for calculation of the ambient concentration:

$$\text{concentration } c = \frac{Q \cdot l}{D \cdot A \cdot t} \qquad (1)$$

c:	concentration	[µg/m^3]
Q:	amount absorbed [	[µg]
l:	diffusion path	[cm]
D:	diffusion coefficient	[cm^2/sec]
A:	cross section	[cm^2]
t:	exposure time	[sec]

According to Maxwell's equation, the diffusion coefficient depends on the absolute temperature and pressure:

$$D_{12} = \frac{B \cdot T^{3/2} \sqrt{1/M1 + 1/M2}}{p \cdot r_{12} \cdot I_D}$$

B:	numerical constant (9.92916. 10^{-4})
T:	temperature (°Kelvin)
M1,M2:	molecular weight
P:	pressure
r_{12}:	collision diameter
I_D:	collision integral

The coefficient of diffusion changes proportional to T $^{3/2}$.

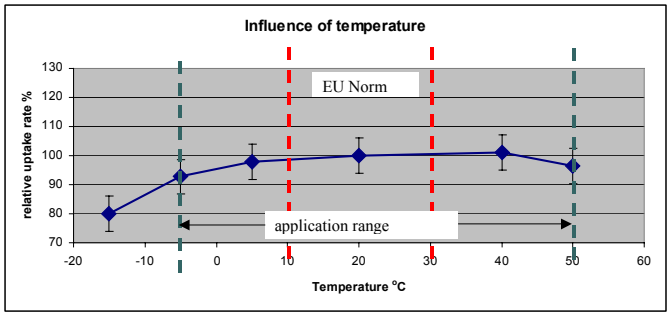
However, . since volume varies directly as T, concentration on a mole per unit volume basis varies inversely with temperature so that as the temperature is raised, the concentration in mass units per unit volume is proportionally decreased. The correction for change in temperature amounts to about 1 % per 5.5°C.

Effect of temperature in the laboratory

NO_2 concentrations were produced using permeation tubes..

To investigate the influence of temperature, two glass chambers were set up in series, the first set thermostatically to 20°C and the second set to the desired temperature.

In the range of 5 to 40 °C no correction has to be made.



The results show further, that corrections of 20 % underestimation should be made below –5°C

Statistical considerations

For the purposes of statistical analysis, the meteorological parameters were correlated with the monitor/diffusive sampler fraction.
The analysed data are taken from a year-long trial conducted at 3 monitoring sites in the same town. In total, 78 14-day measurement comparisons have been are available.

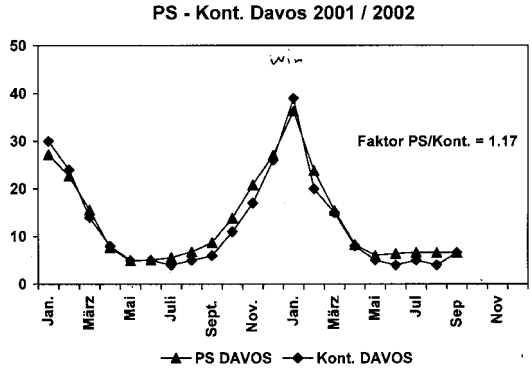
Correlation r with T	0.013
Range of temperature	4 to 27°C
Median of temperatures	15.5
Median test	significant on 5% level

Table 2.2: Correlation coefficient of meteorological parameters for the monitor/diffusive sampler fraction for the NO2 sampler

There is a slight correlation between temperature and deviation from monitor value, though the median test was negative in all cases

Alpine monitoring site

In Swiss alpine Valley 1800 m above sea level, a comparison between monitor and diffusion tube has been carried out, The mean temperature in the coldest season was –4.1 °C.



There is no obvious discrepancy down to –5 °C

Conclusions

Under field conditions with varying meteorological conditions, it is not possible to determine any significant influences which could lead to better results through the use of a correction factor..

Care has to be taken, when temperatures lower than – 5°C are expected.

References

[1] 31. M. Hangartner: Influence of Meteorological Factors on the Performance of Diffusive Samplers. International Conference Measuring Air Pollutants by Diffusive Sampling. Montpellier, 26 – 28 September 2001
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