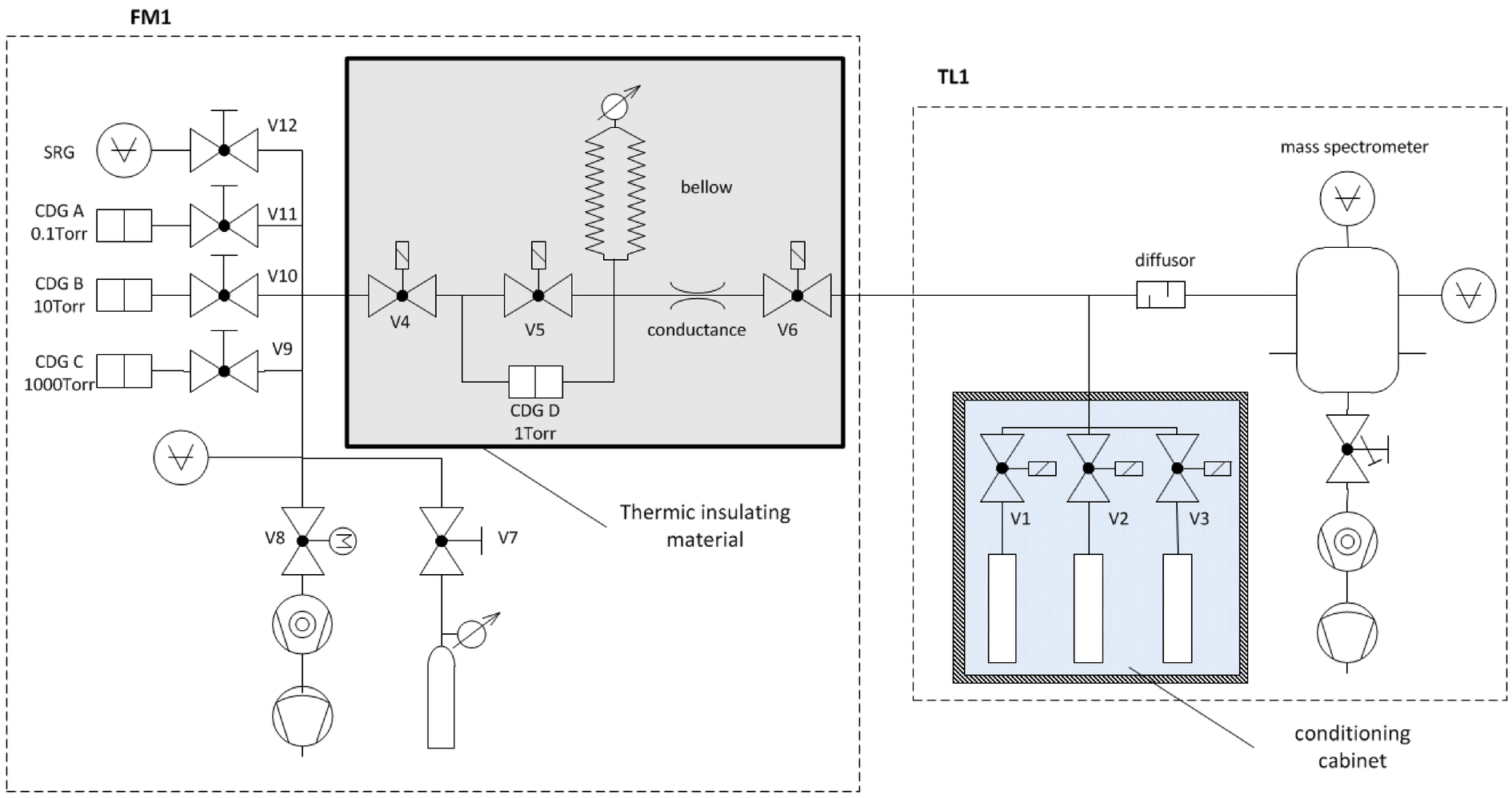
Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
Nationales Metrologieinstitut

Primary standard for test leak calibration



Flowmeter

The gas flow $q_{pv}(FM)$ is calculated from the conductance L and the the pressure p_{FM} in the flowmeter:

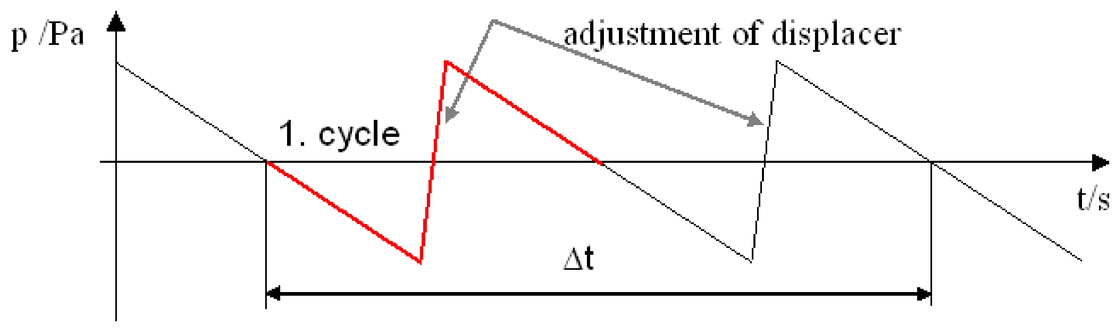
$$q_{pv}(FM) = L \cdot p_{FM} \tag{1}$$

The conductance L is obtained from the temporal volume change ($\Delta V/\Delta t$) of a calibrated bellows and an electronic clock.

$$L = \frac{A \cdot \Delta s}{\Delta t};\ \Delta V = A \cdot \Delta s \qquad \begin{array}{l} \text{A} - \text{displacement area} \\ \text{s} - \text{displacement distance} \end{array} \tag{2}$$

$$q_\nu(FM) = \frac{q_{pV}(FM)}{R \cdot T_{FM}} \qquad \begin{array}{ll} \text{R} & - \text{molar gas constant} \\ q_\nu(FM) & - \text{molar flow} \end{array} \tag{3}$$

Decreasing of the fill pressure in the flowmeter is compensated by reduction of the volume with the help of the displacement. A saw-tooth pressure course is generated from repeated adjusting of the displacement.



Primary standard

The range of the PTB primary standard is from $4 \cdot 10^{-11}$ Pa l/s to 0.1 Pa l/s at 23°C ($1.6 \cdot 10^{-15}$ mol/s bis $4 \cdot 10^{-8}$ mol/s).

The gas flow from the leak TL is compared with a gas flow q_{FM} of about the same flow rate from a flow meter FM by a mass spectrometer. The flow measurement is carried out at constant pressure p and constant (absolute) temperature T_{FM}:

$$q_\nu(FM) = p \cdot L \cdot \frac{1}{R \cdot T_{FM}} \text{ mol/s} \tag{4}$$

The pressure p is measured with a capacitance diaphragm gauge. This gauge is calibrated by comparison with a primary standard of PTB.

The leak rate q_{mol} of the test leak was calculated by the following equation:

$$q_{mol} = q_{FM}\frac{S_{TL}}{S_{FM}} \text{ mol/s} \tag{5}$$

S_{TL} - signal at mass spectrometer for the gas flow from the test leak
S_{FM} - signal at mass spectrometer for the gas flow from the flowmeter

Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin

7.5 Heat and Vacuum
7.54 Vacuum Metrology

Abbestraße 2–12
10587 Berlin
Telefon: +49-30-3481-7467
Fax: +49-30-3481-7503
E-Mail: Ute.Becker@ptb.de
www.ptb.de