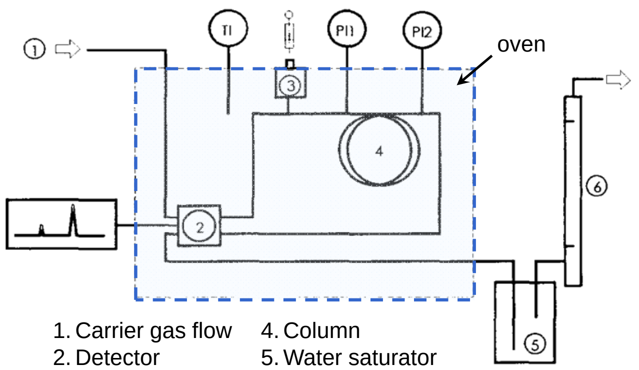
Inverse Gas Chromatography (IGC)

Motivation

- Inverse Gas Chromatography (IGC): the stationary phase (e.g., polymers, polymer blends ionic liquids etc.) is of interest, unlike the traditional GC method
- Applications: activity coefficients of volatiles at infinite dilution / gas solubility in high-boiling/low volatile liquids
- Fast method with a reasonable accuracy
- Key value: retention time

Experimental setup

- House-built gas chromatograph
- Thermal conductivity detector
- Complete data evaluation with PC



1. Carrier gas flow
2. Detector
3. Injection block
4. Column
5. Water saturator
6. Flowmeter

Experimental procedure / data reduction

- Preparation of the column with a known amount of a stationary phase of interest
- Measurement of inlet and outlet pressure, oven temperature, flow rate at ambient conditions, retention time of volatile probes
- Calculation of the net retention volume corrected to the column temperature and pressure

$$v^G = (t_1 - t_0) \cdot \dot{V}(P_{amb}, T_{amb}) \cdot J_3^2 \cdot \frac{P_{amb}}{P_{out}} \cdot \left(1 - \frac{P_{water}^{LV}(T_{amb})}{P_{amb}}\right) \cdot \frac{T}{T_{amb}}$$

$$J_3^2 = \frac{3}{2}\left[\frac{(P_{in}/P_{out})^2 - 1}{(P_{in}/P_{out})^3 - 1}\right]$$ is the James-Martin Factor (pressure correction)

- Calculation of limiting activity coefficients

$$\ln\left(\gamma_i^\infty\right) = \ln\left(\frac{n_3 \cdot R \cdot T}{v^G \cdot P_i^{LV}(T)}\right) - \frac{(B_{ii} - v_{0i}^L)}{R \cdot T} \cdot P_{0i}^{LV}(T)$$

Examples

- Separation factor to characterise entrainers for separation of substances using extractive distillation

$$\alpha_{1,2}^\infty = \frac{\gamma_1^\infty P_{01}^{LV}}{\gamma_2^\infty P_{02}^{LV}}$$

- Selectivity of an extractive agent to separate substances using liquid-liquid extraction

$$S_{1,2}^\infty = \frac{\gamma_1^\infty}{\gamma_2^\infty}$$

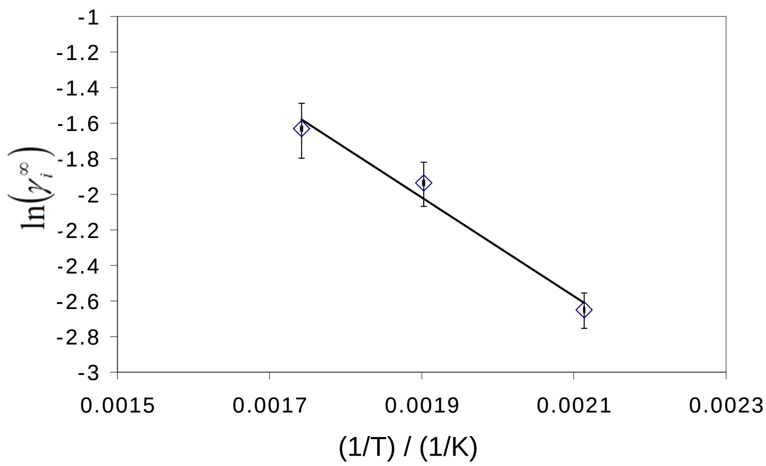
- Henry constants to characterise suitable solvents for absorption

$$H_{12}^\infty = \gamma_1^\infty P_{01}^{LV} \varphi_{01}^{LV}$$

- Flory-Huggins interaction parameter to find a suitable solvent for a polymer

$$\chi_{12}^\infty = \ln \gamma_1^\infty - 1$$

- Temperature dependence of limiting activity coefficients



→ Plotting $\ln\left(\gamma_i^\infty\right)$ as a function of 1/T results a straight line

→ Slope of the line corresponds with the partial molar excess enthalpy of the monomer at infinite dilution in the polymer

$$\left(\frac{\partial \ln(\gamma_i^\infty)}{\partial(1/T)}\right) = \frac{h_i^{E,\infty}}{R}$$

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