UDR - Experiments

Labpartners: Jasmin Schleiss + Elin Sebesta

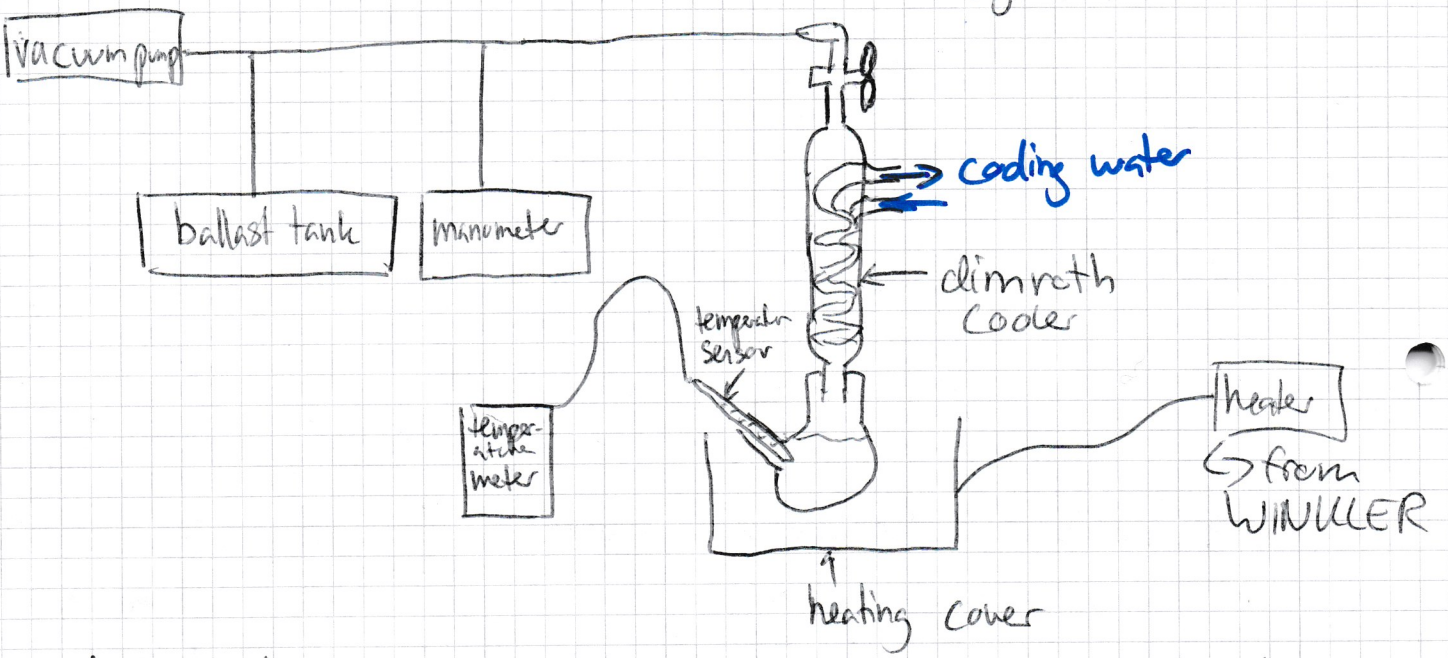
18 May 21

Vapor pressure experiments

Aim: Investigation of the relation between boiling temperature and vapour pressure from pure liquids, because vapour pressure is an important parameter for volatile substances

Used measurement instruments:

- refractive index n_D → ATAGO Digital Refractometers
- density ρ → PAAR Density Meter
- vapor pressure machinery
  - temperature ~~was~~ was measured with Greisinger, GMH 3210 Digital thermometer



Used solvents: → also used for the transient ~~cooling~~ evaporation cooling

ethanole → flash point 13°C
→ UEG 3.4 Vol%, OEG 19 Vol%

n-hexane → flash point -20°C
→ UEG 1 Vol%, OEG 8.9 Vol%

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- important formula!

Clausius-Clapeyron-Equation:

$$\frac{dp_A}{dT} = \frac{\Delta_v H_A}{T \Delta_v V_A}$$

→ vapour pressure formula: $p_A(T) = p_A(T_0) \exp\left(\frac{\Delta_v H_A}{R T_0}\right) \exp\left(\frac{\Delta_v H_A}{R T}\right)$

→ from Antoine: $\log_{10}\left(\frac{p_A}{mbar}\right) = A - \frac{B}{\Theta + C}$

for calculating the evaporation enthalpy:

$$\Delta_v S_A(T_b) = \frac{\Delta_v H_A(T_b)}{T_b}$$

- before the measurements a "density test" for the apparatus was made at 300 mbar

vapour pressure measurement with ethanale (Merck KGaA, CAS. NO: 64-17-5, EMSURE® ACS, ISO, Reag. PH EUr, absolut for analysis)

1) approx. 60 mL was filled into the ground bottom flask
2) ~~Beg~~ startpoint 250 mbar, T = 17.2 °C
   then to 150 mbar, T = 17.4 °C
   then to 100 mbar, T = 17.6 °C

boiling point: 101 mbar, 30.7 °C

~~back to 148 mbar, T = 36.1 °C~~

1. 150 mbar, T = 38.4 °C
2. 200 mbar, T = 43.4 °C
3. 241 mbar, T = 47.7 °C
4. 291 mbar, T = 51.2 °C
5. 351 mbar, T = 54.6 °C
6. 399 mbar, T = 57.3 °C
7. ~~4~~ 451 mbar, T = ~~60.1~~ 59.9 °C
8. 500 ~~488~~ mbar, T = 62.2 °C
9. 550 mbar, T = 64.4 °C

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10. 599 mbar, T = 66.5 °C
11. 648 mbar, T = 68.3 °C
12. 699 mbar, T = 70.1 °C
13. 749 mbar, T = 71.[illegible] °C
14. 799 mbar, T = [illegible] 73.2 °C
15. 851 mbar, T = 74.4 °C
16. 898 mbar, T = 75.9 °C
17. 948 mbar, T = 77.3 °C
18. 899 mbar, T = 75.9 °C
19. 849 mbar, T = 74.4 °C
20. 799 mbar, T = 72.8 °C
21. 749 mbar, T = 71.3 °C
22. 699 mbar, T = 69.7 °C
23. 649 mbar, T = 68.1 °C
24. 599 mbar, T = 66.0 °C
25. 549 mbar, T = 64.2 °C
26. 499 mbar, T = 62.0 °C
27. 449 mbar, T = 59.7 °C
28. 400 mbar, T = 57.[illegible]2 °C
29. 349 mbar, T = 54.4 °C
30. 301 mbar, T = 51.2 °C

With n-hexane (same procedure as with ethanole)

pressure in mbar / temperature in C°

1. 100, 11.6
2. ~~151, 20.1~~ 151, 20.1
3. 200, 26.1
4. 249, 31.0
5. 299, 35.4
6. 350, 39.2
7. 399, 42.6
8. 451, 45.7
9. 500, 48.6
10. 550, 51.2
11. 600, 53.6
12. 650, 56.0
13. 700, 58.1
14. 750, 60.1
15. 800, 62.1

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16. 848, 63.8
17. ~~898~~ 898, 65.6
18. 946, 67.2
19. 900, 65.7
20. 849, 63.7
21. 800, 61.9
22. 750, 60.0
23. 701, 57.9
24. 650, 55.8
25. 601, 53.5
26. 549, 51.0
27. 499, 48.5
28. 450, ~~47~~ 45.7
29. 400, 42.7
30. 350, 39.2

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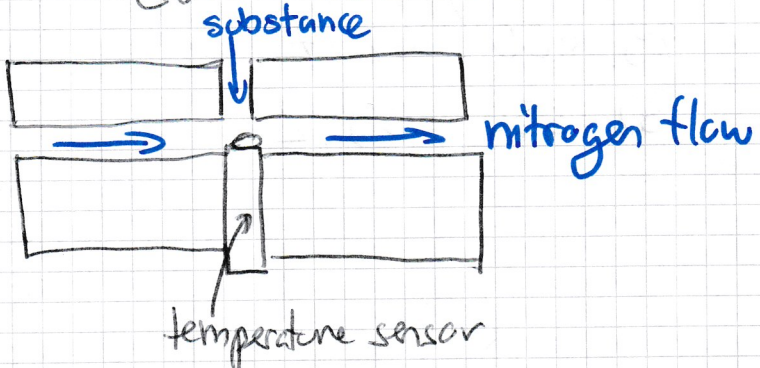
Transient evaporation cooling

Aim: Determination of the enthalpy of evaporation of a liquid from the temperature curve of a surface on which a drop of liquid evaporates

measurement instrument

a TREVAC measurement instrument was used



important formula

$$\Delta_v H_L = \underbrace{\Delta_v H_{Ref} \frac{p_{Ref} \cdot M_L}{M_{Ref} \cdot \rho_L}}_{f_{Ref/L}} \cdot \frac{A_L}{A_{Ref}}$$

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TREVAC Measurement / Software Temperature Logger (V21.7)

- syringe from hamilton was not straight

current T: 34.59 °C

with n-hexane 3 measurements were made

as a reference substance methanol for analysis EMSURE®, Merck KGaA, ACS, ISO, Reag. Ph. EUR was used, 3 measurements with methanol were made

details to n-hexane (for liquid chromatography):

from Merck KGaA, CAS. No 110-54-3

→ was used for all DDR experiments

Refractive index measurement with ATAGO, RX-5000

→ for n-hexane

current T: ~~[illegible]~~ 19.8°C

- 1.37514
- 1.37516
- 1.37519

density determination using a libra (METTLER TOLEDO XA204 Delta Range)

weight of the "Kolbe": 16.251g

→ the "Kolbe was filled with 25mL of n-hexane and then weighted

m_1 = 32.655g ("Kolbe" + liquid)

m_2 = 32.668g " "

m_3 = 32.668g " "

- using a densitymeter (ADPAAR, DMA 48) at 20°C

→ for n-hexane

	period/vibration frequency [1/s]	density [g/cm³]
①	3719.66	0.6594
②	~~[illegible]~~3719.43	0.6597
③	3719.42	0.6591

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TREVAC

x measurement with Ethanol
→ ethanol_jasmin

TRANSIENT DENSITY

- 25ml of liquid ethanol
  1. Messung : 35.8543 g
  2. Messung : 35.8363 g
  3. " : 35.885 g

Brechungsindex n

1.	$n = 1.36125$	$T = 19.9\,^{\circ}C$
2.	$n = 1.36125$	$T = 19.9\,^{\circ}C$
3.	$n = 1.36125$	$T = 19.9\,^{\circ}C$

Density

1. $\mu s = 0.5025$ (?) $\rho = 0.78913$
2. $\mu s = 3833.09$ $\rho = 0.7892$
3. $\mu s = 3833.07$ $\rho = 0.7891$