Normalno vrelišče etilenglikola je pri 197 °C. Izračunaj T_{vr}, če tekočina destilira pri 0,04 bar?

$\Delta_{izp}H_{spec.} = 799\ J/g$ $\quad \Delta_{izp}H_m = \Delta_{izp}H_{spec.} \cdot M = 799\ J/g \cdot 62\ g/mol =$

$= \underline{49{,}538\ kJ/mol}$

$T_{vr}\ (p_2 = 0{,}04\ bar) = ?\ (T_2)$

$M = 62\ g/mol$

$T_1\ (p_1 = 1{,}013\ bar) = 197\,^{\circ}C$ $\quad \ln\frac{p_2}{p_1} = -\frac{\Delta_{izp}H_m}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

$$T_2 = \frac{T_1}{1 - \frac{RT_1}{\Delta_{izp}H_m}\cdot\ln\frac{p_2}{p_1}} = \frac{470{,}15\ K}{1 - \frac{8{,}314\ J/mol\,K \cdot 470{,}15\ K}{49538\ J/mol}\cdot\ln\frac{0{,}04}{1{,}013}} =$$

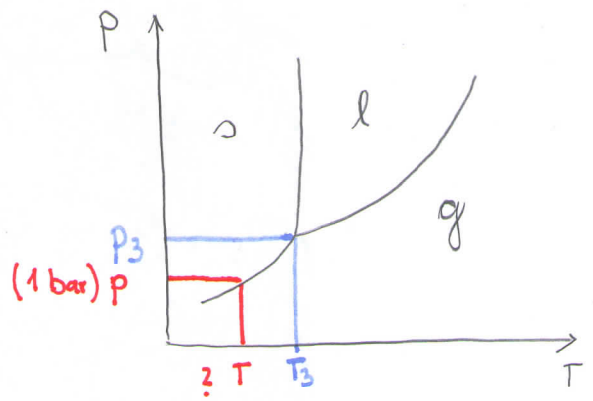
$$T_2 = 374{,}6\ K = \underline{101{,}5\,^{\circ}C}$$

UF_6 - pari tlak se spreminja:

s: $\log p_s = 10{,}648 - \frac{2559{,}5}{T\ (v\ K)}$

p_s (v torr oz. mm h Hg)

l: $\log p_l = 7{,}5396 - \frac{1511{,}3}{T}$



Pri kateri T so v ravnotežju vse tri faze (s, l in g)? Pri kateri T je trdni UF_6 v ravnotežju s svojimi parami pri tlaku 1 bar?

$p = p_3$ (trojna točka) $\quad p_s = p_l$

$$10{,}648 - \frac{2559{,}5}{T_3} = 7{,}5396 - \frac{1511{,}3}{T_3}$$

$$T_3 = 337{,}2\ K = \underline{64{,}1\,^{\circ}C}$$

$$p_3 = 10^{\left(7{,}5396 - \frac{1511{,}3}{T_3}\right)} = \underline{1142\ torr}$$

$\log p_s = 10{,}648 - \frac{2559{,}5}{T}$

1 bar ... 750 torr

$\log 750\ \text{torr} = 10{,}648 - \frac{2559{,}5}{T}$

$T = 329{,}3\,K = \underline{56{,}2\,^\circ C}$

Kakšna je Tvr pri tlaku 1 bar?

Ta T ne obstaja, saj smo na fazni meji med trdnim in plinastim ag. stanjem.

V zaprti posodi je 1 mol nasičene vodne pare pri 100°C. Koliko vode dobimo, če posodo ohladimo na 20°C? Para se obnaša idealno.

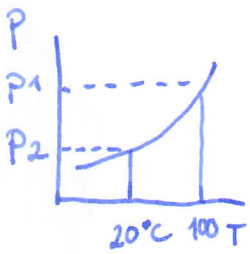
$n_1 = 1\ mol$
$T_1 = 100^\circ C$
$T_2 = 20^\circ C$
$\Delta_{izp}H = 42{,}92\ kJ/mol$

$p_1 \cdot V = n_1 R T_1$

$p_2 \cdot V = n_2 R T_2$

$\frac{p_1}{p_2} = \frac{n_1}{n_2} \cdot \frac{T_1}{T_2}$

$n_2 = \frac{p_2\, n_1\, T_1}{p_1\, T_2}$



$\ln \frac{p_2}{p_1} = -\frac{\Delta H_{izp}}{R} \cdot \left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

p_1 = 1 atm; T_2 = 293,15 K; T_1 = 373,15 K

$n_2 = \underline{0{,}029\ mol}$

$p_2 = p_1 \cdot e^{-\frac{\Delta H_{izp}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)} =$

$p_2 = \underline{0{,}023\ atm}$

$n(H_2O_2) = n_1 - n_2 = \underline{0{,}971\ mol}$

$m(H_2O_2) = n \cdot M = 0{,}971\ mol \cdot 18{,}02\ g/mol =$

$= \underline{17{,}5\ g}$

Normalno tališče bizmuta je 271,3 °C. $\Delta_{tal} H_{sp}$ je 52,8 J/g. Gostota trdnega bizmuta je 9,673 g/mL, gostota tekočega bizmuta pa 10,00 g/mL. Kolikšna je temperatura tališča pri tlaku 100 atm?

$T_1 = 271{,}3\,°C$

$p_1 = 1\,atm$

$\Delta_{tal} H_{sp} = 52{,}8\,J/g$

$\rho(s) = 9{,}673\,g/mL$

$\rho(l) = 10{,}00\,g/mL$

$p_2 = 100\,atm$

$T_{tal} = ?$

$$\frac{dp}{dT} = \frac{\Delta_{tal} H_m}{T \cdot \Delta V_m}$$

$$\int_{p_1}^{p_2} dp = \frac{\Delta_{tal} H_m}{\Delta V_m} \int_{T_1}^{T_2} \frac{dT}{T}$$

$$p_2 - p_1 = \frac{\Delta_{tal} H_m}{\Delta V_m} \ln \frac{T_2}{T_1}$$

$$p_2 - p_1 = \frac{\Delta_{tal} H_{spec}}{\Delta V_{spec}} \ln \frac{T_2}{T_1}$$

$$V_{spec} = \frac{V}{m} = \frac{V}{\rho \cdot V} = \frac{1}{\rho}$$

$$\Delta V_{sp} = V_{sp(l)} - V_{sp(s)} = \frac{1}{\rho_{(l)}} - \frac{1}{\rho_{(s)}} = -3{,}38 \cdot 10^{-3}\ mL/g$$

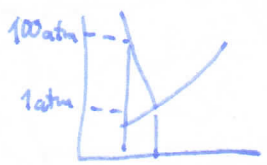
$$T_2 = T_1 \, e^{\frac{(p_2 - p_1)\,\Delta_{tal} V_{sp}}{\Delta_{tal} H_{sp}}}$$

$p_2 - p_1 = 99\,atm = 99 \cdot 1{,}013 \cdot 10^5\,Pa$

$T_2 = 544{,}10\,K = 270{,}95\,°C$

$\Delta_{tal} V_{sp} = -3{,}38 \cdot 10^{-3} \cdot 10^{-6}\ m^3/g$

$\Delta T = -0{,}35\,K$ zaradi negativnega naklona talilne krivulje:



$$\frac{dp}{dT} = \frac{k}{-2{,}869 \cdot 10^7\ \frac{Pa}{K}}$$ (iz podatkov)

$$dp = k \cdot dT$$

$$\Delta p = k \cdot \Delta T$$

$$\Delta T = \frac{\Delta p}{k} = \frac{99 \cdot 1{,}013 \cdot 10^5\,Pa\ K}{-2{,}869 \cdot 10^7\,Pa}$$

Imamo benzen ($M = 78\ g/mol$). Pri tlaku 1 atm benzen zmrzne pri 5,5 °C. Gostota se spremeni iz $0,879\ g/cm^3$ na $0,891\ g/cm^3$. Kolikšna bi bila T zmrzlišča pri tlaku 1000 atm?

$\Delta tal H_m = 10,5\ kJ/mol$

Rezultat: $T_2 = 281,85\ K = 8,7\ °C$

Parni tlak 2,2-dimetilbutanda je podan z $\ln\left(\frac{p}{torr}\right) = -\frac{11166}{T} - 14,701 \cdot \ln\left(\frac{T}{K}\right) + 122,31$

$\Delta_{izp}H_m = f(T) = ?$

$T_1 = 25\ °C$

$T_2 = 136,7\ °C$ pri normalnem vrelišču

$$\boxed{\frac{d \ln p}{dT} = \frac{\Delta_{izp} H_m}{RT^2}}$$

to enačbo uporabimo, ko nimamo predpostavke, da je $\Delta_{izp}H_m$ konstanta

$$\Delta_{izp} H_m = RT^2 \cdot \frac{d \ln p}{dT} = RT^2 \cdot \left(\frac{11166}{T^2} - \frac{14,701}{T}\right) =$$

$$\underline{\Delta_{izp} H_m = R\left(11166 - 14,701 \cdot T\right)} \quad \text{funkcija T-ja}$$

$\Delta_{izp} H_m(T_1) = 56,4\ kJ/mol$

$\Delta_{izp} H_m(T_2) = 42,7\ kJ/mol$

Pri 35 °C je parni tlak Et-OH 100,0 torr. Kolikšen bo parni tlak, če nadaljnji uvedemo Ar s parnim tlakom 100 bar.? Gostota tekočega etanola je 0,7767 g/l.

p_0 ... parni tlak Et-OH brez Ar

Δp ... parni tlak Ar

$$p = p_0 \cdot e^{\frac{V_m \cdot \Delta p}{RT}}$$

$$V_m = \frac{M}{\rho}$$

$$p = p_0 \cdot e^{\frac{M \cdot \Delta p}{\rho RT}} =$$

$$= 100,0\ torr \cdot e^{\frac{46\ g/mol \cdot 100 \cdot 10^5\ Pa\ m^3\ K\ mol}{0,7767 \cdot 10^{-6}\ g\ 8,314\ J \cdot 308,15\ K}} =$$

$$\underline{p = 126\ torr}$$

$p = 100,2$ torr, če uvedemo vodo s parnim tlakom 1 bar (g)

Kolikšen je parni tlak vode pri 100 °C? Trojna točka: 0,01 °C in tlak 0,00603 atm

$\Delta_{izp}H_m = 40656\ J/mol$

$$\ln\frac{p_2}{p_1} = -\frac{\Delta_{izp}H_m}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$p_2 = p_3$, $T_2 = 100\,°C$, $T_1 = T_3$

Izračunamo 0,731 atm, saj imamo širok interval => enačba predpostavlja konst. $\Delta_{izp}H_m$

Imamo 1 mol H_2O. Temperatura je zaradi ravnotežja tosej 0 °C in 1 atm oz. ravno obratno.

$H_2O(l) \rightleftharpoons H_2O(s)$ Izračunaj $\Delta U, \Delta H, \Delta G, \Delta S, w, q$!

$\Delta_{tal}H_m = 6{,}008\ kJ/mol$

Ker je vzpostavljeno ravnotežje => $\Delta G = 0$

$$\Delta H = n \cdot \Delta_{tal}H_m = n \cdot (-\Delta_{tal}H_m) = -6{,}008\ kJ$$

$$\Delta U = \Delta(H - pV) = \Delta H - \Delta(pV) = \Delta H - p\Delta V = \Delta H$$

$\Delta H \gg p\Delta V$

$\Delta S \geq \frac{q}{T}$ ravnotežje =>

$$\Delta S = \frac{q}{T} \xrightarrow{p=konst} \Delta S = \frac{\Delta H}{T} = \frac{-6{,}008\ kJ}{273{,}15\ K} = -22{,}0\ J/K$$

$q = \Delta H$

$$w = -p\cdot\Delta V = -p\cdot(V_{(s)} - V_{(l)}) = -0{,}17\ J$$

$p = 1{,}013\cdot10^5\ Pa$