Fazno ravnotežje

Odon Planinšek

Fazno pravilo

Fazo definiramo kot homogeno fizikalno različno in mehansko ločljivo količino sistema. Primeri so plini, čista topila (taline), trdne snovi in raztopine.

Ravnotežje je stanje mirovanja sistema

$$\left.\begin{array}{l}T\text{(temperatura)}\\ P\text{(tlak)}\\ x\text{(sestava)}\end{array}\right\rangle \quad \text{Konst.}$$

Fazno pravilo

Primer: NaCl in voda

Topnost NaCl pri 30℃ v vodi je 36,1 g v 100 g vode

Število faz enako 3-trdni NaCl, vodna raztopina in para

Komponenti sta dve: NaCl in H_2O

Število komponent je najmanjše število snovi (sestavin) s katerimi lahko opišemo sestavo posamezne faze.

Fazno pravilo

P+F=C-2

P-faza
F-prostostna stopnja
C-komponenta

Ločujemo
-enokomponentne sisteme
-dvokomponentne sisteme
-večkomponentne sisteme

F=0 nonvariantni sistem, vse je določeno
F=1 monovariantni sistem
F=2 divariantni sistem

Fazno pravilo

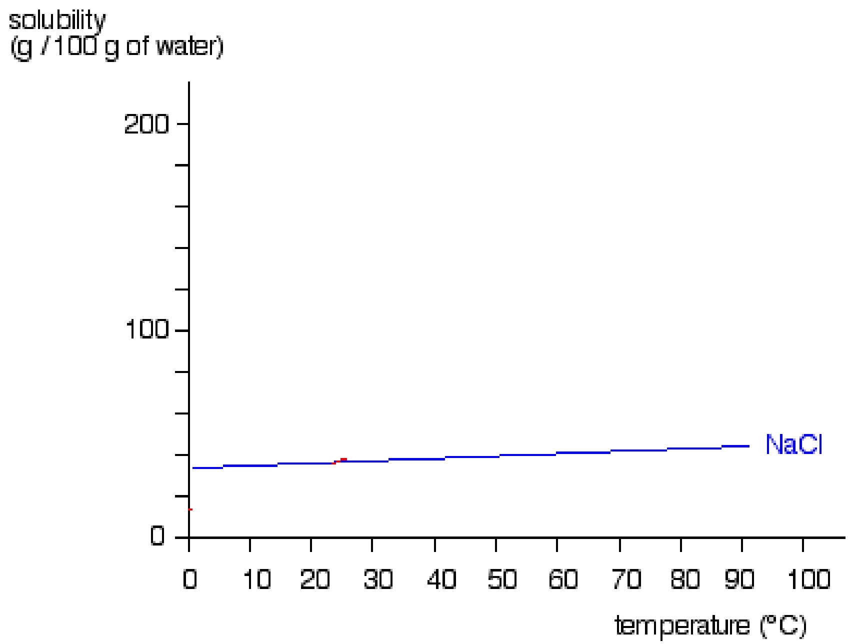
$$P+F=C+2$$

Primer:
Enokomponentni sistem (voda), tri faze (para, tekoča voda, led)

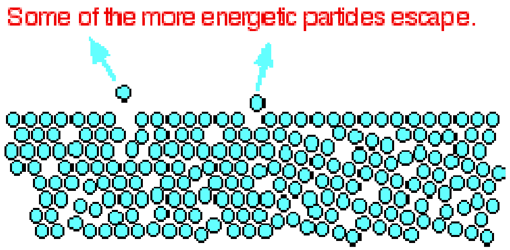
F=1+2-3=0

Primer:
Dvokomponentni sistem (NaCl, voda), tri faze (trdno, tekoče, plinasto)

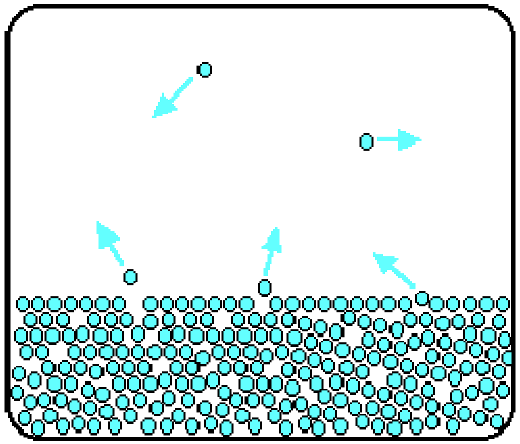
F=2+2-3=1



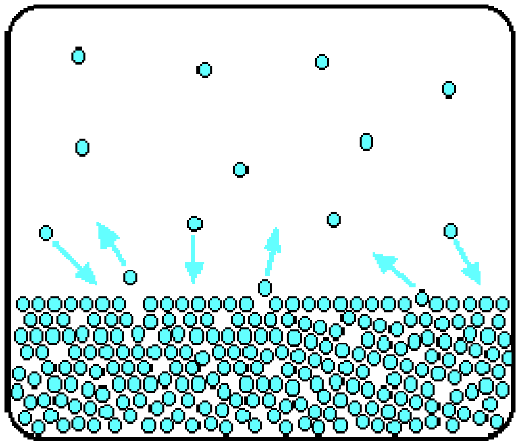
Nasičen parni tlak



Izhlapevanje v odprti posodi

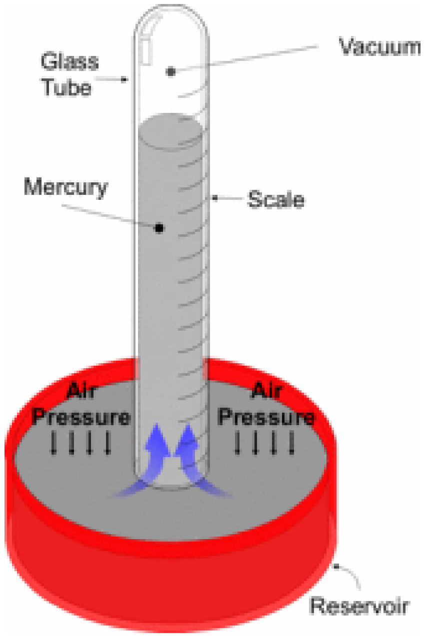


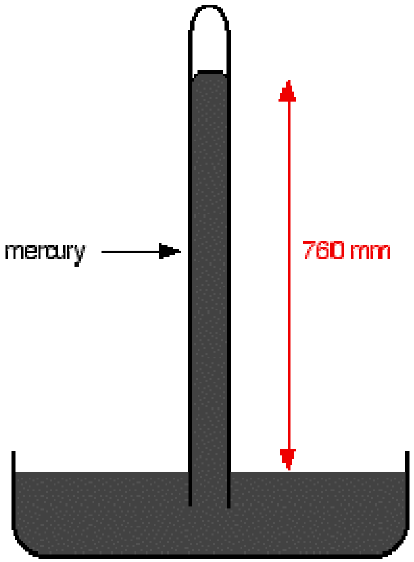
Izhlapevanje v zaprti posodi

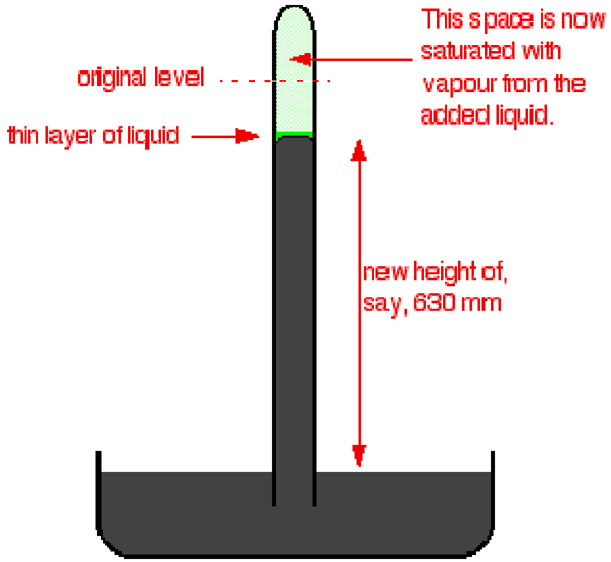


Ravnotežje

Merjenje nasičenega parnega tlaka



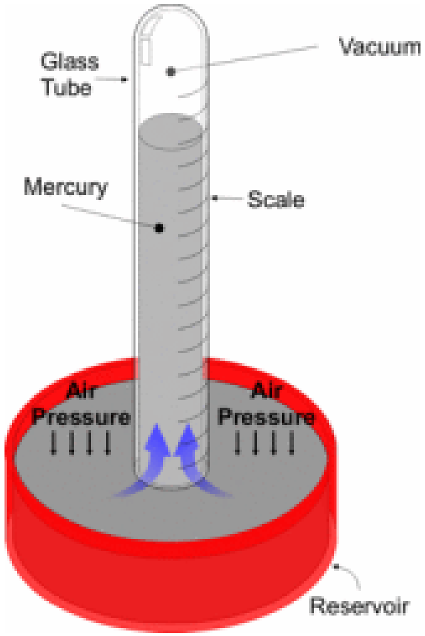




Dvig Hg v cevi

Tlak vodne pare
v zaprtem delu cevi

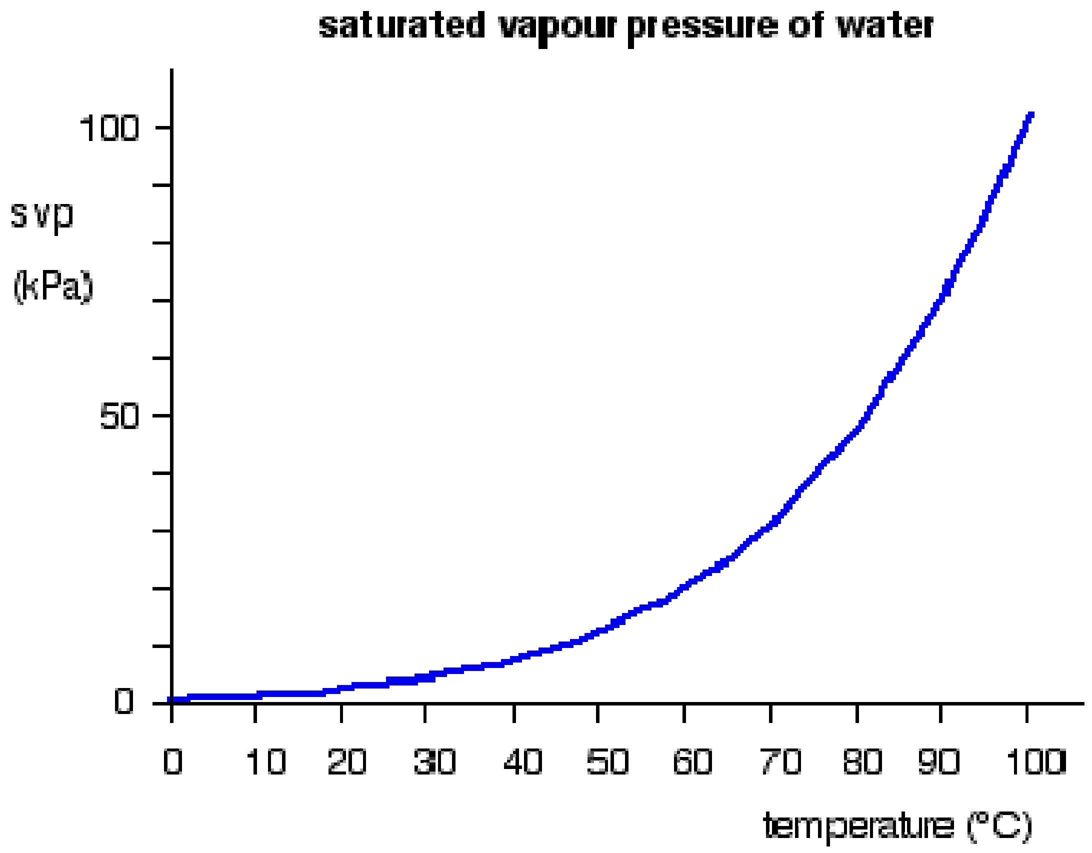
Merjenje nasičenega parnega tlaka



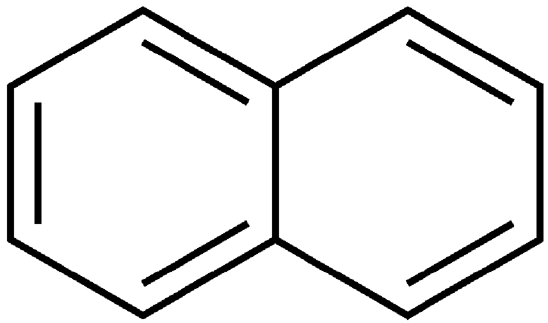
Elementary mercury occurs naturally and is present in the atmosphere. **The vapour pressure of Hg is 0.001201 mmHg at 20 °C**, and the solubility of Hg in water is about 20 mg dm-3.

Pure & ***Appl. Chem.,*** Vol. **70,** No. 8, **pp.** 1585-1615, 1998
THE DETERMINATION OF MERCURY SPECIES IN ENVIRONMENTAL AND BIOLOGICAL SAMPLES
MASATOSHI MORITA", JUN YOYOSHINAGA" AND JOHN ***S .*** EDMONDST

Vpliv temperature na parni tlak



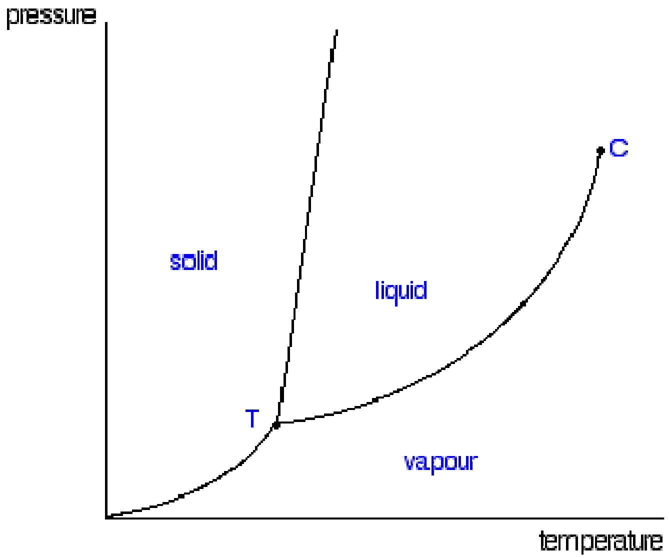
Nasičen parni tlak in trdne snovi

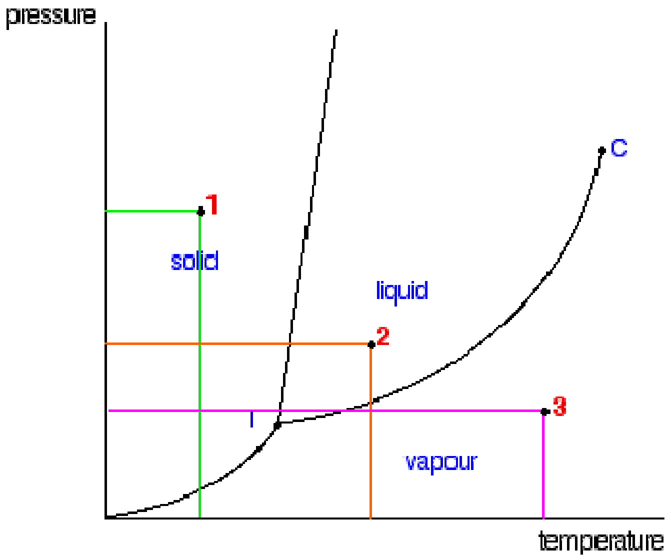


Naftalen (tališče 78°C)

SUBLIMACIJA

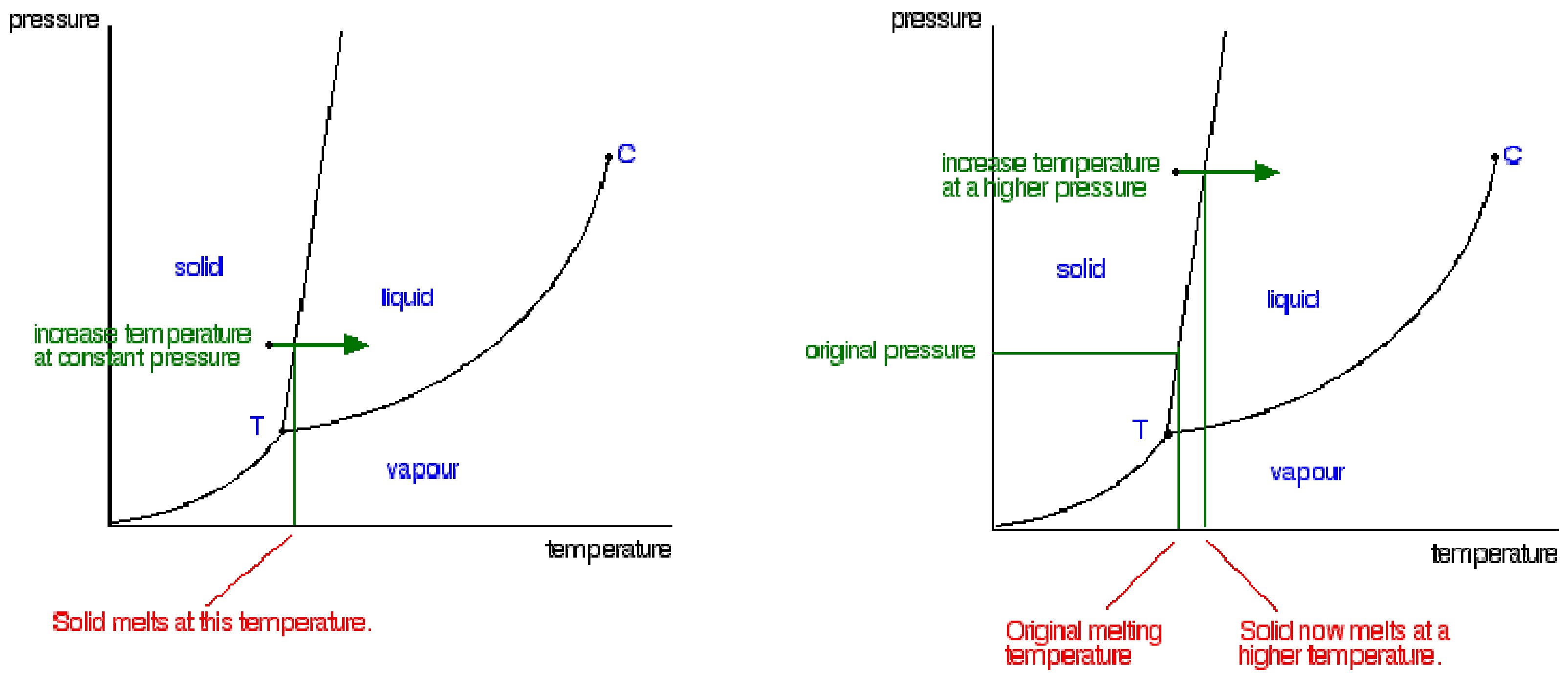
Fazni diagrami čistih snovi





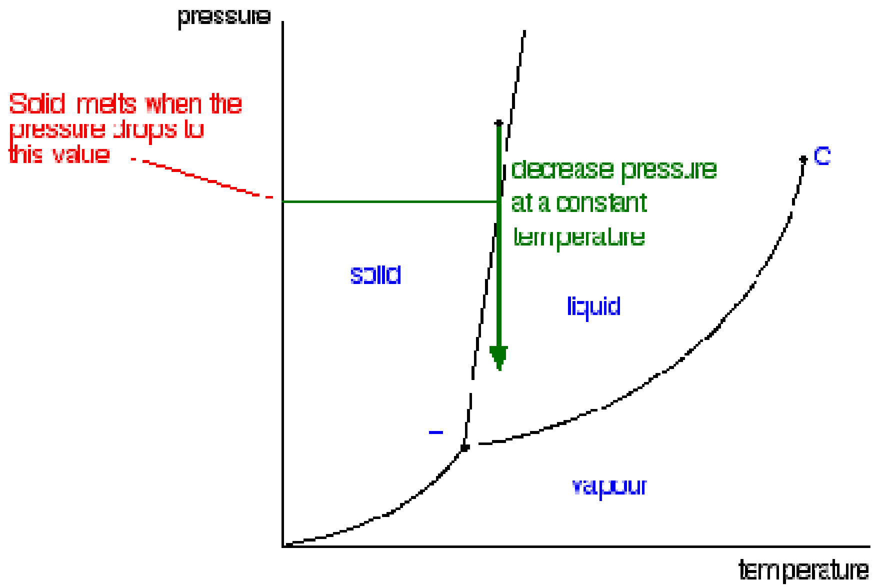
Fazni diagram snovi

Fazni diagrami čistih snovi



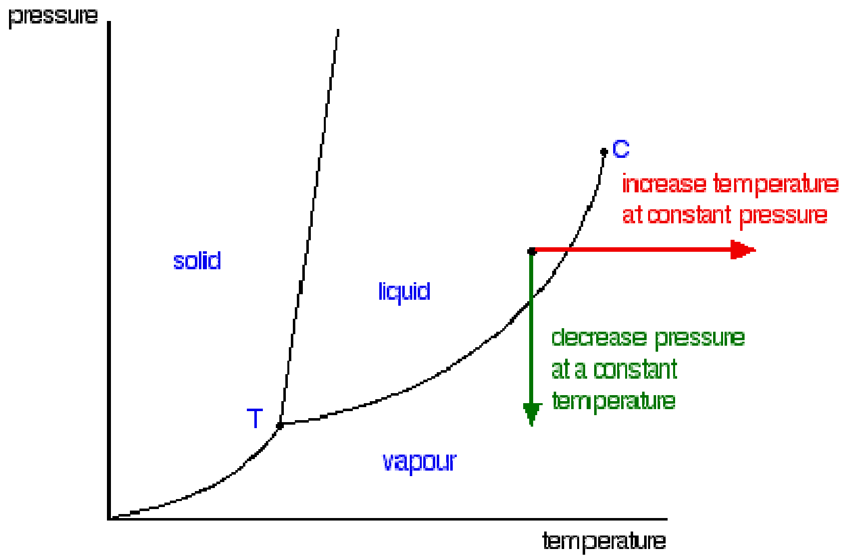
Prehod trdna snov-tekočina s spremembo temperature

Fazni diagrami čistih snovi



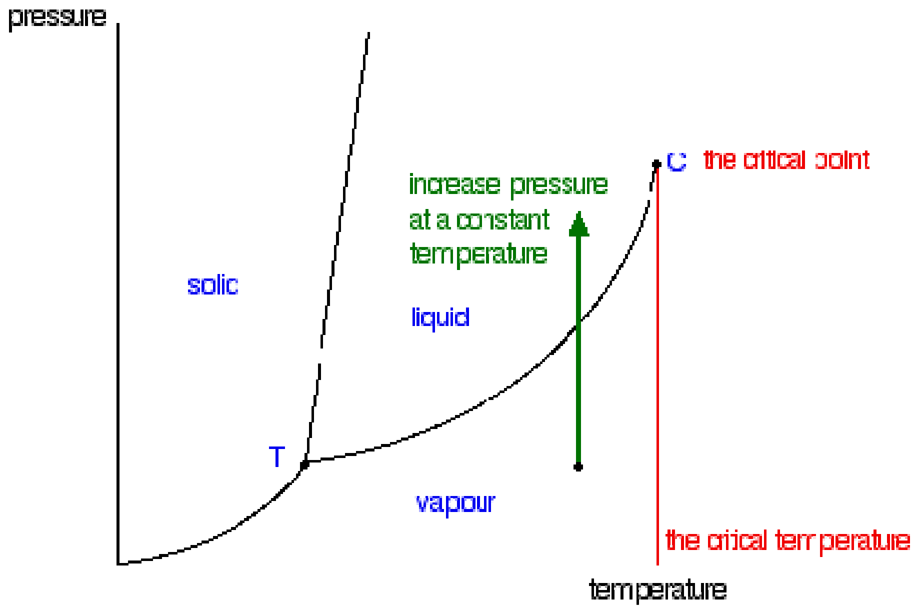
Prehod trdna snov-tekočina s spremembo tlaka

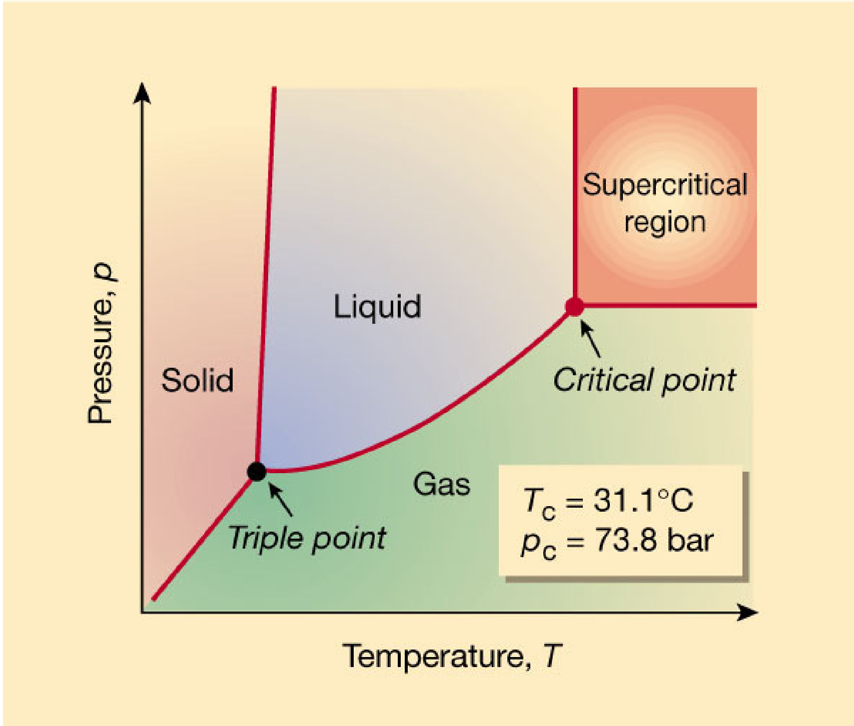
Fazni diagrami čistih snovi



Prehod trdna snov tekočina-para

Fazni diagrami čistih snovi

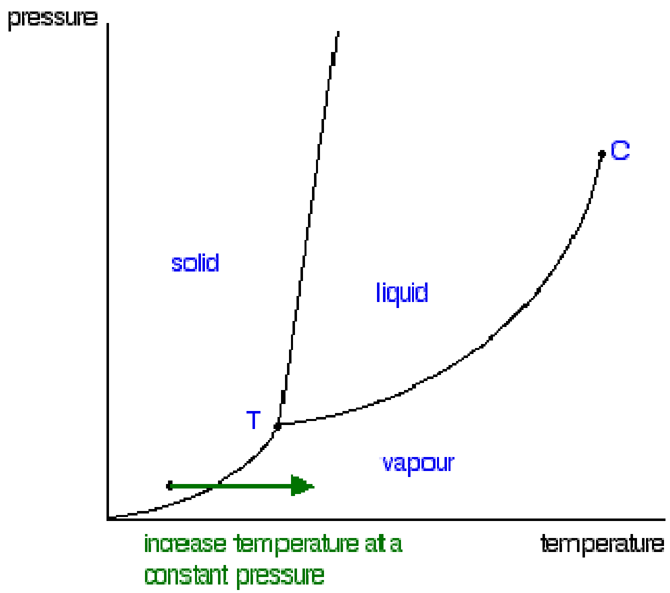




Kritična točka

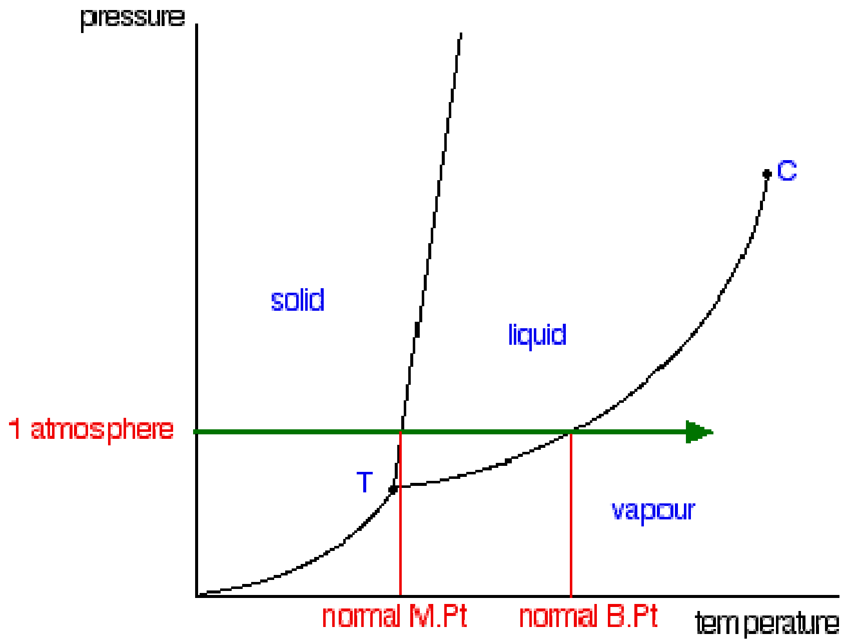
Fazni diagram CO2-superkritični fluid

Fazni diagrami čistih snovi



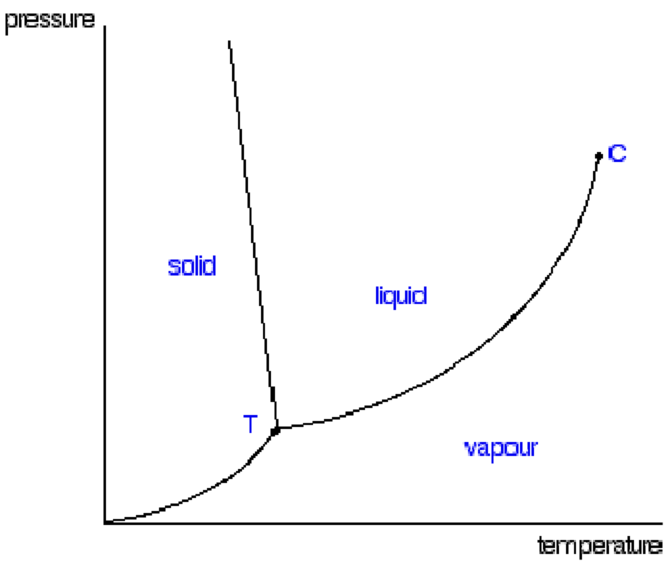
Prehod trdna snov para in trojna točka
Liofilizacija http://www.youtube.com/watch?v=ORI8PrcrLVs

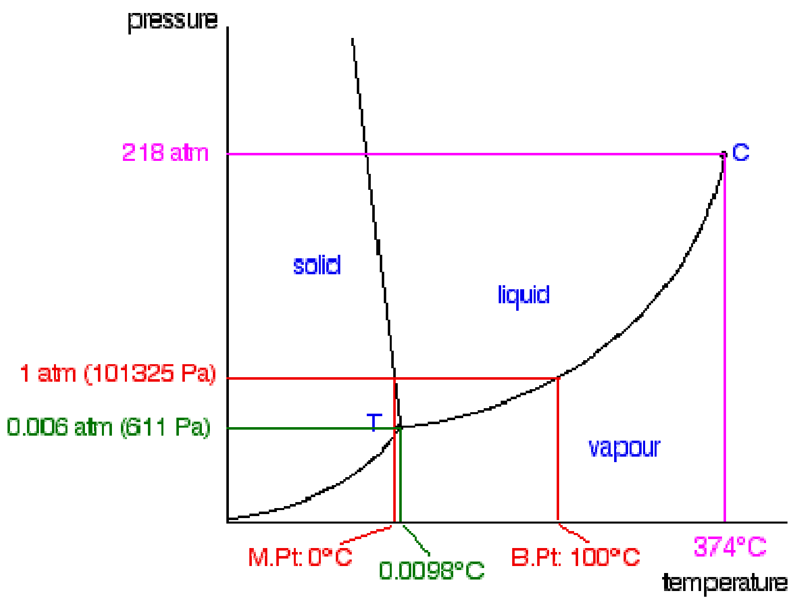
Fazni diagrami čistih snovi



Fazni prehodi pri normalnem tlaku

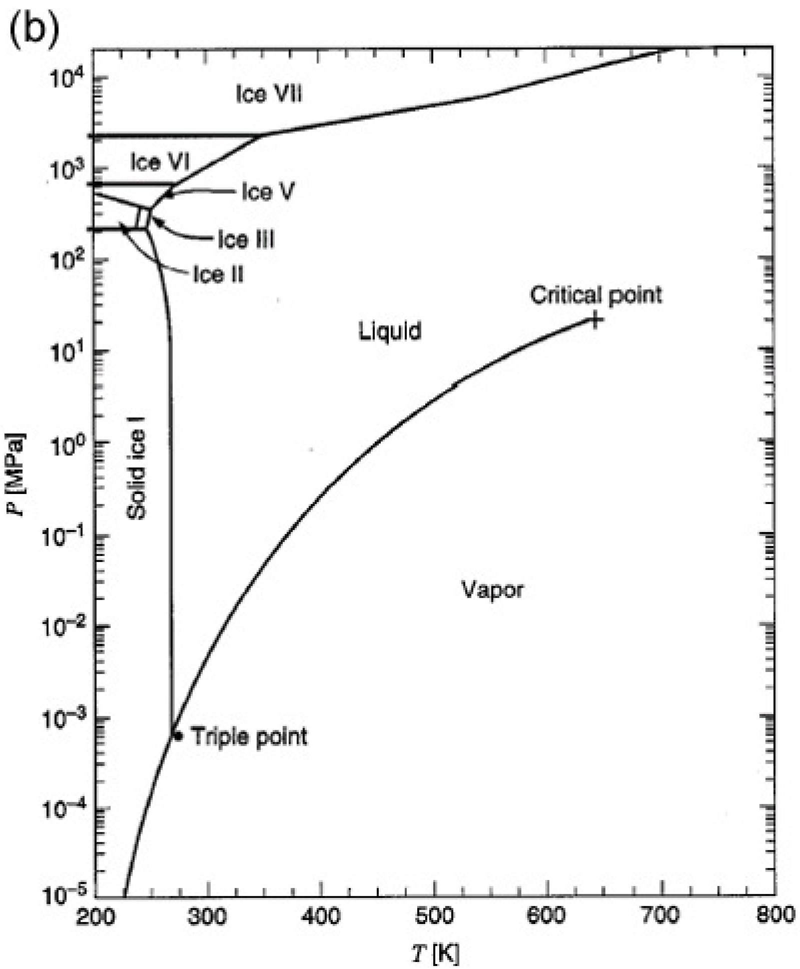
Fazni diagram vode





Gostota ledu je manjša od gostote tekoče vode

Fazni diagram vode



http://www.lsbu.ac.uk/water/sitemap.html

Fazni diagram vode

It is commonly thought that ice skating is possible because of pressure melting; the pressure applied by the skate melts the ice below it, and the water film allows the blade to glide. That fact alone, however, cannot explain the slipperiness of ice; the answer involves not only frictional melting but also surface melting, which describes the natural state of the free surface of ice as being covered by a thin liquid film of water.

The current theory

So what is going on? The problem seems to have been solved in the late 1990s by a chemist, Gabor Somarjai, and a physicist, Michel Van Hove, of the Lawrence Berkeley National Laboratory in California, who studied the slipperiness of ice on an atomic scale.

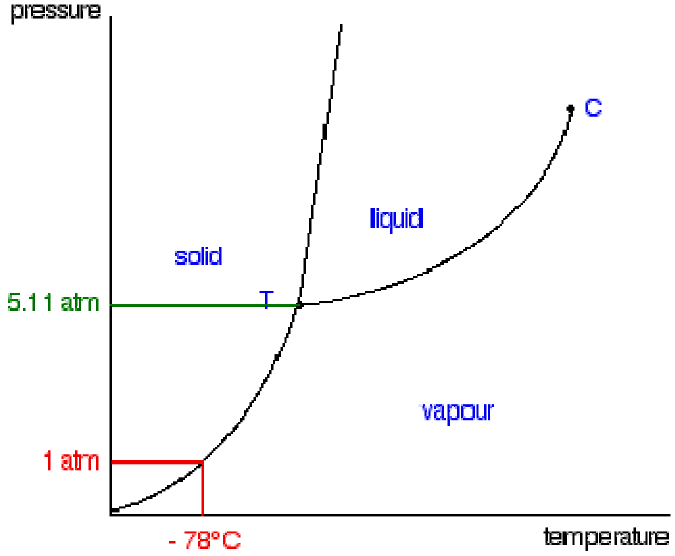
According to them, the ice itself is intrinsically slippery. You don't need to melt the ice to skate on it because the ice has a 'quasi-fluid layer' that coats the surface and provides a permanent lubricant. When pressure is applied, the molecules in the layer compact into underlying interstices, or spaces in the ice structure, and create a smooth surface for easy gliding.

The 'quasi-fluid layer' is not actually liquid water but ice molecules vibrating very rapidly. The ice molecules have an unusually high degree of vibrational motion, several times that of the molecules deeper in the bulk of the ice. But importantly it is only in one direction, up and down. If the atoms moved from side to side, the 'quasi-fluid layer' would literally become liquid (which is what happens above 0°C).

Drsanje http://www.thermablade.com/en/about/index.php

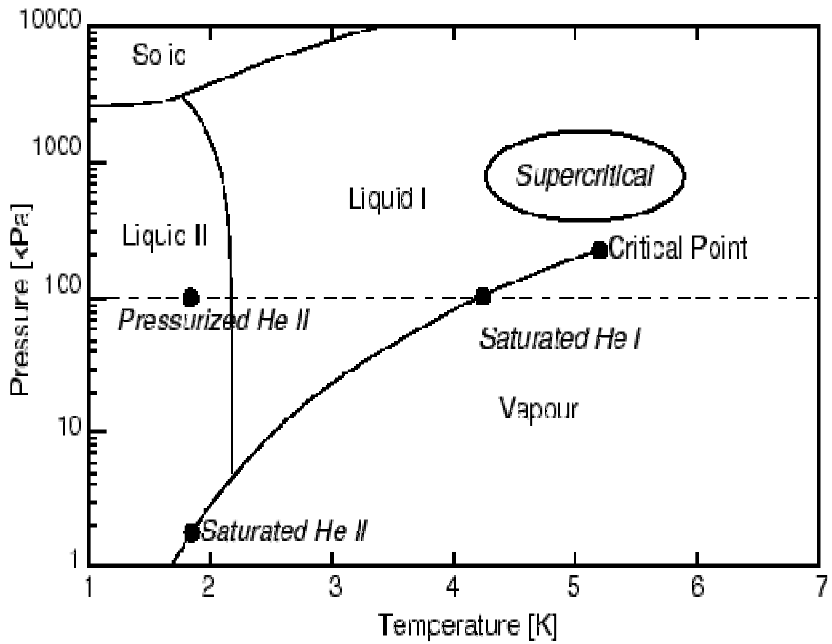
Taljenje ledu pri povišanem tlaku http://www.youtube.com/watch?v=2mimXPID2OU

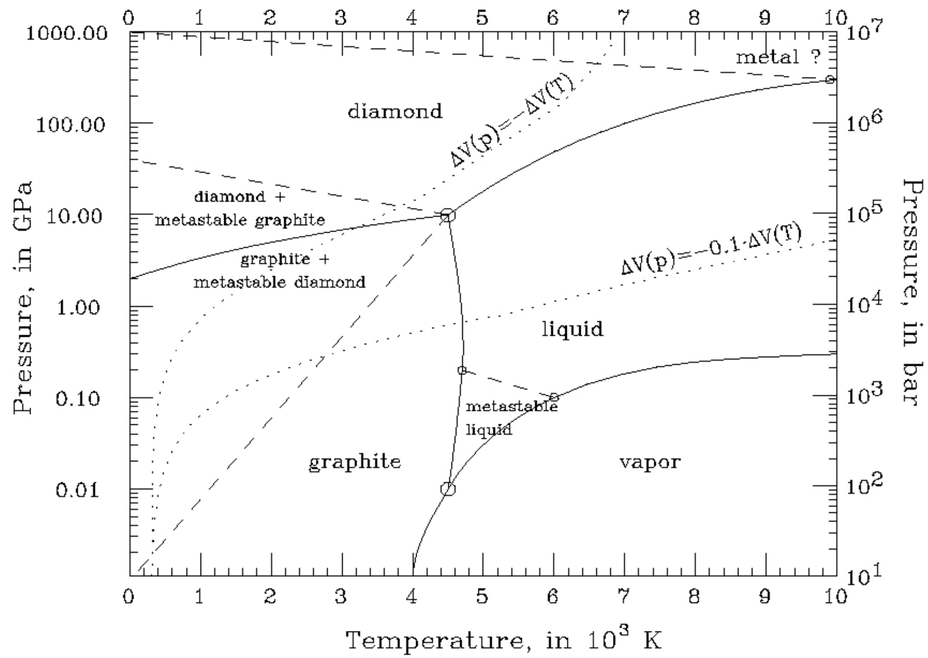
Fazni diagram CO_2



Suhi led

Fazni diagram He in C





Fazni diagram He

Fazni diagram C

Raultov zakon in raztopine z nehlapnim topljencem

Dvokomponentni sistem

$$p = x_{topilo} \cdot P^0_{topilo}$$

p=parni tlak raztopine

P^0_{topilo}=parni tlak čistega topila pri določeni temperaturi

X_{topilo}=molski delež topila

$$x_{topilo} = \frac{moli\ \ topila}{moli\ \ raztopine}$$

Primer

Raztopina vsebuje 10 molov vode in 0,1 mol sladkorja skupaj 10,1 mol raztopine

$$x_{voda} = \frac{10}{10{,}1} = 0{,}99$$

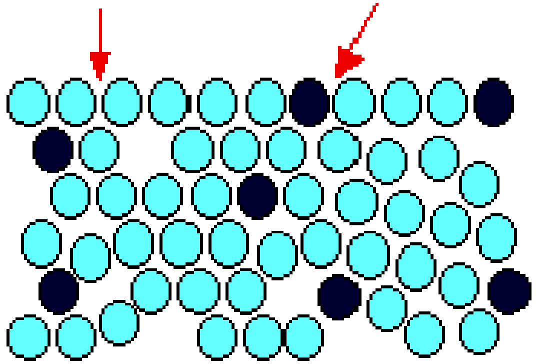
$$Na^+Cl^-_{(s)} \longrightarrow Na^+_{(aq)} + Cl^-_{(aq)}$$

1 mole of solid salt   2 moles of ions in solution

Omejitve Raultovega zakona

In an ideal solution, the forces between the solvent molecules . . .

. . . are exactly the same as those between solvent and solute.



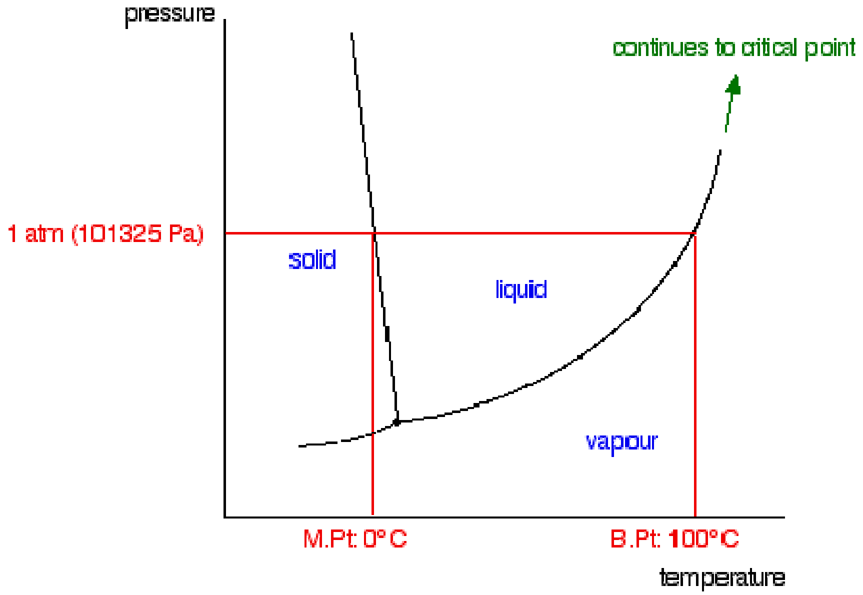
That means that it takes the same amount of energy for solvent molecules to break away from the surface in either case.

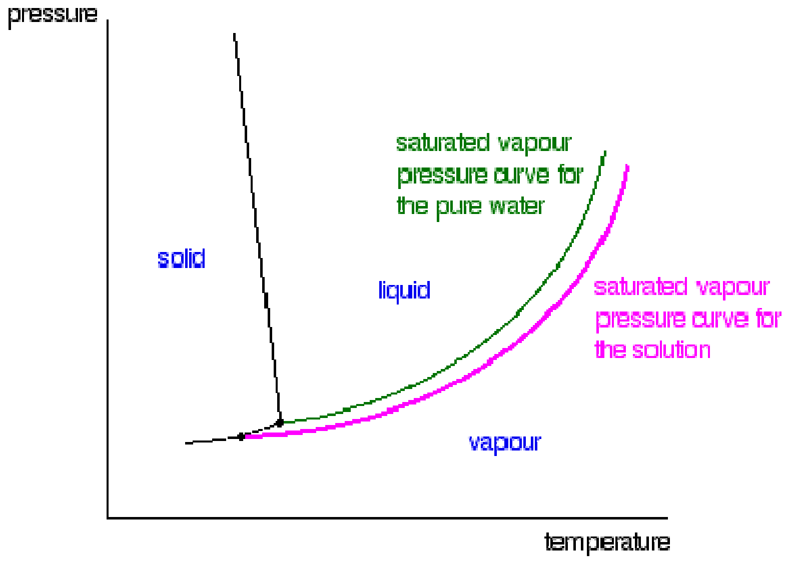
TABLE 1

Surface Tensions of Water and Electrolyte Solutions Determined Experimentally in Comparison with Literature Data

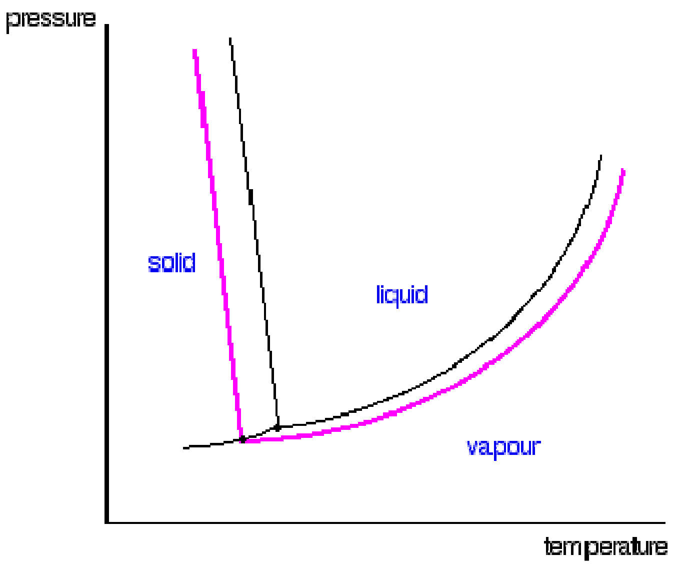
		γ_{lv} (mJ/m^2) This work	γ_{lv} (mJ/m^2) Literature data
H_2O		72.0 ± 0.02	72.37 ± 0.03 [a]
KCl	0.1 mol/L	72.0 ± 0.2	72.6 [a]
	1.0 mol/L	73.1 ± 0.02	74.2 [a]
KI	0.1 mol/L	73.6 ± 0.6	72.64 [b]
	1.0 mol/L	74.4 ± 0.1	73.76 [b]
KNO_3	0.1 mol/L	72.8 ± 0.2	73.1 [c]
	1 mol/L	73.6 ± 0.02	—

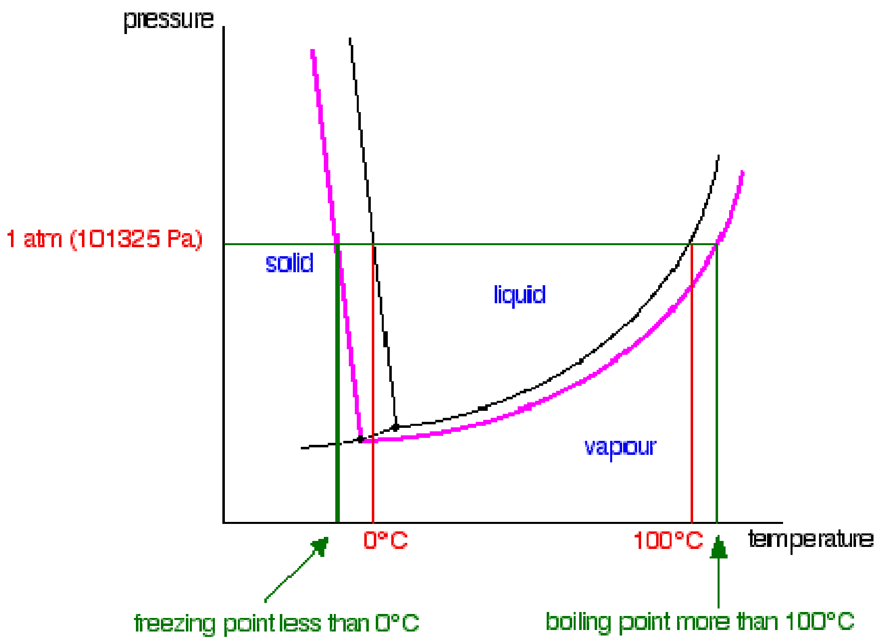
Raultov zakon, tališče in vrelišče





Raultov zakon, tališče in vrelišče

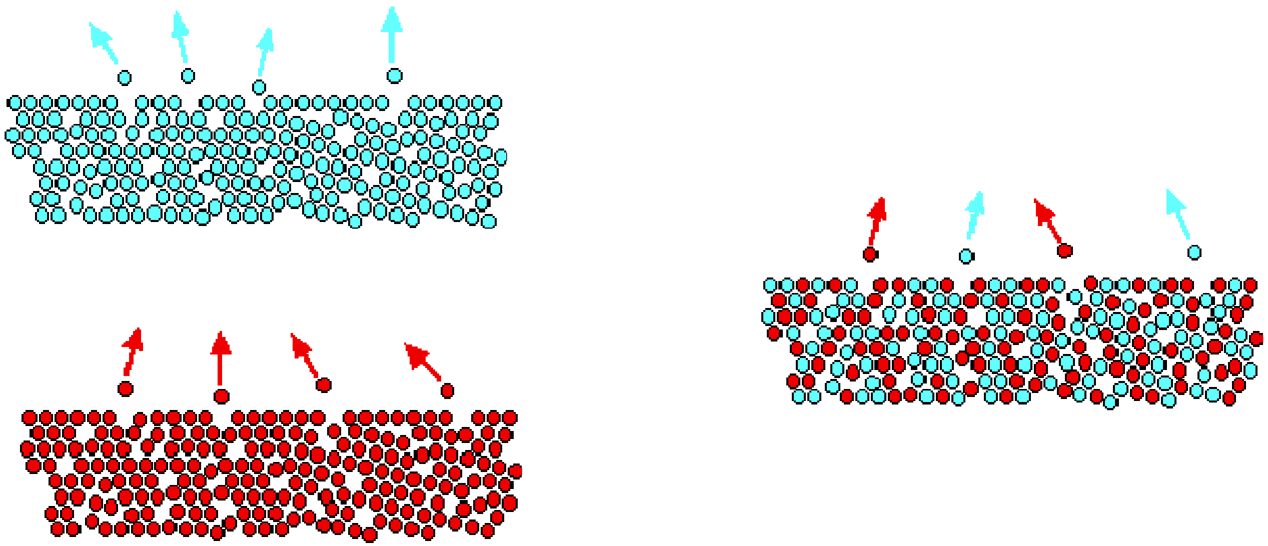




Raultov zakon in idealne zmesi tekočin

Dvokomponentni sistem

Heptan - heksan
Benzen – metilbenzen
Propan-1-ol – propan-2-ol



Raultov zakon in idealne zmesi tekočin

$$p_A = x_A \cdot P_A^0 \qquad p_B = x_B \cdot P_B^0$$

p_A, p_B=parcialni parni komponente A in B

$P^0_{A,B}$=parni tlak čistega topila A ali B pri določeni temperaturi

$X_{A,B}$=molski delež topila

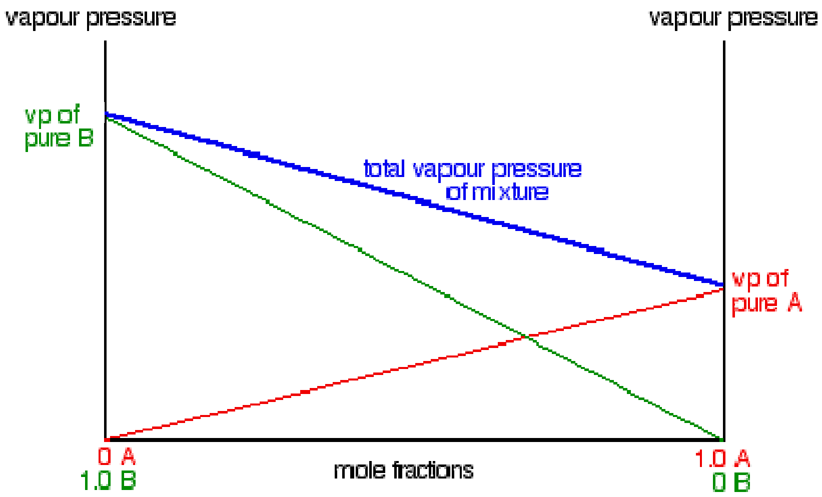
$$x_{A,B} = \frac{moli\ \ A,B}{moli\ \ raztopine}$$

Celokupni parni tlak = $p_A + p_b$

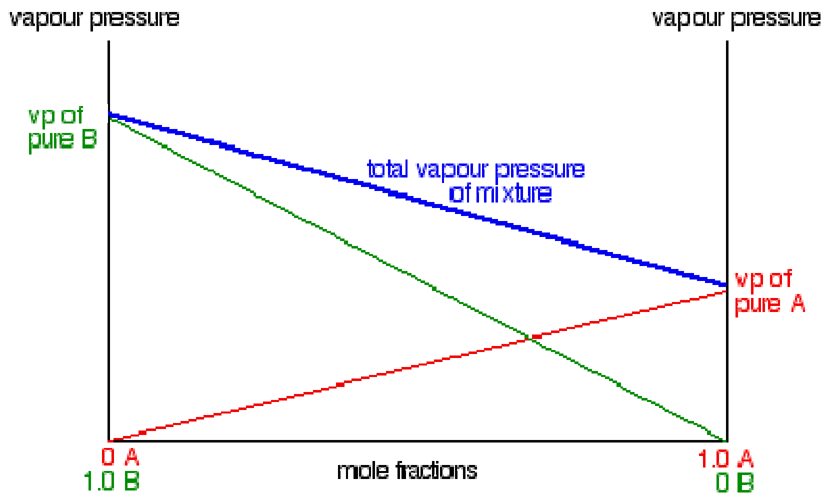
$Na^+Cl^-_{(s)} \longrightarrow Na^+_{(aq)} + Cl^-_{(aq)}$

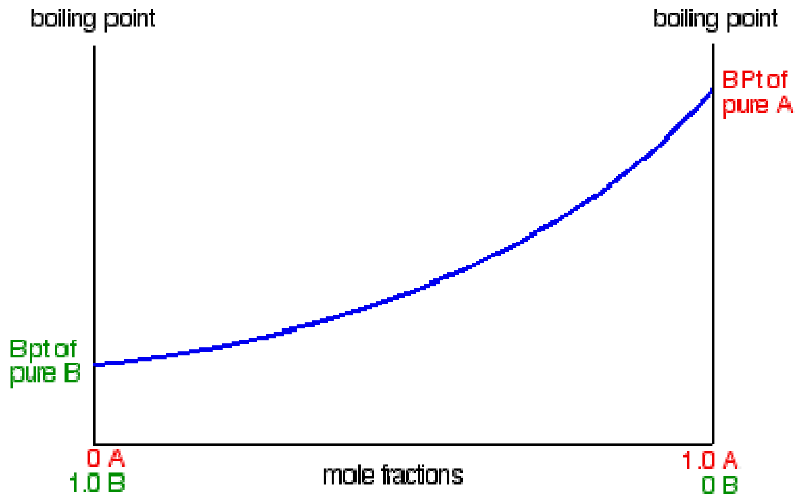
1 mole of solid salt — 2 moles of ions in solution

Raultov zakon in idealne zmesi tekočin

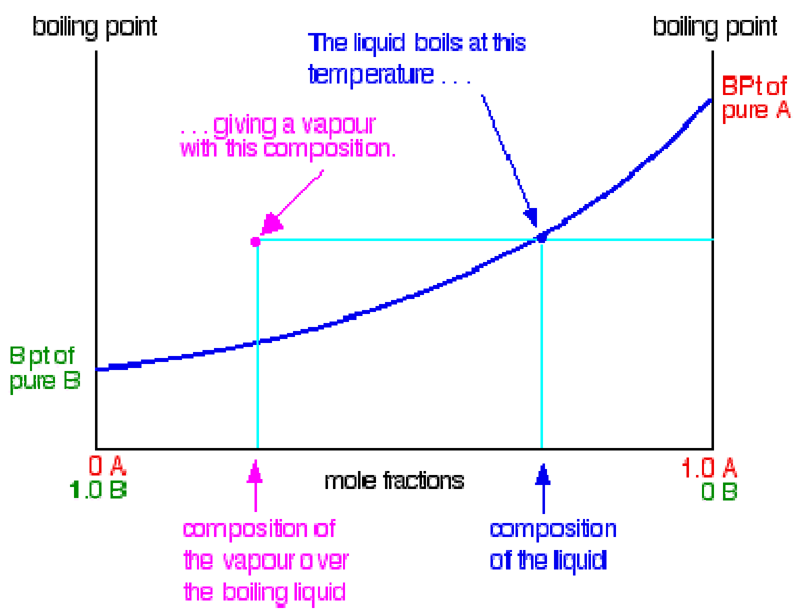


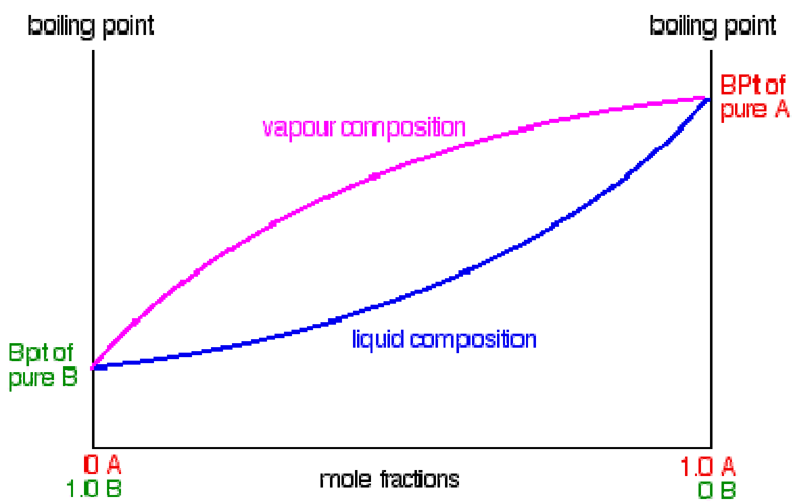
Povezava med vreliščem in parnim tlakom



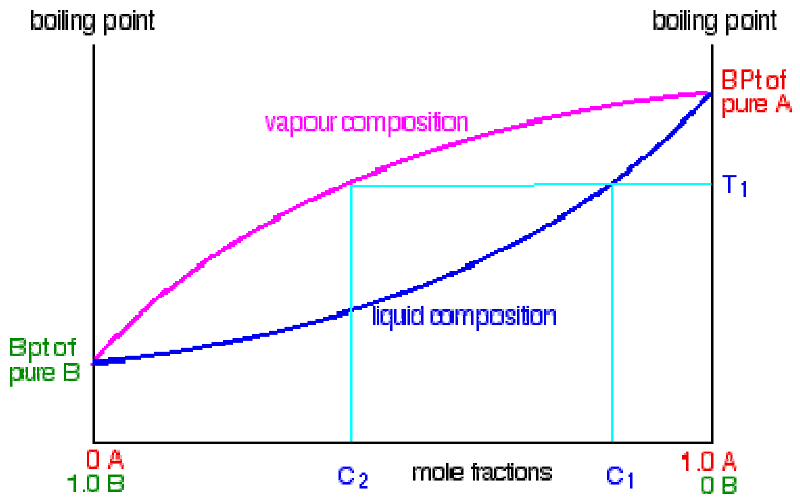


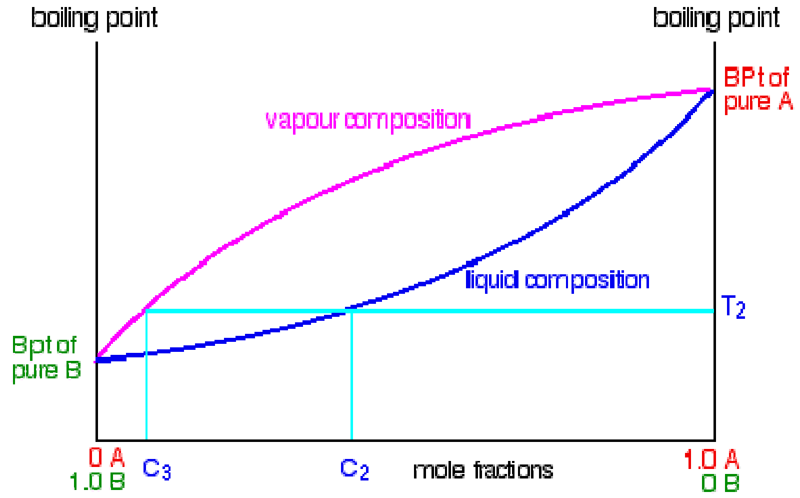
Povezava med vreliščem in parnim tlakom



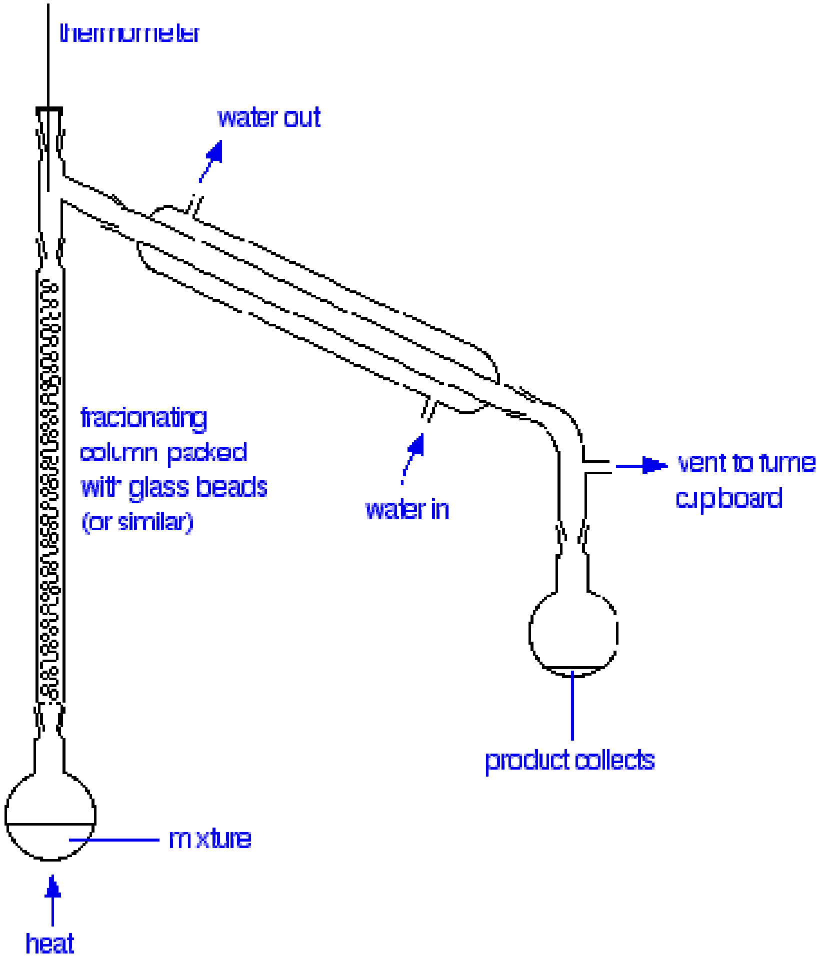


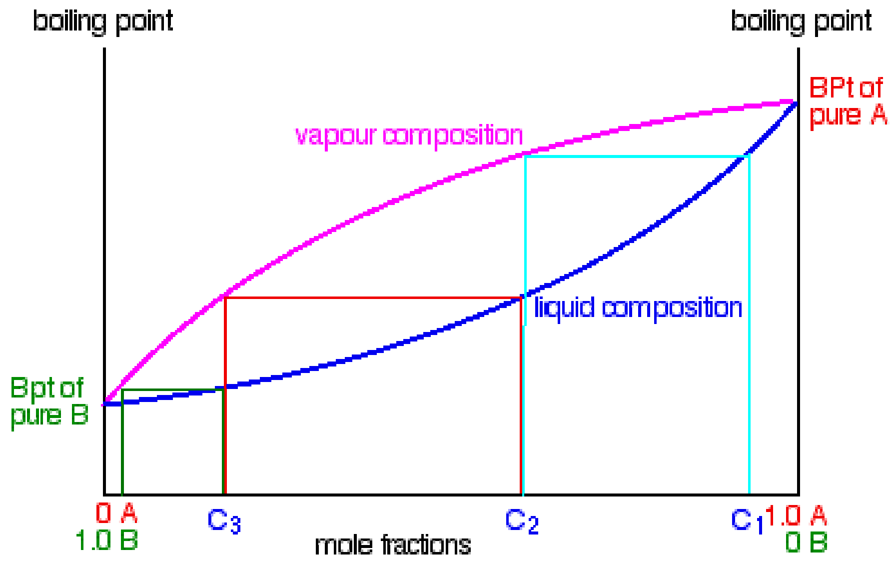
Povezava med vreliščem in parnim tlakom





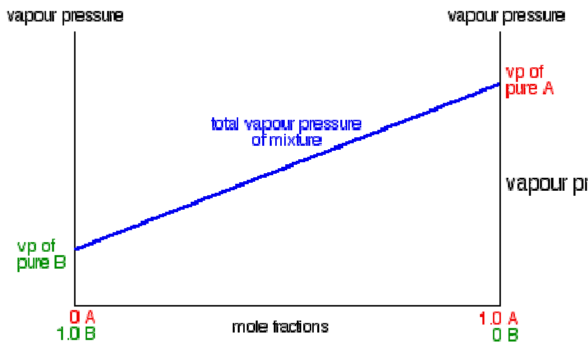
Frakcionirana destilacija v laboratoriju



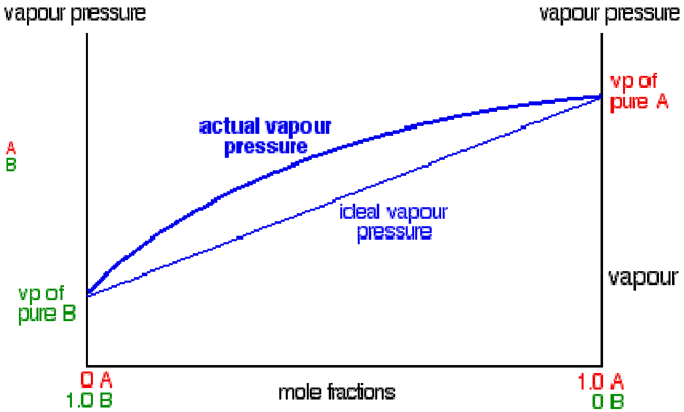


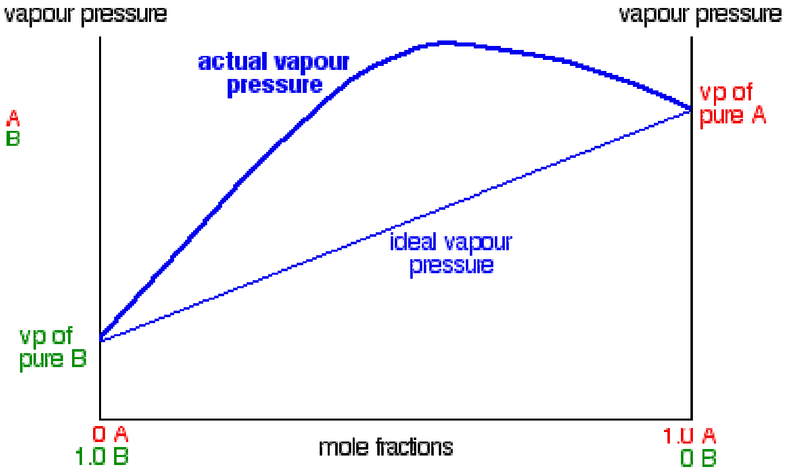
Frakcionirana destilacija v laboratoriju

Neidealne zmesi tekočin



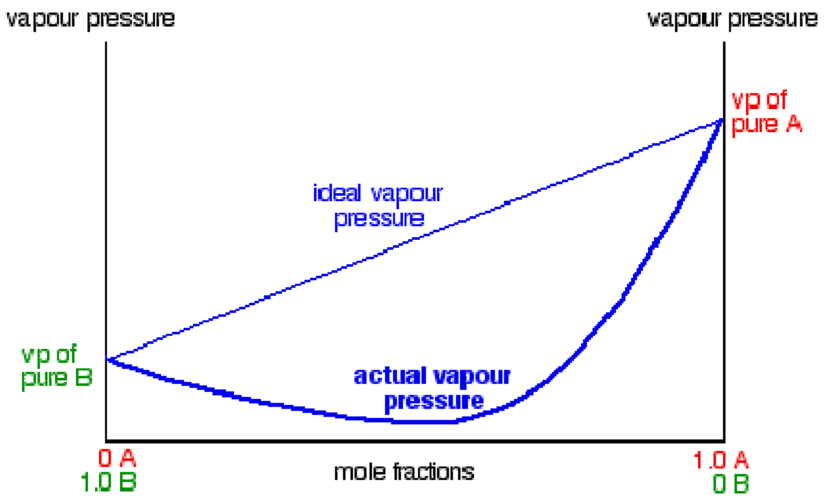
Pozitiven odklon od Raultovega zakona





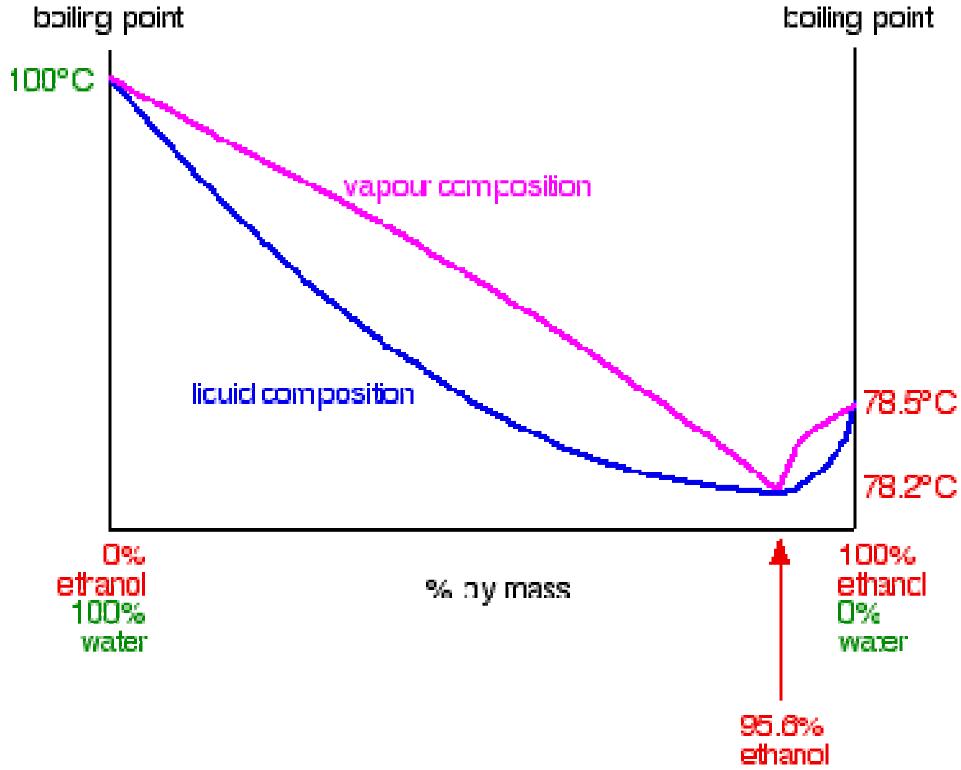
Neidealne zmesi tekočin

Negativen odklon od Raultovega zakona

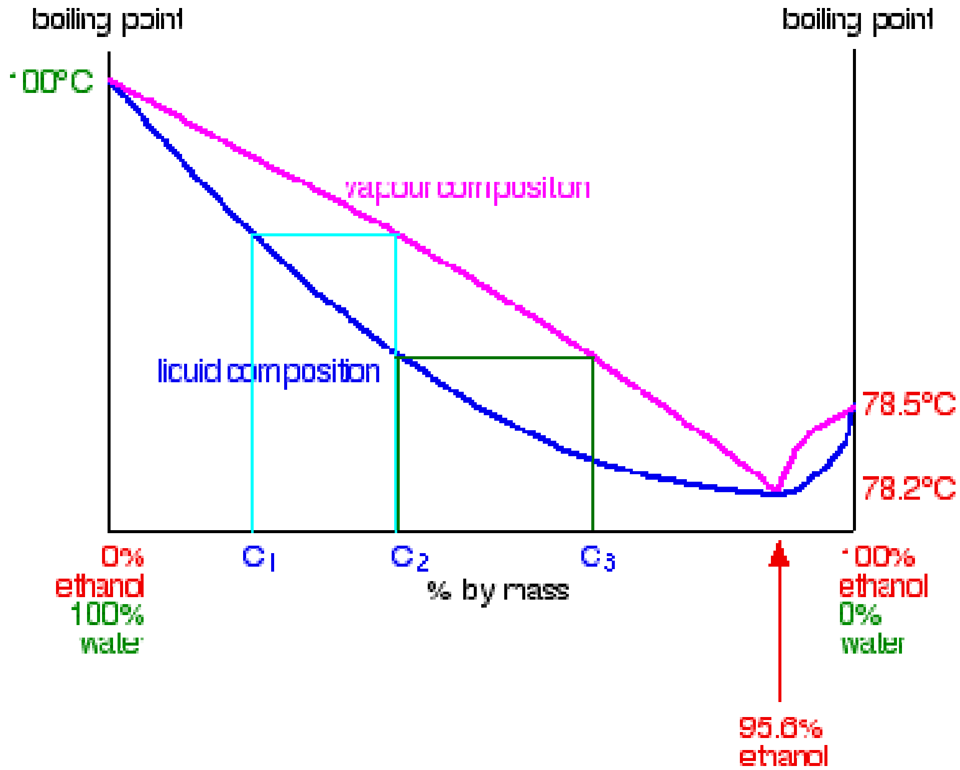


$$H_2O_{(l)} + HNO_{3(l)} \rightleftharpoons H_3O^+_{(aq)} + NO_3^-{}_{(aq)}$$

Neidealne zmesi tekočin
-fazni diagram zmesi etanol-voda



Neidealne zmesi tekočin
-fazni diagram zmesi etanol-voda



Kaj se zgodi če destiliramo zmes, ki vsebuje več kot 96,5% etanola

Neidealne zmesi tekočin
-fazni diagram zmesi toluol-voda

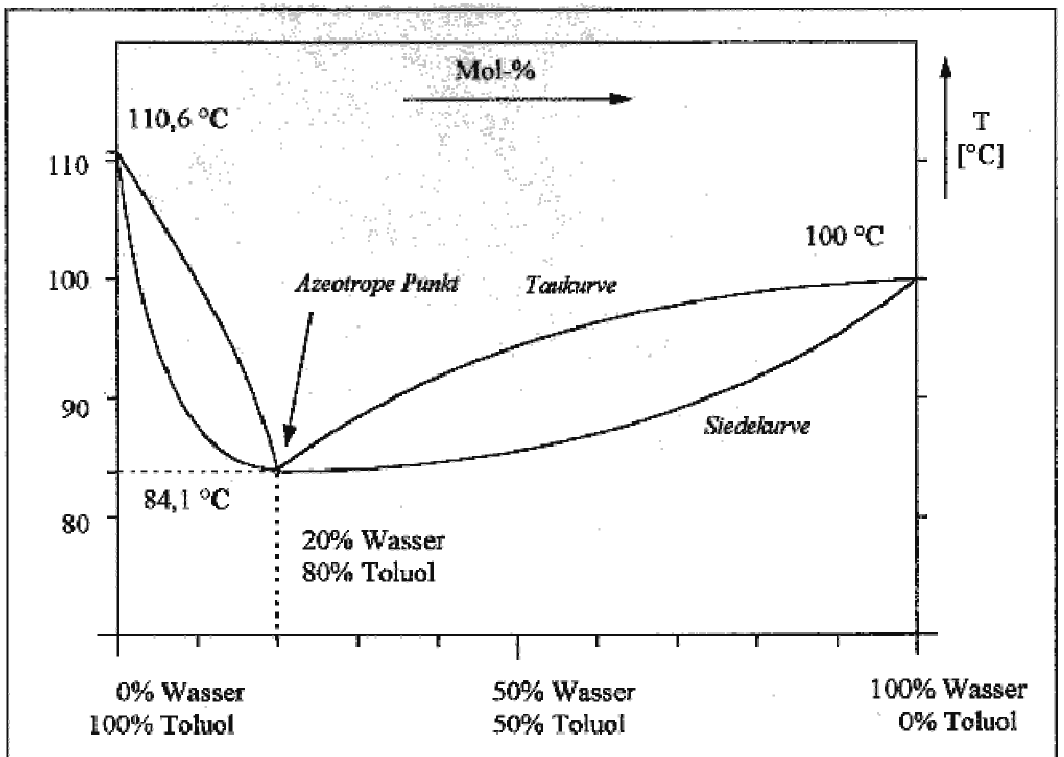
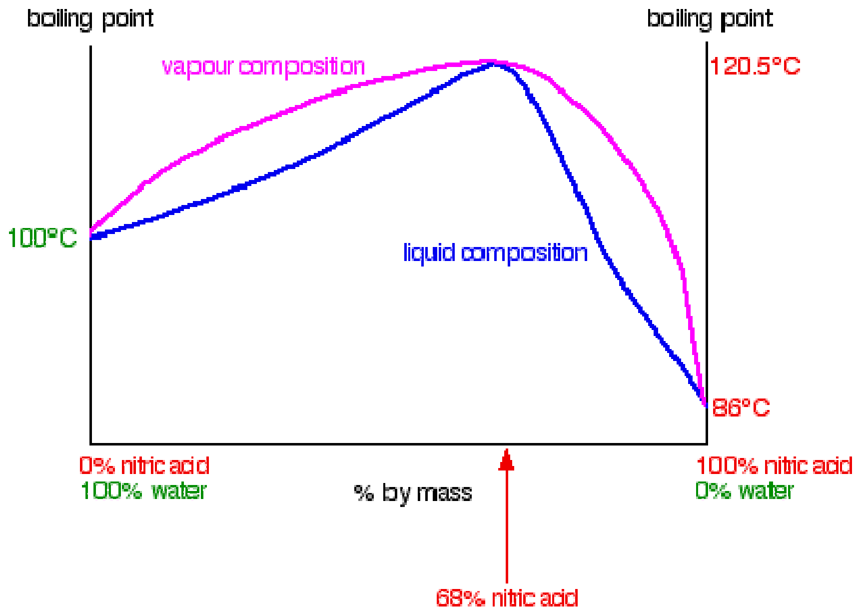
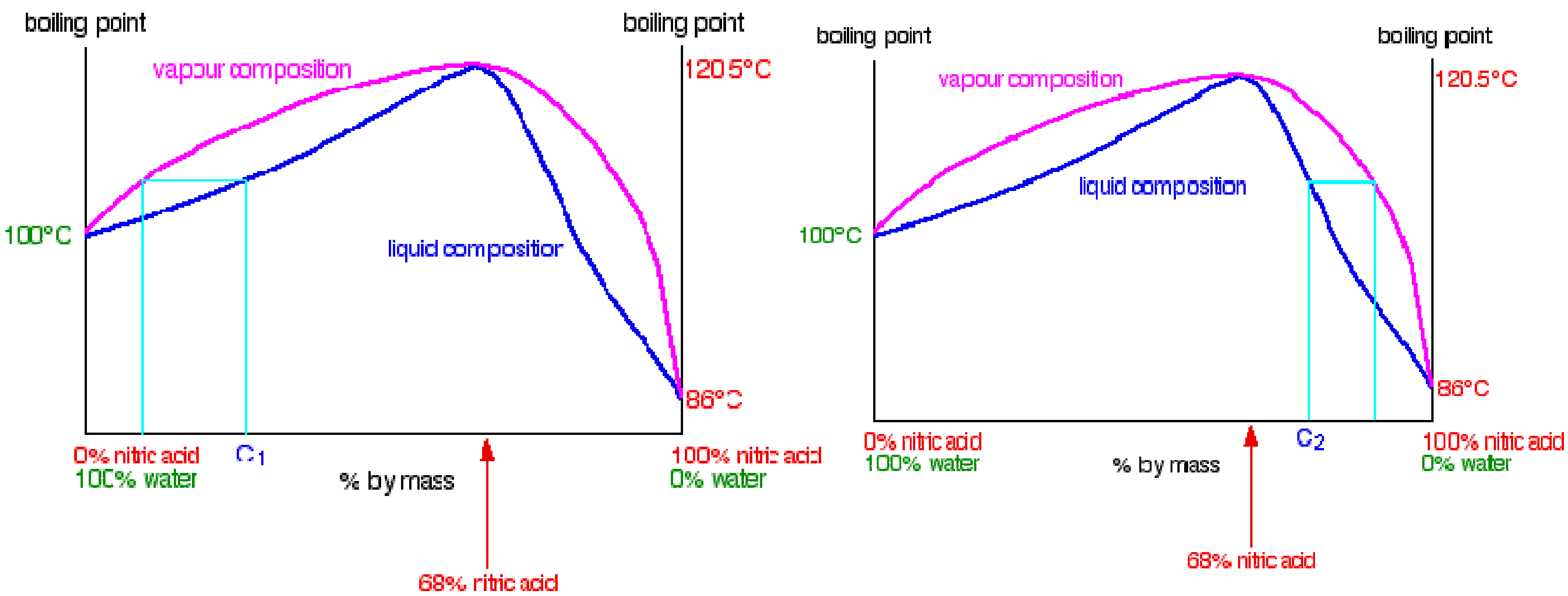


Abb. 41 : Siedediagramm eines Toluol / Wasser-Gemsiches

Neidealne zmesi tekočin
-fazni diagram zmesi dušikova kislina-voda



Neidealne zmesi tekočin
-fazni diagram zmesi dušikova kislina-voda



Tekočini, ki se ne mešata in destilacija z vodno paro

$$p_{celokupni} = p_a + p_b$$

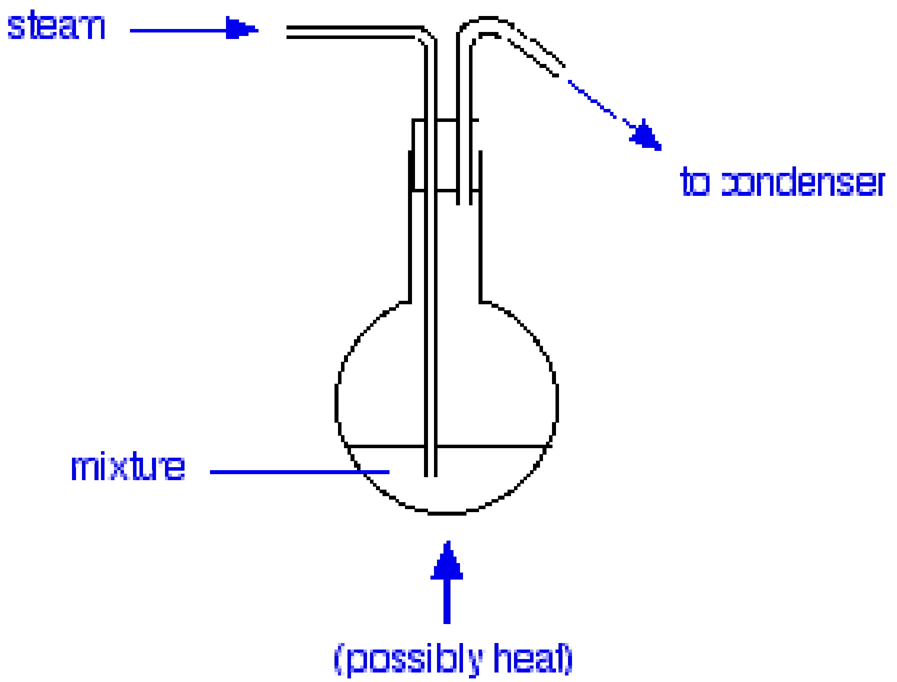
p_a=parni tlak komponente a
p_b=parni tlak komponenete b

Pri 98 °C je nasičen parni tlak fenilamina 7,07 kPa
Nasičen parni tlak vode 94,30 kPa. Vsota =101,37 kPa

Normalni zračni tlak=101,325 kPa
Tekočini vreta ko je njun parni tlak enak zračnemu tlaku

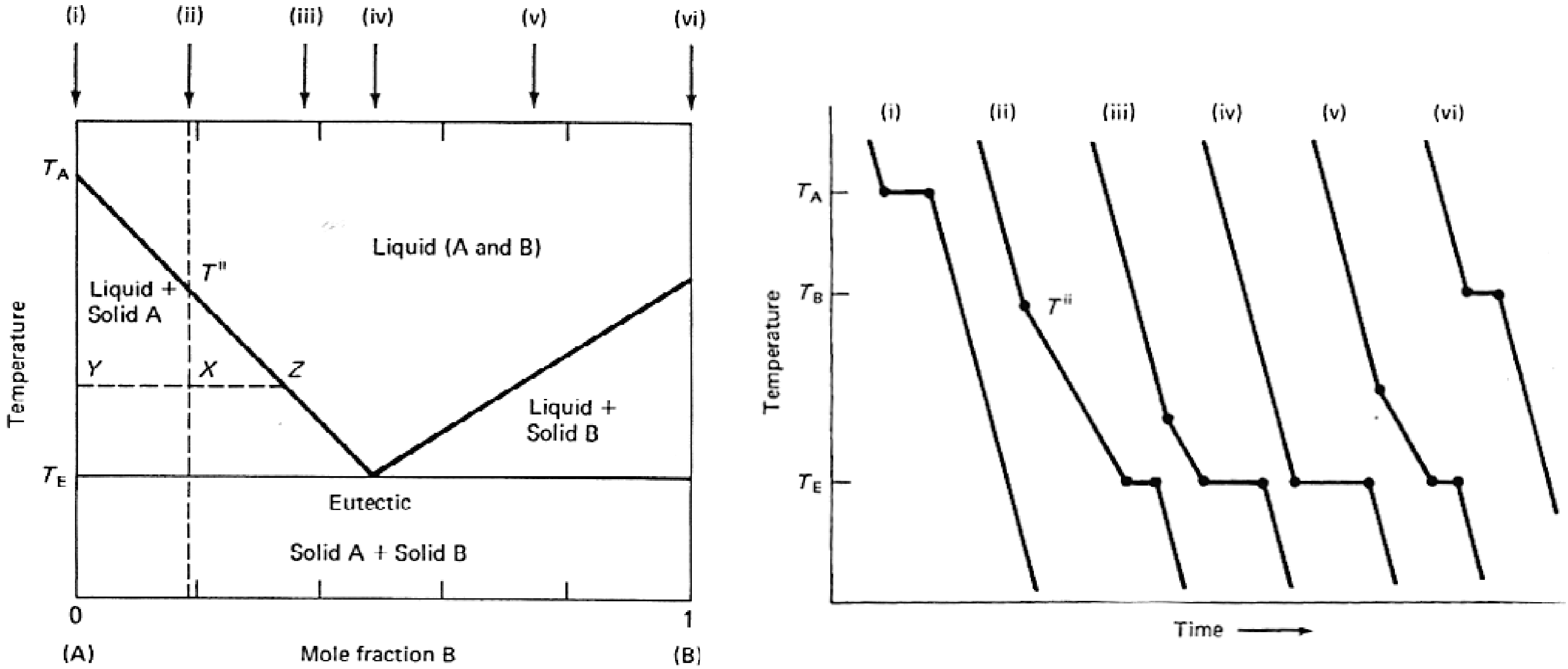
Zmes vode in fenilalanina vre pri normalnem tlaku in temperaturi 98°C
Vrelišče vode 100 °C
Vrelišče fenilamina 184 °C

Tekočini, ki se ne mešata in destilacija z vodno paro

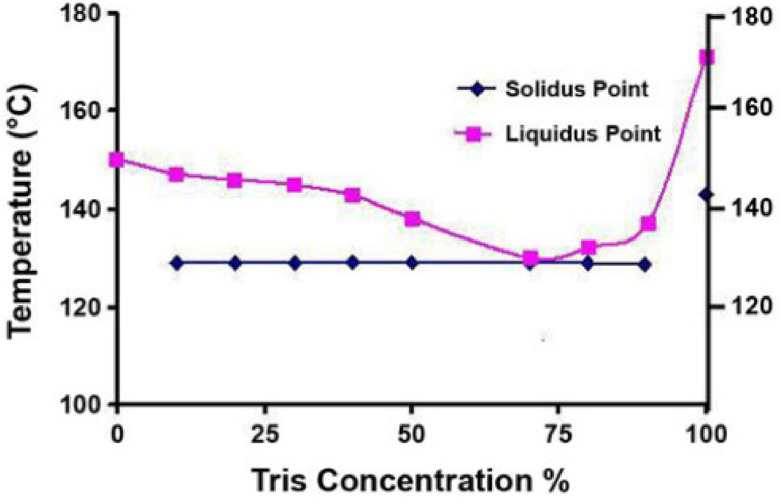


Vrelišče vode 100 °C
Vrelišče fenilamina 184 °C

Fazni diagram trdno tekoče-evtektična zmes



Fazni diagram trdno tekoče-evtektična zmes



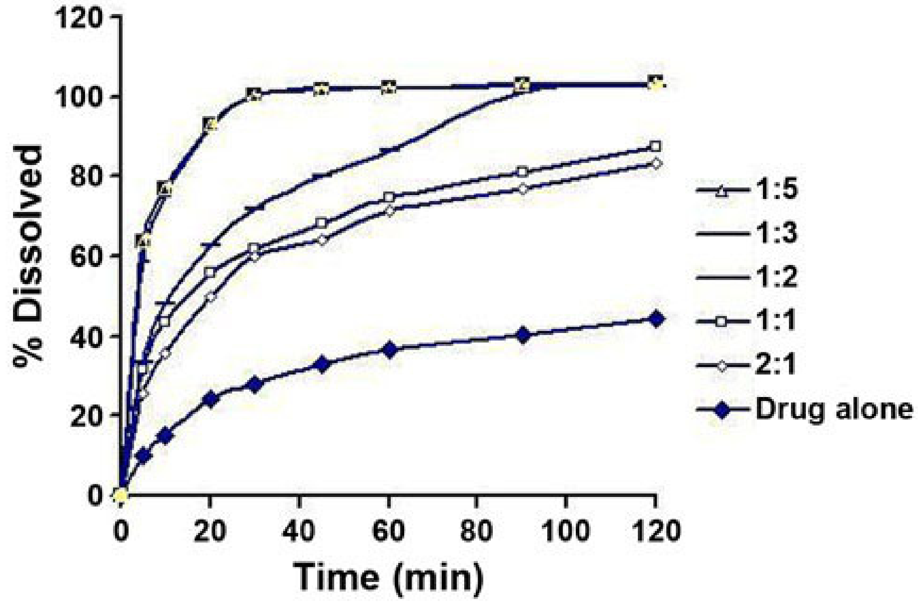


Figure 7. Phase diagram of coprecipitated mixtures of nimesulide and Tris; liquidus point, solidus point.

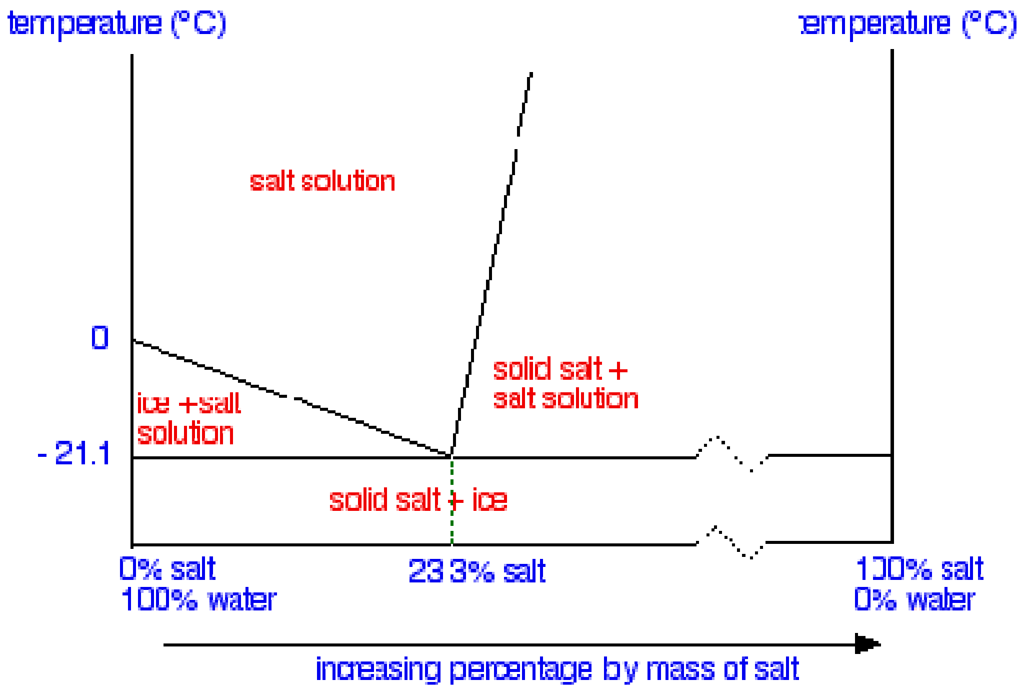
AAPS PharmSciTech 2007; 8 (3) Article 65 (http://www.aapspharmscitech.org).

Comparison of The Effect of Tromethamine and Polyvinylpyrrolidone on Dissolution Properties and Analgesic Effect of Nimesulide

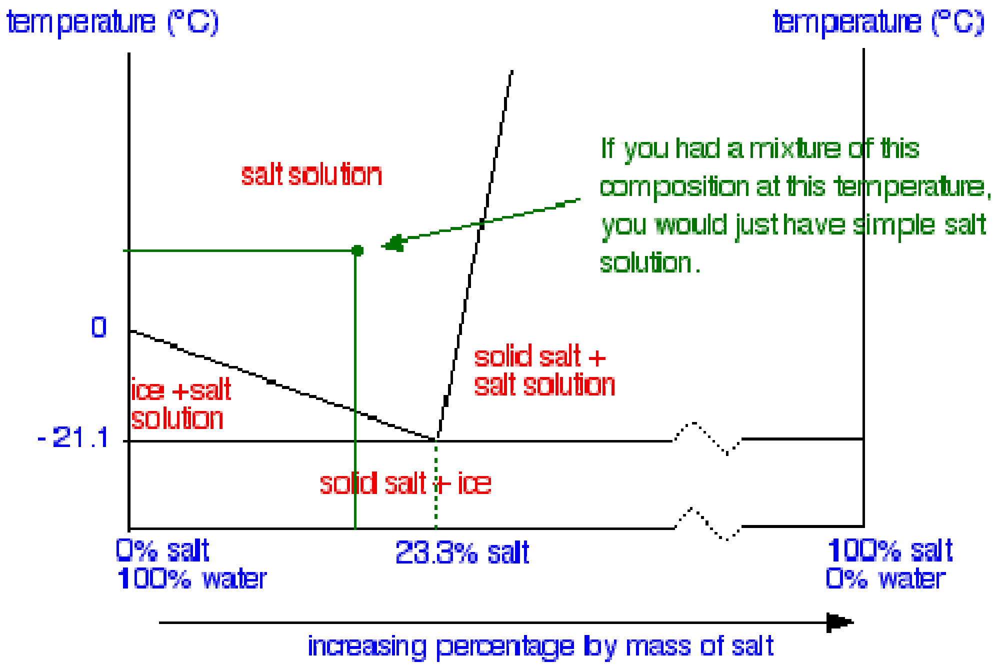
Received: November 6, 2006; Final Revision Received: March 19, 2007; Accepted: March 20, 2007; Published: August 10, 2007

Hamdy Abdelkader,[1] Ossama Y Abdallah,[2] and Hesham S Salem[3]

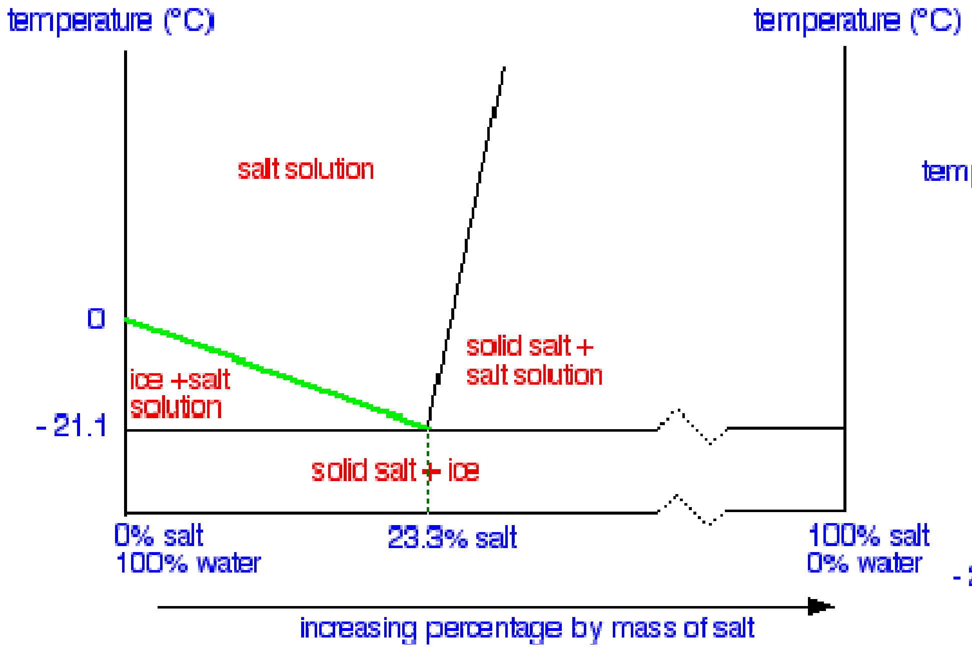
Fazni diagram vodne raztopine NaCl

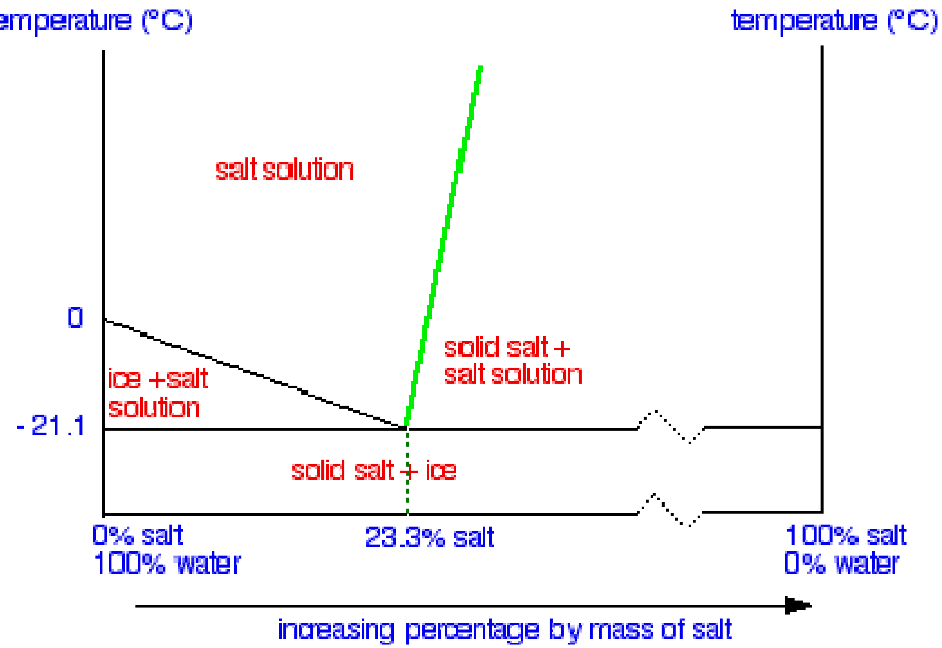


Fazni diagram vodne raztopine NaCl

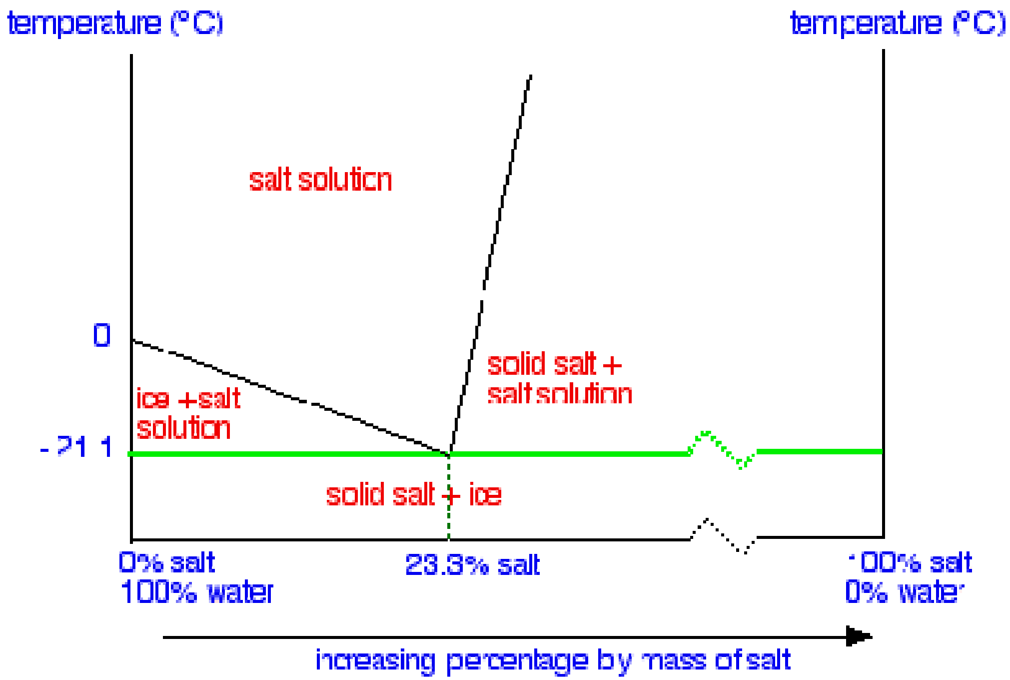


Fazni diagram vodne raztopine NaCl

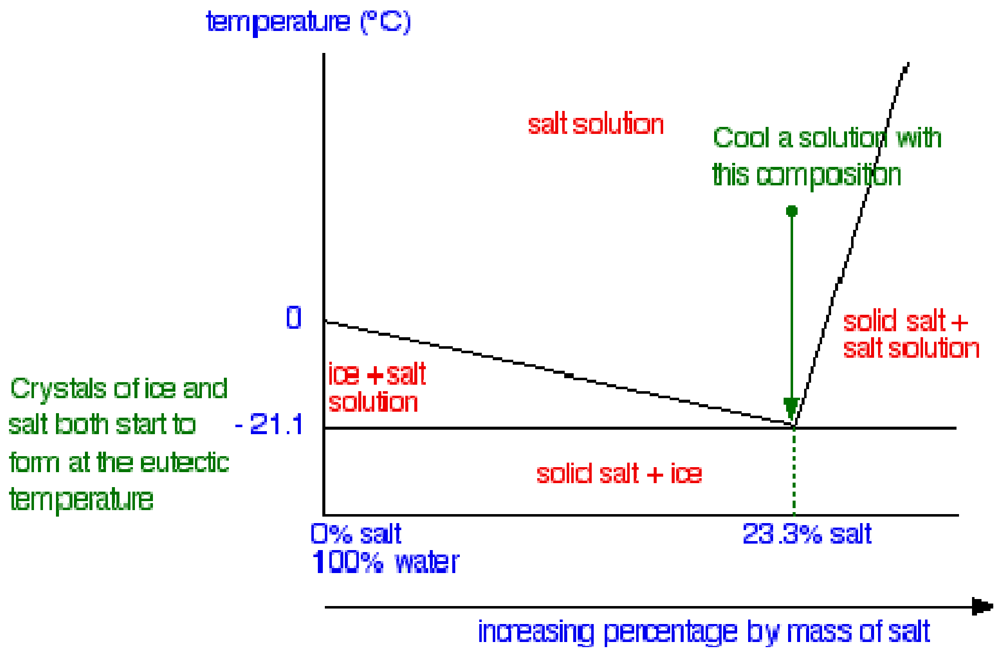




Fazni diagram vodne raztopine NaCl

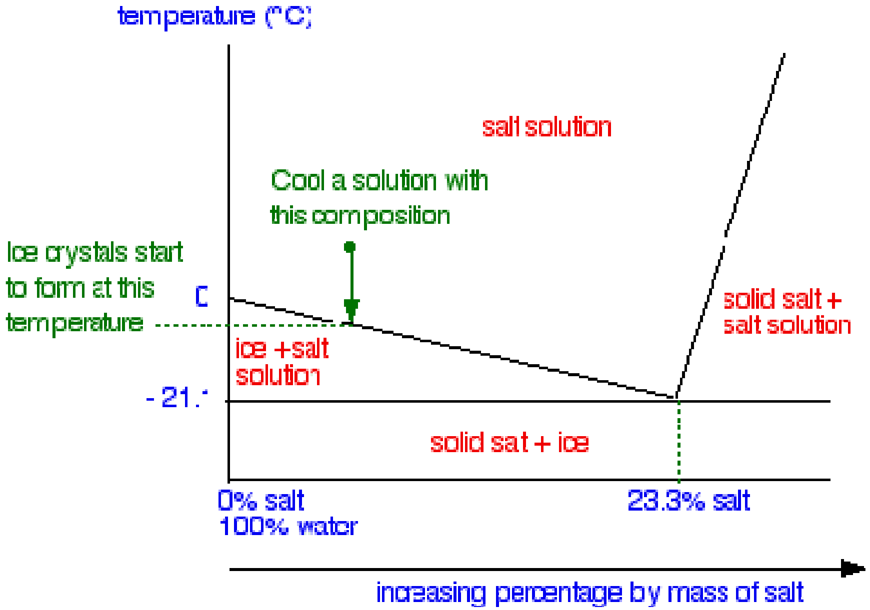


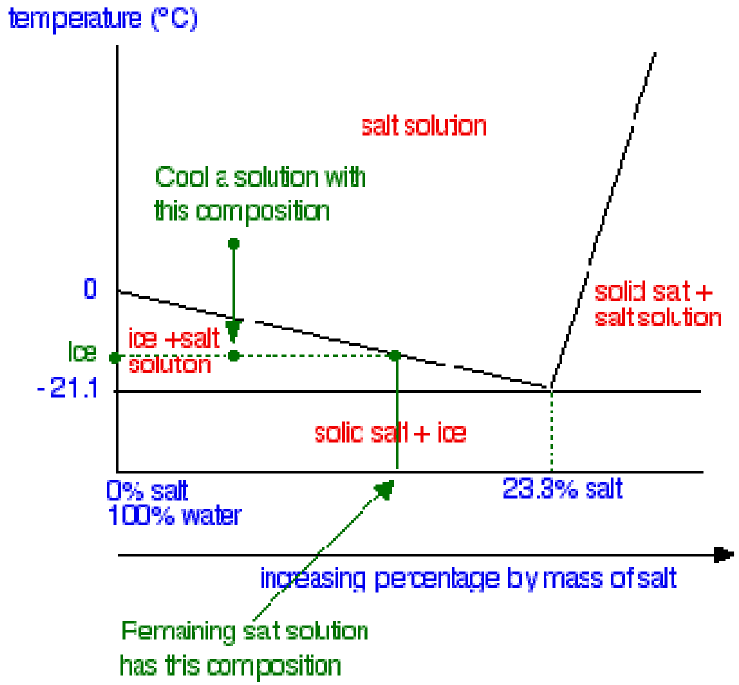
Fazni diagram vodne raztopine NaCl



Fazni diagram vodne raztopine NaCl

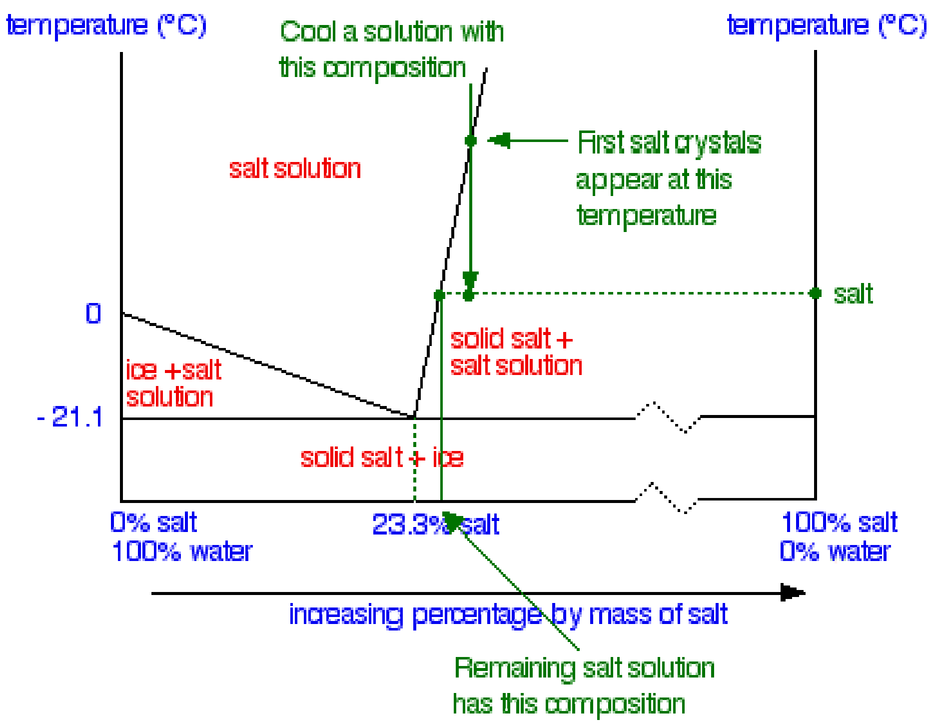
Ohlajanje raztopine, ki vsebuje manj kot 23,3% soli



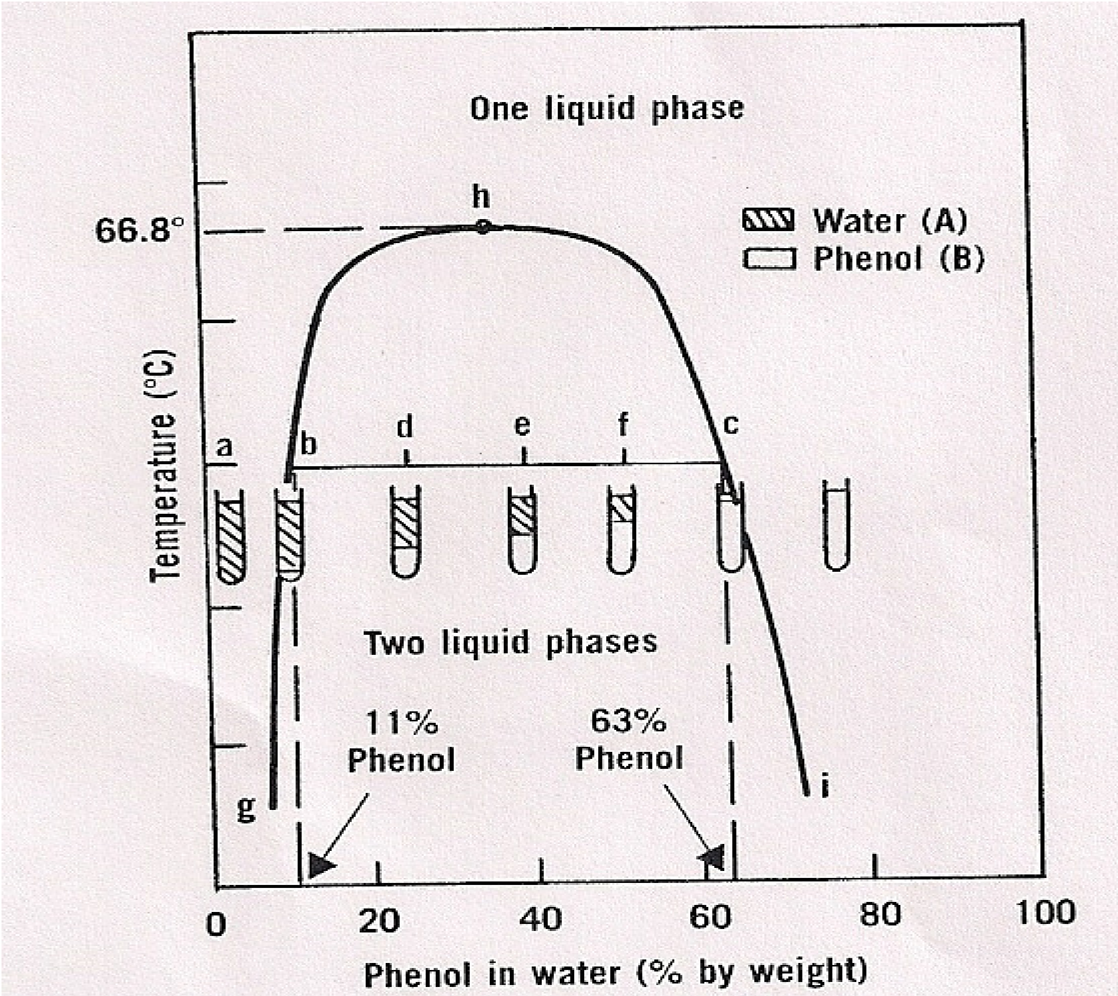


Fazni diagram vodne raztopine NaCl

Ohlajanje raztopine, ki vsebuje več kot 23,3% soli



Fazni diagram komponent, ki se delno mešata Fenol-voda



$$\frac{A}{B} = \frac{dc}{bd}$$

Fazni diagram komponent, ki se delno mešata Fenol-voda

Alternative Names

Phenol; Hydrobenzene and phenylic acid; Phenylic acid and hydrobenzene

Poisonous Ingredient

Phenol

Where Found

Various antiseptics
Various disinfectants
Various germicides
Adhesive dyes
Perfumes
Textiles
Lubricating oils

Fazni diagram komponent, ki se delno mešata

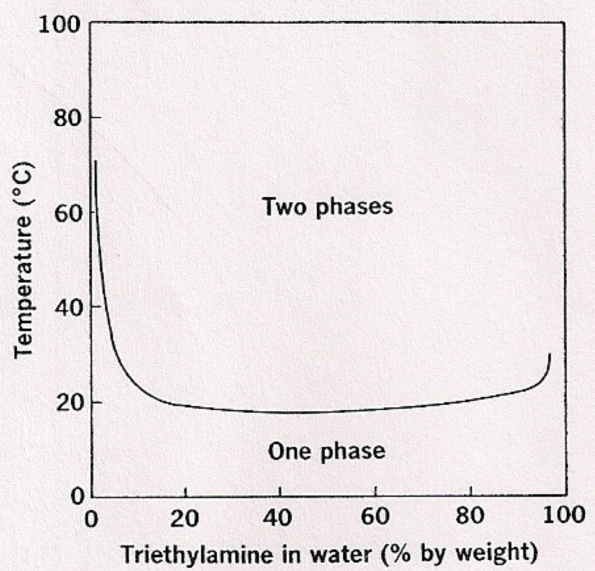


Fig. 2–15. Phase diagram for the system triethylamine–water showing lower consolute temperature.

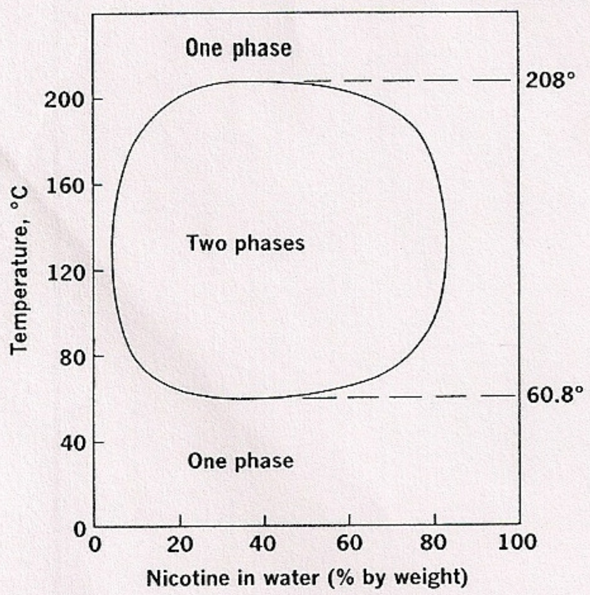


Fig. 2–16. Nicotine–water system showing upper and lower consolute temperatures.

Trikomponentni sistemi

Evtektična zmes

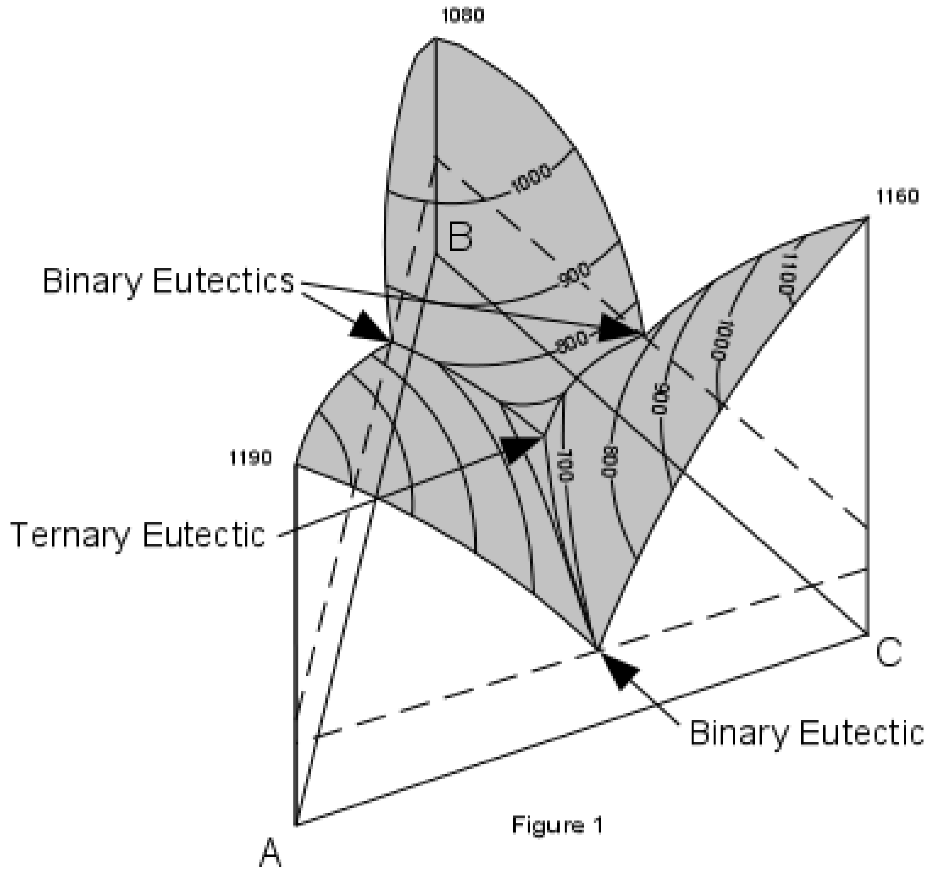
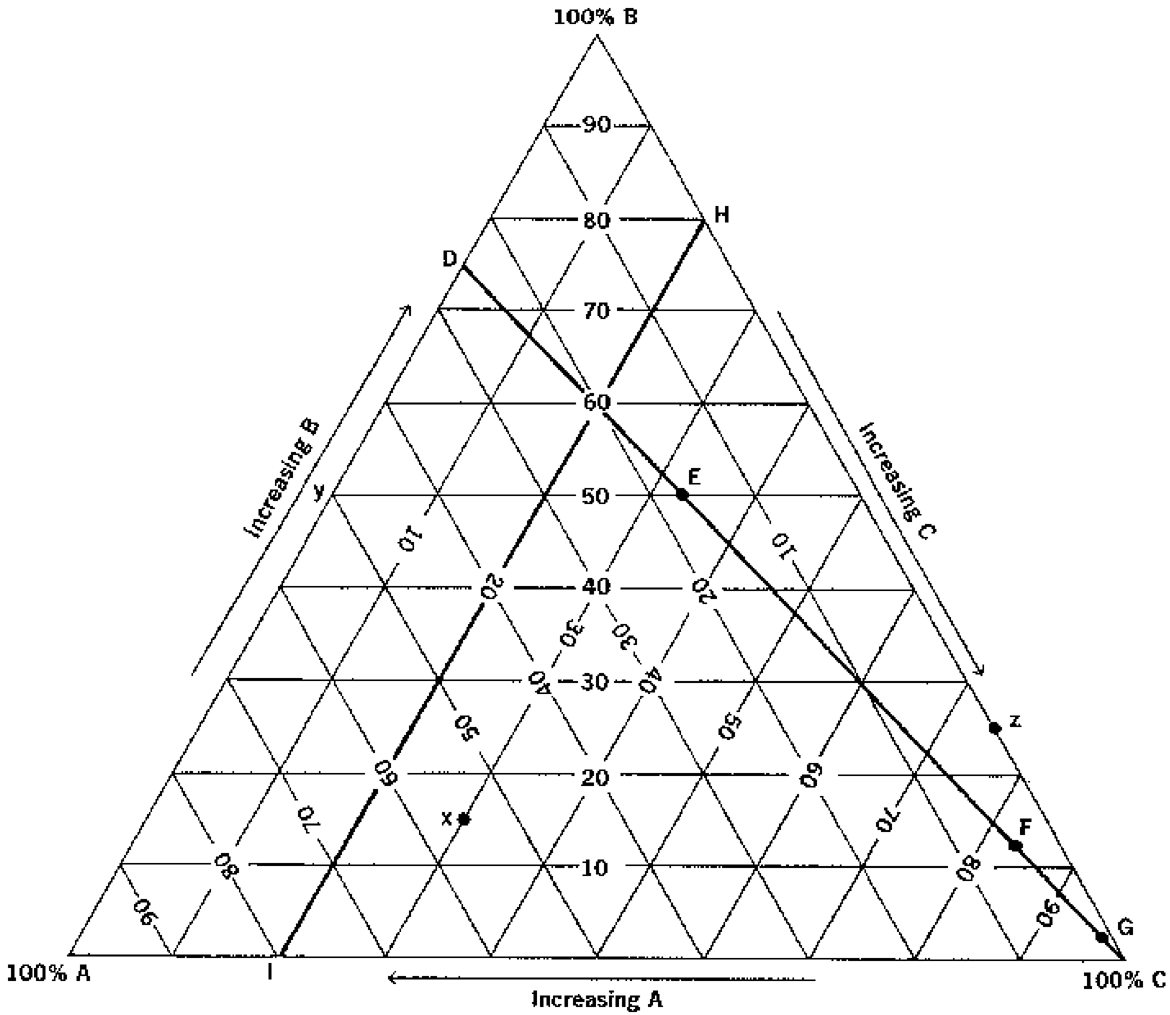


Figure 1

Trikomponentni sistemi

Trikotni diagram



Trikomponentni sistemi

Trikotni diagram

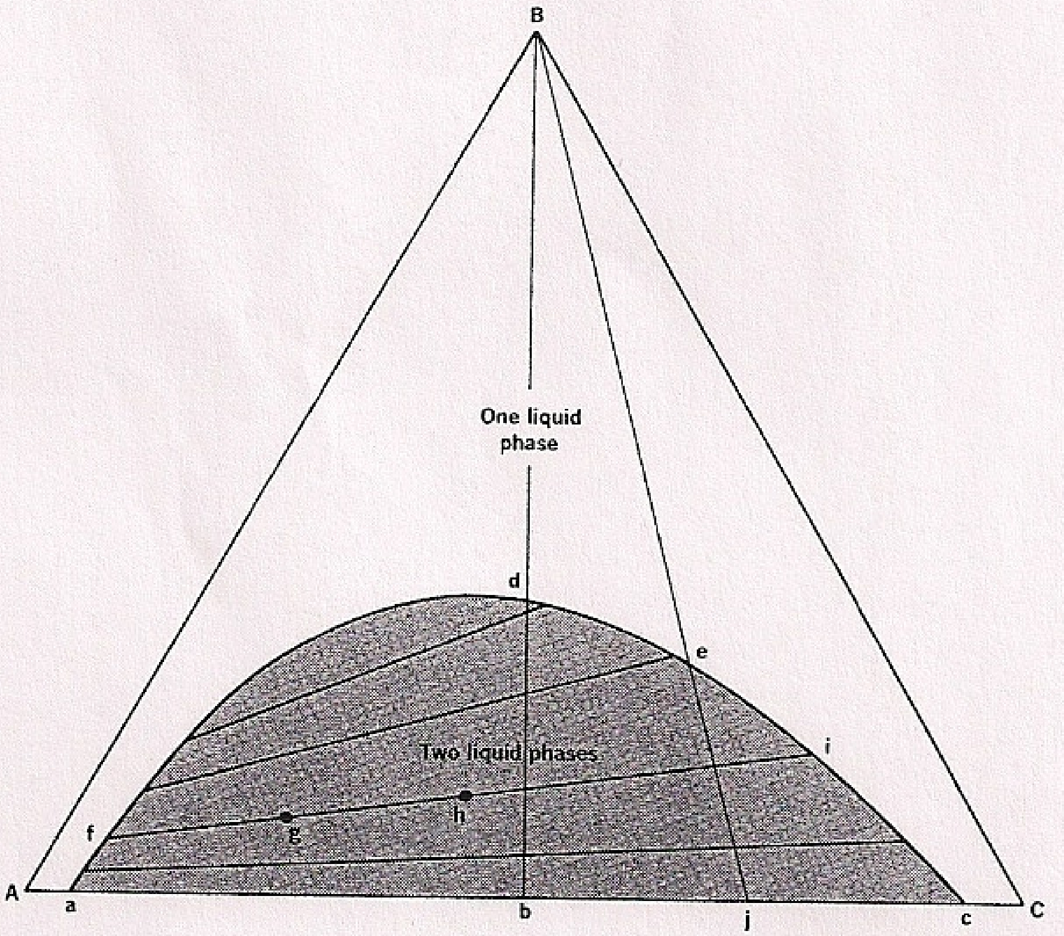


Fig. 2–19. A system of three liquids, one pair of which is partially miscible.

Trikomponentni sistemi

Trikotni diagram