

AZAS TEKNIK KIMIA II

PERTEMUAN KE EMPAT TENTANG VAPORIZATION AND
COOLING OF MIXTURE

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Kerjakan di kelas: campuran senyawa

Tentukan Panas yang diperlukan untuk menaikkan suhu 100 mol/jam campuran 50% Air dan 50 % etanol dari 25 °C menjadi 150 °C.

Data dari Tabel B.1:

Senyawa	bp (°C)	ΔH_v (kJ/mol)
Air	100	40,656
etanol	78,5	38,58

Senyawa	a	b	c	d
Air (l)	$75,4 \times 10^{-3}$			
Air (g)	$33,46 \times 10^{-3}$	$0,688 \times 10^{-5}$	$0,7604 \times 10^{-8}$	$-3,593 \times 10^{-12}$
Etanol (l)	$103,1 \times 10^{-3}$			
Etanol (g)	$61,34 \times 10^{-3}$	$15,72 \times 10^{-5}$	$-8,749 \times 10^{-8}$	$19,83 \times 10^{-12}$

Jawaban slide 2

n =	100	mol
T1 =	25	°C
T2 =	150	°C

$$\Delta H_{air} = n \int_{25}^{100} C_p(l) dT + n \cdot \Delta H_v + n \int_{100}^{150} C_p dT(v)$$

$$\Delta H_{ALKOHOL} = n \int_{25}^{78,5} C_p(l) dT + n \cdot \Delta H_v + n \int_{78,5}^{150} C_p dT(v)$$

$$\Delta H_{air} = n \int_{25}^{100} (p(T)) dT + n \cdot \Delta H_v + n \int_{100}^{150} (p(T)) dT$$

$$= n \int_{25}^{100} (p(T)) dT$$

$$= (0,5 \times 100) \int_{25}^{100} (0,0754) dT$$

$$= (50) (0,0754) (100 - 25)$$

$$= 282,75 \text{ Q}_1$$

$$= n \int_{100}^{150} (C_p dT(T))$$

$$= (0,5 \times 100) \int_{100}^{150} (33,46 \times 10^{-3} + 0,688 \times 10^{-5} T + 0,7604 \times 10^{-8} T^2 - 3,593 \times 10^{-12} T^3) dT$$

$$= (50) [33,46 \times 10^{-3} (150 - 100) + \frac{0,688 \times 10^{-5}}{2} (150^2 - 100^2) + \frac{0,7604 \times 10^{-8}}{3} (150^3 - 100^3) - \frac{3,593 \times 10^{-12}}{4} (150^4 - 100^4)]$$

$$= 86,1083 \text{ Q}_2 \quad Q_i = Q_1 + Q_2 + Q_3$$

$$= n \cdot \Delta H_v$$

$$= (0,5 \times 100) (40,656)$$

$$= 50 \times 40,656$$

$$= 2032,8 \text{ Q}_2$$

Untuk Ethanol
kerjakan sama
seperti air ini

Senyawa	$Q1 = n \cdot cp \cdot dT$ (kJ)	$Q2 = n \cdot \Delta H_v$ (kJ)	$Q3 = n \cdot cp \cdot dT$ (kJ)	$Q_i = Q1 + Q2 + Q3$
H2O	282,75	2032,8	86,08274596	2401,632746
C2H5OH	275,7925	1929	279,3979877	2484,190488
			Q =	4886

Example: vaporization and cooling of mixture:

An equimolar liquid mixture of benzene (B) and toluene (T) at 10 °C is feed continuously to a vessel in which the mixture is heated to 50 °C. The liquid product is 40.0 mole% B, and the vapor product is 68.4 mole% B. How much heat must be transferred to the mixture per mole of feed?

Substances	bp (°C)	ΔH_v (kJ/mol)
C_6H_6	80,1	30,765
C_7H_8	110.62	33,47

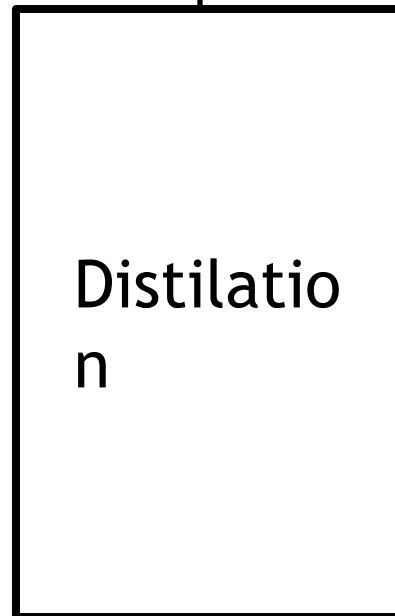
Substances	a	b	c	d
$C_6H_6(l)$	$126,5 \times 10^{-3}$	23.4×10^{-5}	0	0
$C_7H_8(l)$	$148,8 \times 10^{-3}$	$32,4 \times 10^{-5}$	0	0
$C_6H_6(v)$	$74,06 \times 10^{-3}$	$32,95 \times 10^{-5}$	$-25,20 \times 10^{-8}$	$77,57 \times 10^{-12}$
$C_7H_8(v)$	$94,18 \times 10^{-3}$	38×10^{-5}	$-27,86 \times 10^{-8}$	$80,33 \times 10^{-12}$

Mass Balance:

Basis : 1 mol feed

Feed , 1 mol, 10°C

0.5 C₆H₆
0.5 C₇H₈



Neraca Total:

$$1 = V + L$$

$$V = 1 - L \quad (1)$$

Neraca Benzen

$$0,5 = 0,684V + 0,4 L \quad (2)$$

V mol 50°C, 34.8 mm Hg = 0,46 atm
0.684 C₆H₆
0.316 C₇H₈

Substitusi (1) ke (2):

$$0,5 = 0,684 (1-L) + 0,4L$$

$$0,5 = 0,684 - 0,684L + 0,4L$$

$$0,184 = 0,284 L$$

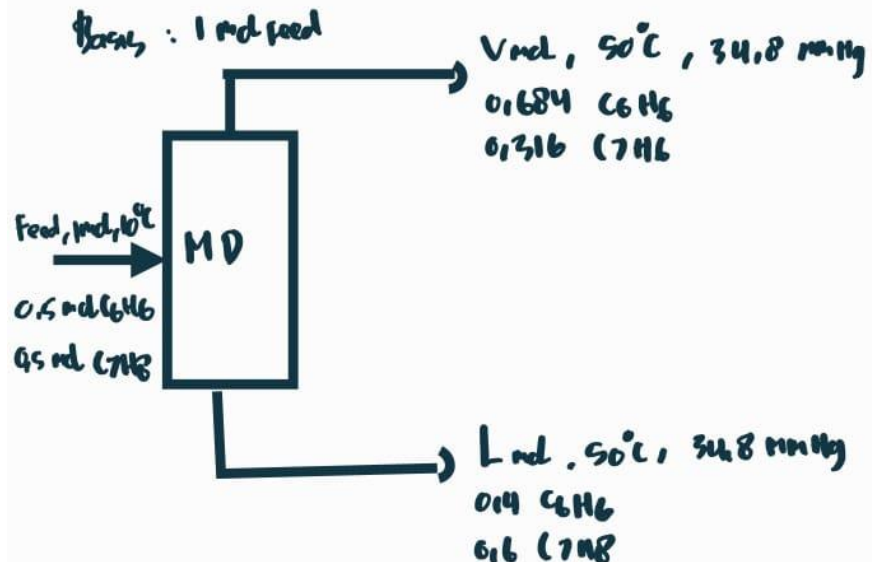
$$L = 0,648 \text{ mol}$$

$$V = 0,352 \text{ mol}$$

L mol 50°C, 34.8 mm Hg
0.4 C₆H₆
0.6 C₇H₈

Energy Balance

$$\begin{aligned}
Q = \Delta H &= n \int_{10}^{50} C_{p_m}(l).dT + n \int_{10}^{bp} C_{p_m}(l).dT + n \int_{bp}^{50} C_{p_m}(v).dT \\
&= n \int_{10}^{50} cp.dT_{benzen(l)} + n \int_{10}^{50} cp.dT_{toluen(l)} + n \int_{10}^{bp} cp.dT_{benzen(l)} + n.\Delta H_{v,benzen} + n \int_{bp}^{50} cp.dT_{benzen(v)} \\
&+ n \int_{10}^{bp} cp.dT_{toluen(l)} + n.\Delta H_{v,toluen} + n \int_{bp}^{50} cp.dT_{toluen(v)}
\end{aligned}$$



N.M. total :

$$F = V + L$$

$$V = F - L \quad \dots (1)$$

N.M. Benzene :

$$0.5 = 0.684V + 0.14L \quad \dots (2)$$

substitusi ke 2

$$0.5 = 0.684V + 0.14L$$

$$0.5 = 0.684(1-L) + 0.14L$$

$$0.184 = 0.1284L$$

$$L = 0.1648 \text{ mol}$$

$$V = 1 - L$$

$$= 1 - 0.1648$$

$$= 0.8352 \text{ mol}$$

mol output liquid (bottom product)

$$\begin{aligned} \text{mol C}_6\text{H}_6 &= 0.1648 \times 0.14 \\ &= 0.23072 \text{ mol} \end{aligned}$$

$$\begin{aligned} \text{mol C}_7\text{H}_8 &= 0.1648 \times 0.6 \\ &= 0.9888 \text{ mol} \end{aligned}$$

mol output vapor (product atas)

$$\begin{aligned} \text{mol C}_6\text{H}_6 &= 0.8352 \times 0.684 \\ &= 0.5712768 \text{ mol} \end{aligned}$$

$$\begin{aligned} \text{mol C}_7\text{H}_8 &= 0.8352 \times 0.316 \\ &= 0.2639232 \text{ mol} \end{aligned}$$

-> Neraca energi

tentukan kondisi referensi (kondisi awal) $T_{ref} = 10^\circ\text{C}$

1. INPUT

$$\Delta H_{input} (\text{C}_6\text{H}_6) = n \int_{10^\circ\text{C}}^{50^\circ\text{C}} c_p (\text{C}_6\text{H}_6) dT = 0$$

$$\Delta H_{input} (\text{C}_7\text{H}_8) = n \int_{10^\circ\text{C}}^{50^\circ\text{C}} c_p (\text{C}_7\text{H}_8) dT = 0$$

2. Output

a. output liquid

$$\Delta H_{output} (\text{C}_6\text{H}_6) = n \int_{50^\circ\text{C}}^{10^\circ\text{C}} c_p (\text{C}_6\text{H}_6) dT$$

$$\Delta H_{output} (\text{C}_7\text{H}_8) = n \int_{50^\circ\text{C}}^{10^\circ\text{C}} c_p (\text{C}_7\text{H}_8) dT$$

b. output vapor

$$\begin{aligned} \Delta H_{output} (\text{C}_6\text{H}_6) &= n \int_{10^\circ\text{C}}^{bp} c_p dT_{\text{C}_6\text{H}_6(l)} + n \Delta H_{vapor} \\ &\quad + n \int_{bp}^{50^\circ\text{C}} c_p dT_{\text{C}_6\text{H}_6(v)} \end{aligned}$$

$$\begin{aligned} \Delta H_{output} (\text{C}_7\text{H}_8) &= n \int_{10^\circ\text{C}}^{bp} c_p dT_{\text{C}_7\text{H}_8(l)} + n \Delta H_{vapor} \\ &\quad + n \int_{bp}^{50^\circ\text{C}} c_p dT_{\text{C}_7\text{H}_8(v)} \end{aligned}$$

SOAL DIKERJAKAN

Campuran cair equimolar dari benzene (B) dan toluene pada 10 °C diumpankan terus menerus ke menara distilasi di mana campuran dipanaskan sampai 50 °C. Produk vapor yang diinginkan 100 mol terdiri dari 70 mole% B dan 30 % mol toluene, produk cair sebesar 40 mole % B dan sisanya merupakan toluen. Berapa banyak panas yang harus ditransfer ke campuran per mol umpan?

From the Table B.1:

Substances	bp (°C)	ΔH_v (kJ/mol)
C ₆ H ₆	80,1	30,765
C ₇ H ₈	110.62	33,47

From the Table B.2:

Substances	a	b	c	d
C ₆ H _{6(l)}	126,5x10 ⁻³	23.4x10 ⁻⁵	0	0
C ₇ H _{8(l)}	148,8x10 ⁻³	32,4x10 ⁻⁵	0	0
C ₆ H _{6(v)}	74,06x10 ⁻³	32,95x10 ⁻⁵	-25,20x10 ⁻⁸	77,57x10 ⁻¹²
C ₇ H _{8(v)}	94,18x10 ⁻³	38x10 ⁻⁵	-27,86x10 ⁻⁸	80,33x10 ⁻¹²

SOAL: Kerjakan Di kelas

