GJ

The University of Calgary
Department of Chemical & Petroleum Engineering

ENCH 501: Transport Phenomena Quiz #3 October 4, 2011

Time Allowed: 25 mins. Name:

On average, about 19.5 US gallons (~73.8 litres) of gasoline are obtained from a 42-US-gallon (~159 litres) barrel of crude oil. The amount of gasoline varies with the quality of the crude and the grade of the gasoline. The product obtained from atmospheric distillation, the straight-run gasoline, is 0-20% by volume of the crude and is therefore insufficient for the need. It also, without addition of lead, has a low octane rating. Most of the gasoline sold is reformulated and obtained through reforming and catalytic cracking.

The composition of a gasoline is given below. The density of the gasoline is 712 kg/m^3 and its volume is 219.1 litres at 15°C.
Estimate the **molar density** {c, moles/m^3} of the gasoline mixture at -20°C. The coefficient of volume expansion, α, for the gasoline is $9.6(10^{-4})$ °C^{-1}. ($V = V_o(1 + \alpha T)$; T in °C). ~~Molar~~ Atomic masses, C=12.01, H=1.0079 g/mol.

Component	Chemical Formula	Wt. %		
Propane	C_3H_8	0.05		
iso-Butane	C_4H_{10}	1.44		
n-Butane	C_4H_{10}	4.79		
iso-Pentane	C_5H_{12}	7.59		
2-Methyl But-2-en	C_5H_{10}	2.38		
iso-Hexane	C_6H_{14}	8.21		
n-Hexane	C_6H_{14}	7.13		
Benzene	C_6H_6	2.85		
2,3 Dimethyl Pentane	C_7H_{16}	3.45		
n-Heptane	C_7H_{16}	4.14		
Toluene	C_7H_8	11.16		
m-Xylene	$C_6H_4(CH_3)_2$	15.17		
3-Ethyl Toluene	C_9H_{12}	9.08		
pseudo Cumene	C_9H_{12}	5.03		
1,3 Diethyl Benzene	$C_{10}H_{14}$	8.65		
n-Pentane	C_5H_{12}	8.88		

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Component	Chemical Formula	Wt. %	Mol. wt (kg/kmol)	moles (kmols)
Propane	C_3H_8	0.05	44.0932	0.0011
iso-Butane	C_4H_{10}	1.44	58.119	0.0248
n-Butane	C_4H_{10}	4.79	58.119	0.0824
iso-Pentane	C_5H_{12}	7.59	72.1448	0.1052
2-Methyl But-2-en	C_5H_{10}	2.38	70.129	0.0339
iso-Hexane	C_6H_{14}	8.21	86.1706	0.0953
n-Hexane	C_6H_{14}	7.13	86.1706	0.0827
Benzene	C_6H_6	2.85	78.1074	0.0365
2,3 Dimethyl Pentane	C_7H_{16}	3.45	100.1964	0.0344
n-Heptane	C_7H_{16}	4.14	100.1964	0.0413
Toluene	C_7H_8	11.16	92.1332	0.1211
m-Xylene	$C_6H_4(CH_3)_2$	15.17	106.159	0.1429
3-Ethyl Toluene	C_9H_{12}	9.08	120.1848	0.0756
pseudo Cumene	C_9H_{12}	5.03	120.1848	0.0419
1,3 Diethyl Benzene	$C_{10}H_{14}$	8.65	134.2106	0.0645
n-Pentane	C_5H_{12}	8.88	72.1448	0.1231

Σ 100 Σ 1.1067

ENCH 501 Quiz #3 Solution October 4, 2011

Basis: 100 kg of gasoline at 15°C

on table, determine molecular weights and the number of moles.

The total # moles (for all constituents) = 1106.7 moles

The mass of gasoline provide is

$$\underset{kg/m^3}{712}\;\underset{m^3}{(0.2191)} = 156 \text{ kg}$$

The volume of 100 kg of gasoline at 15°C $= \frac{100}{156}(0.2191) = 0.1404 \, m^3$

Given $V = V_0(1 + \alpha T)$, V_0 is volume at 0°C

∴ At 15°C

$$0.1404 = V_0\left(1 + 9.6(10^{-4})(15)\right)$$

$$= V_0(1.0144)$$

$$\therefore V_0 = 0.1385 \, m^3$$

At −20°C

$$V = 0.1385\left(1 + 9.6(10^{-4})(-20)\right)$$

$$= 0.1358 \, m^3$$

$$\therefore C = \frac{\sum \text{moles}}{V_{mixture}} = \frac{1106.7}{0.1358} = 8{,}147.04 \, \frac{\text{moles}}{m^3}$$

→?