
UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2005/2006

April/Mei 2006

EKC 111 – Imbangan Jisim

Masa : 3 jam

Sila pastikan bahawa kertas peperiksaan ini mengandungi SEPULUH muka surat yang bercetak dan SATU muka surat Lampiran sebelum anda memulakan peperiksaan ini.

Arahan: Jawab TUJUH (7) soalan. Jawab SEMUA soalan dari Bahagian A. Jawab mana-mana TIGA (3) soalan dari Bahagian B.

Pelajar boleh menjawab semua soalan dalam Bahasa Malaysia. Jika pelajar ingin menjawab dalam Bahasa Inggeris, pelajar hendaklah menjawab sekurang-kurangnya SATU soalan dalam Bahasa Malaysia.

...2/-

Bahagian A : Jawab SEMUA soalan.

Section A : Answer ALL questions.

1. Senaraikan

- [a] 3 jenis penukar haba
- [b] 2 faktor yang mempengaruhi kecekapan penyejat
- [c] 3 jenis reaktor

[4 markah]

1. List down

- [a] 3 types of heat exchangers
- [b] 2 factors that effect the efficiency of evaporators
- [c] 3 types of reactors

[4 marks]

2. Tinggi sekeping logam berbentuk silinder ialah 2 kaki dan jejaringnya pula ialah 2 inci. Kirakan

- [a] Isipadu ($V = \pi r^2 h$) dalam milimeter sehingga empat angka bererti.

[4 markah]

- [b] Ketumpatan dalam unit g/L sehingga empat angka bererti. Diberi jisim logam ialah 1500 lb_m.

[4 markah]

2. A cylindrical piece of metal of 2 feet height has a radius of 2 inches. Calculate;

- [a] The volume ($V = \pi r^2 h$) in millimeters to the four significant figures $V = \pi r^2 h$.

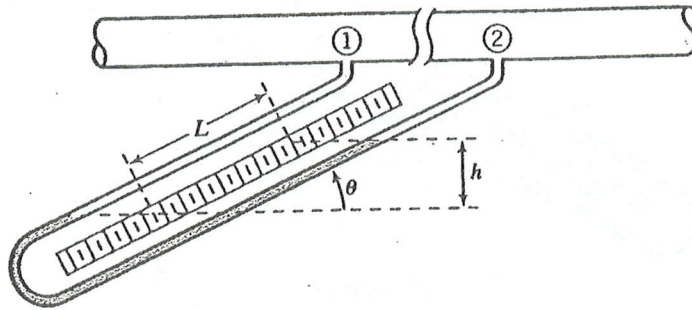
[4 marks]

- [b] The density in units g/L to the four number of significant figures given it has a mass of 1500 lb_m.

[4 marks]

...3/-

3. [a] Sebuah manometer condong seperti yang ditunjukkan dalam Rajah S.3 adalah sejenis peranti yang berguna untuk mengukur perbezaan tekanan yang kecil.



Rajah S.3

Diberi tekanan, $P = P_o + \rho gh$

Di mana P_o ialah tekanan permukaan

ρ ialah ketumpatan bendalir

g ialah graviti

h ialah perbezaan tinggi bendalir

- [i] Terbitkan formula bagi h dalam sebutan L dan θ .

[1 markah]

- [ii] Andaikan bendalir manometer adalah air, bendalir proses ialah suatu gas, kecondongan manometer, $\theta = 15^\circ$, dan bacaan yang diperolehi bagi $L = 8.7$ sm. Apakah perbezaan tekanan di antara titik (1) & (2)?

[6 markah]

- [b] Tekanan tolok pada silinder yang mengandungi CO_2 untuk digunakan mengisi botol-botol air soda memberi bacaan 51.0 lb/inci^2 . Pada masa yang sama, tekanan baromatik memberi bacaan 28.0 inci Hg. Berapakah nilai **tekanan mutlak** dalam

[i] psia

[ii] atm

[iii] N/m^2

[6 markah]

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3. [a] An inclined manometer shown in Figure Q.3 is a useful device for measuring small pressure differences.

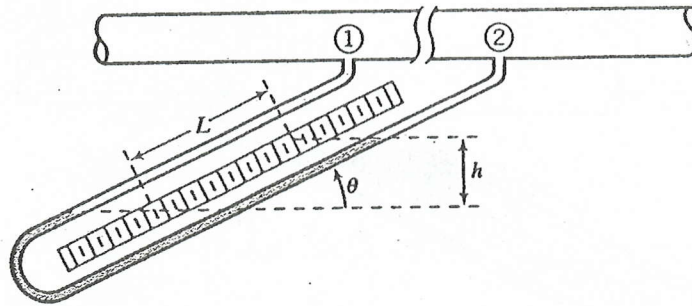


Figure Q.3

Given that Pressure, $P = P_o + \rho gh$

where P_o is the surface pressure
 ρ is the density of the fluid
 g is the gravity
 h is the difference in height of the fluid

- [i] Derive a formula for h in terms of L and θ . [1 marks]
- [ii] Suppose the manometer fluid is water, the process fluid is a gas, the inclination of the manometer is $\theta = 15^\circ$, and a reading $L = 8.7$ cm is obtained. What is the pressure difference between points (1) & (2)?

[6 marks]

- [b] A pressure gauge on a cylinder of CO_2 used to fill soda water bottles reads 51.0 lb/inch^2 . At the same time, the barometric pressure reads 28.0 inches of Hg. What is the absolute pressure in:

[i] psia

[ii] atm

[iii] N/m^2

[6 marks]

4. [a] 100 mol/jam butana (C_4H_{10}) dan 5000 mol/jam udara disuap ke dalam sebuah reaktor pembakaran. Kirakan peratus udara lebih.

[4 markah]

- [b] Suatu gas paip tumpu mengandungi 60 mol% N_2 , 15% CO_2 , 10% O_2 dan selebihnya ialah H_2O . Kirakan komposisi molar gas berdasarkan asas kering.

[4 markah]

...5/-

- [c] Suatu gas asli yang tidak diketahui komposisinya dibakar dengan udara. Analisis gas produk menghasilkan keputusan yang berikut:

0.130 mol H₂O/mol gas basah

Analisis Orsat gas serombong:

1.5% CO
6.0% CO₂
8.2% O₂
84.3% N₂

Kirakan nisbah hidrogen kepada karbon dalam gas.

[7 markah]

4. [a] 100 mol/hr of butane (C₄H₁₀) and 5000 mol/hr of air are fed into a combustion reactor. Calculate the percent of excess air.

[4 marks]

- [b] A stack gas contains 60 mol% N₂, 15% CO₂, 10% O₂ and the balance is H₂O. Calculate the molar composition of the gas on a dry basis.

[4 marks]

- [c] A natural gas of an unknown composition is burned with air. An analysis of the product gas yields the following results:

0.130 mol H₂O/mol wet gas

Orsat Analysis of flue gas:

1.5% CO
6.0% CO₂
8.2% O₂
84.3% N₂

Calculate the ratio of hydrogen to carbon in the gas.

[7 marks]

...6/-

Bahagian B : Jawab mana-mana TIGA soalan.

Section B : Answer any THREE questions.

5. [a] Suatu ampaian zarah kalsium karbonat (CaCO_3) di dalam air mengalir melalui sebatang paip. Tugas anda ialah untuk menentukan kadar aliran dan komposisi buburan. Anda pun pergi untuk mengumpulkan aliran tadi dalam silinder bersengat selama 1.00 minit. Selepas itu, anda menimbang silinder tersebut, menyejatkan air terkumpul dan menimbang semula silinder. Keputusan yang berikut telah diperolehi:

Jisim silinder kosong : 65.0 g

Jisim silinder + buburan terkumpul : 565 g

Isipadu terkumpul : 455 mL

Jisim silinder selepas sejatan : 215 g

Kirakan:

- [i] Kadar aliran isipadu (dalam L/s) dan kadar aliran jisim (dalam lb_m/jam) ampaian.

[6 markah]

- [ii] Ketumpatan dan graviti tentu ampaian

[6 markah]

- [ii] Pecahan jisim CaCO_3 dalam ampaian.

[2 markah]

- [b] Satu persamaan yang diringkaskan bagi pemalar pemindahan haba, h untuk aliran gas dalam sebatang paip, dengan udara tetap di bahagian luar paip diberi sebagai;

$$h = 0.026G^{0.6}D^{-0.4}$$

di mana

h = pemalar pemindahan haba dalam $\text{Btu}/(\text{jam})(\text{kaki}^2)(^\circ\text{F})$

G = kadar aliran jisim dalam $\text{lb}/(\text{jam})(\text{kaki}^2)$

D = diameter paip dalam kaki

Sekiranya pembolehubah di atas diukur dalam unit berikut;

G dalam unit $\text{g}/(\text{min})(\text{sm}^2)$

D dalam unit sm

Apakah nilai pemalar yang baru bagi persamaan di atas sekiranya pemalar pemindahan haba, h diukur dalam unit $\text{kal}/(\text{min})(\text{sm}^2)(^\circ\text{C})$?

[6 marks]

...7/-

5. [a] A suspension of calcium carbonate (CaCO_3) particles in water flows through a pipe. Your assignment is to determine both the flow rate and the composition of this slurry. You proceed to collect the stream in a graduated cylinder for 1.00 min; you then weigh the cylinder, evaporate the collected water, and reweigh the cylinder. The following results are obtained:

Mass of empty cylinder : 65.0 g
 Mass of cylinder + collected slurry : 565 g
 Volume collected : 455 mL
 Mass of cylinder after evaporation : 215 g

Calculate:

[i] The volumetric flow rate (in L/s) and mass flow rate (in lb_m/hr) of the suspension. [6 marks]

[ii] The density and the specific gravity of the suspension [6 marks]

[iii] The mass fraction of CaCO_3 in the suspension. [2 marks]

- [b] A simplified equation for the heat transfer coefficient, h for gas flow inside a pipe with still air on the outside is:

$$h = 0.026G^{0.6}D^{-0.4}$$

where h = heat transfer coefficient in $\text{Btu}/(\text{h})(\text{ft}^2)(^\circ\text{F})$

G = Mass flowrate in $\text{lb}/(\text{h})(\text{ft}^2)$

D = diameter of pipe in ft

If the variable above are actually measured in units as follows;

G in $\text{g}/(\text{min})(\text{cm}^2)$

D in cm

What should be the new constant in the equation if the heat transfer coefficient, h is to be expressed in $\text{cal}/(\text{min})(\text{cm}^2)(^\circ\text{C})$? [6 marks]

6. Akrilnitril dihasilkan dalam tindakbalas propilena, amonia dan oksigen



Suapan mengandungi 10 mol% propilena, 12 mol% amonia dan 78 mol% udara. Penukaran pecahan 30% bagi bahan tindakbalas terhad telah dicapai. Dengan mengambil 100 mol suapan sebagai asas, tentukan bahan tindakbalas terhad, peratusan lebihan bagi setiap bahan tindakbalas yang lain dan jumlah molar bagi kesemua gas produk. Diberi penukaran bagi bahan tindakbalas terhad ialah 30%.

[20 markah]

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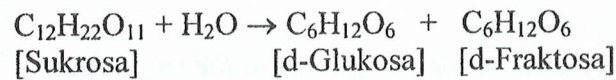
6. Acrylnitrile is produced in the reaction of propylene, ammonia and oxygen



The feed contains 10 mol% propylene, 12 mol% ammonia and 78 mol% air. A fractional conversion of 30% of the limiting reactant is achieved. Taking 100 mol of feed as the basis, determine which reactant is limiting, the percentage by which each of the other reactants is in excess and the molar amounts of all product gas constituents for a 30% conversion of the limiting reactant.

[20 marks]

7. Sukrosa boleh ditukar ke glukosa dan fruktosa melalui proses penyongsangan seperti berikut:

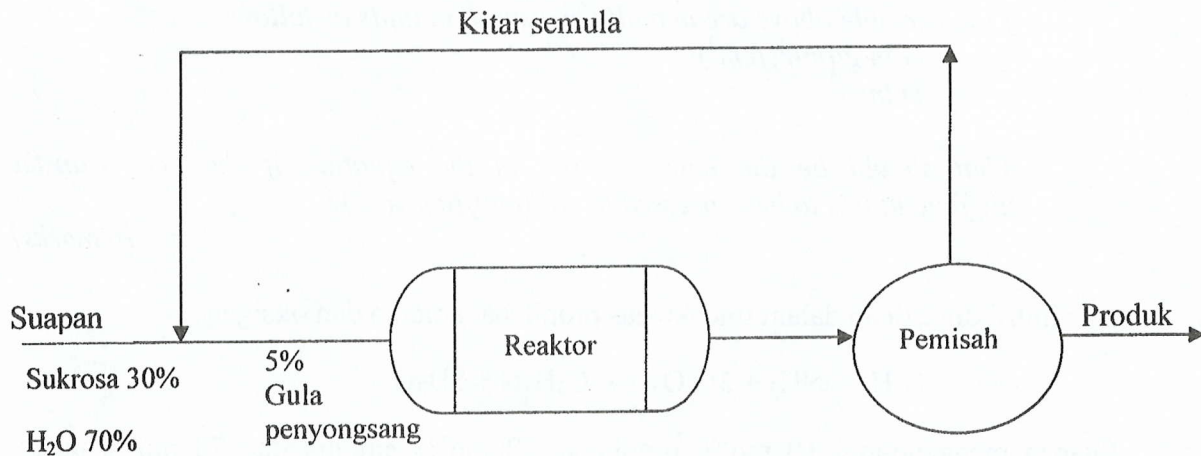


Kuantiti tergabung glukosa dan fruktosa dipanggil sebagai gula penyongsangan. Jika penukaran sukrosa bagi satu laluan melalui reaktor ialah 90%:

- [a] Berapakah aliran kitar semula bagi edar semula per 100 lb suapan segar larutan sukrosa yang memasuki proses seperti yang ditunjukkan di Rajah S. 7.
- [b] Berapakah kepekatan gula penyongsangan dalam aliran kitar semula dan aliran produk.

Andaian:

Kepekatan komponen-komponen dalam aliran kitar semula dan aliran produk adalah sama.

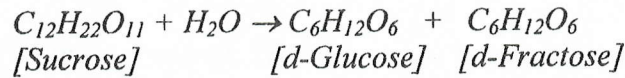


Rajah S.7

[20 markah]

...9/-

7. Sucrose can be converted to glucose and fructose by the inversion process as the following:



The combined quantity glucose plus fructose is called inversion sugar. If 90% conversion of sucrose occurs on one pass through the reactor:

- [a] What would be the recycle stream flow per 100lb fresh feed of sucrose solution entering the process shown in Figure Q. 7.
- [b] What is the concentration of inversion sugar in the recycle stream and in the product stream.

Assumption:

The concentration of components in the recycle stream and product stream are the same.

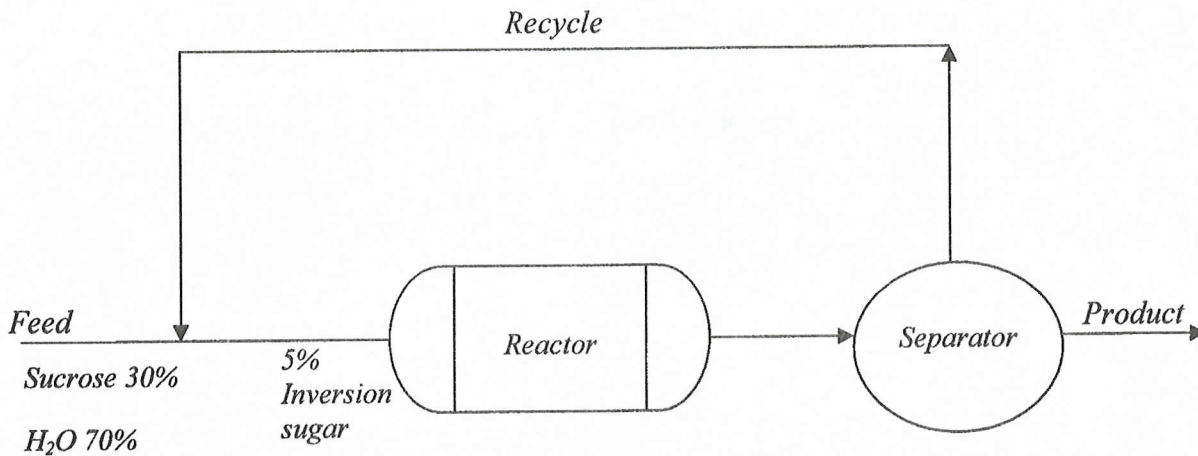


Figure Q.7

[20 marks]

8. Suatu aliran udara pada 100°C dan 5260 mmHg mengandung 10% air (mengikuti isipadu). Kirakan

- [a] Titik embun udara dan darjah panas lampau wap air.
- [b] Peratusan wap yang terpeluwap dan komposisi akhir fasa gas jika gas tersebut disejukkan sehingga 80°C pada tekanan malar.
- [c] Peratusan pemeluwapan dan komposisi fasa gas akhir jika gas tidak disejukkan tetapi dimampatkan (sesuhu) sehingga 8500 mmHg.

[20 markah]

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Lampiran

Common Engineering Conversion Factors

Length	Volume
1 ft = 12 in = 0.3048 m, 1 yard = 3 ft 1 mi = 5280 ft = 1609.344 m 1 nautical mile (nmi) = 6076 ft	1 ft ³ = 0.028317 m ³ = 7.481 gal, 1 bbl = 42 U.S. gal 1 U.S. gal = 231 in ³ = 3.7853 L = 4 qt = 0.833 Imp. gal. 1 L = 0.001 m ³ = 0.035315 ft ³ = 0.2642 U.S. gal
Mass	Density
1 slug = 32.174 lb _m = 14.594 kg 1 lb _m = 0.4536 kg = 7000 grains	1 slug/ft ³ = 515.38 kg/m ³ , 1 g/cm ³ = 1000 kg/m ³ 1 lb _m /ft ³ = 16.0185 kg/m ³ , 1 lb _m /in ³ = 27.68 g/cm ³
Acceleration & Area	Velocity
1 ft/s ² = 0.3048 m/s ² 1 ft ² = 0.092903 m ²	1 ft/s = 0.3048 m/s, 1 knot = 1 nmi/h = 1.6878 ft/s 1 mi/h = 1.4666666 ft/s (fps) = 0.44704 m/s
Mass Flow & Mass Flux	Volume Flow
1 slug/s = 14.594 kg/s, 1 lb _m /s = 0.4536 kg/s 1 kg/m ² -s = 0.2046 lb _m /ft ² -s = 0.00636 slug/ft ² -s	1 gal/min = 0.002228 ft ³ /s = 0.06309 L/s 1 million gal/day = 1.5472 ft ³ /s = 0.04381 m ³ /s
Pressure	Force and Surface Tension
1 lb _f /ft ² = 47.88 Pa, 1 torr = 1 mm Hg 1 psi = 144 psf, 1 bar = 10 ⁵ Pa 1 atm = 2116.2 psf = 14.696 psi = 101,325 Pa = 29.9 in. Hg = 33.9 ft H ₂ O	1 lb _f = 4.448222 N = 16 oz, 1 dyne = 1 g-cm/s ² = 10 ⁻⁵ N 1 kg _f = 2.2046 lb _f = 9.80665 N 1 U.S. (short) ton = 2000 lb _f , 1 N = 0.2248 lb _f 1 N/m = 0.0685 lb _f /ft
Power	Energy and Specific Energy
1 hp = 550 (ft-lb _f)/s = 745.7 W 1 (ft-lb _f)/s = 1.3558 W 1 Watt = 3.4123 Btu/h = 0.00134 hp	1 ft-lb _f = 1.35582 J, 1 hp-h = 2544.5 Btu 1 Btu = 252 cal = 1055.056 J = 778.17 ft-lb _f 1 cal = 4.1855 J, 1 ft-lb _f /lb _m = 2.9890 J/kg
Specific Weight	Heat Flux
1 lb _f /ft ³ = 157.09 N/m ³	1 W/m ² = 0.3171 Btu/(h-ft ²)
Viscosity	Kinematic Viscosity
1 slug/(ft-s) = 47.88 kg/(m-s) = 478.8 poise (p) 1 p = 1 g/(cm-s) = 0.1 kg/(m-s) = 0.002088 slug/(ft-s)	1 ft ² /h = 2.506 · 10 ⁻⁵ m ² /s, 1 ft ² /s = 0.092903 m ² /s 1 stoke (st) = 1 cm ² /s = 0.0001 m ² /s = 0.001076 ft ² /s
Temperature Scale Readings	
$^{\circ}\text{F} = (9/5)^{\circ}\text{C} + 32$	$^{\circ}\text{C} = (5/9)(^{\circ}\text{F} - 32)$
$^{\circ}\text{R} = ^{\circ}\text{F} + 459.69$	$^{\circ}\text{K} = ^{\circ}\text{C} + 273.16$
Specific Heat or Gas Constant*	Thermal Conductivity*
1 (ft-lb _f)/(slug-°R) = 0.16723 (N-m)/(kg-K) 1 Btu/(lb-°R) = 4186.8 J/(kg-K)	1 cal/(s-cm-°C) = 242 Btu/(h-ft-°R) 1 Btu/(h-ft-°R) = 1.7307 W/(m-K)
• Note that the intervals in absolute (Kelvin) and °C are equal. Also, 1 °R = 1 °F. Latent heat: 1 J/kg = 4.2995 × 10 ⁻⁴ Btu/lb _m = 10.76 lb _f -ft/slug = 0.3345 lb _f -ft/lb _m , 1 Btu/lb _m = 2325.9 J/kg. Heat transfer coefficient: 1 Btu/(h-ft ² -°F) = 5.6782 W/(m ² · °C). Heat generation rate: 1 W/m ³ = 0.09665 Btu/(h-ft ³) Heat transfer per unit length: 1 W/m = 1.0403 Btu/(h-ft) Mass transfer coefficient: 1 m/s = 11.811 ft/h, 1 lbmol/(h-ft ²) = .0013562 kgmol/(s-m ²)	