SULIT

POLITEKNIK MALAYSIA

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENDIDIKAN MALAYSIA

JABATAN TEKNOLOGI KIMIA DAN MAKANAN

PEPERIKSAAN AKHIR

SESI DISEMBER 2018

DMT6023: FUNDAMENTALS OF FOOD ENGINEERING

TARIKH : 16 APRIL 2019
MASA : 2.30 PETANG – 4.30 PETANG (2 JAM)

Kertas ini mengandungi **SEPULUH (10)** halaman bercetak.

Struktur (5 soalan)

Dokumen sokongan yang disertakan : Buku Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

Formula

Specific gravity = [density of substance / density of reference]

Hydrostatic pressure = density X gravity X height of liquid

Pressure = Force / Area

Gravity = 9.81 m/s^2

% w/w = [mass of solute/weight of solution] X 100

% w/v = [mass of solute/volume of solution] X 100

Mole = Mass / Relative Molecular Mass

% Mole $_A$ = (mole $_A$ / mole $_{total}$) x 100%

Linear interpolation:

$y = y_1 + [(x - x_1)(y_2 - y_1)/(x_2 - x_1)]$

Enthalpy of vapor-liquid mixtures:

$h = (x)hg + (1-x)h_f$

Linear interpolation

$$y = y_1 + \frac{x - x_1}{x_2 - x_1}(y_2 - y_1)$$

Siebel's equation when fat is present:

Above freezing (>273 K @ 0°C)

Cp = (1674.72F + 837.36SNF + 4186.8M) J/kg.K

Below freezing (<273K @ 0°)

Cp = (1674.72F + 837.36SNF + 2093.4M) J/kg.K

Specific heat equation:

$Cp = a + bT + CT^2 + dT^3$ J/mol.K

Enthalpy change calculation:

$\Delta H = a(T_2 - T_1) + b/2(T_2^2 - T_1^2) + c/3(T_2^3 - T_1^3) + d/4(T_2^4 - T_1^4)$ J/mol.K

Heat flowrate: $Q = mCp(T^2-T^1)$

Conduction heat transfer rate: $q = kA\ (T^2-T^1)/\Delta x$

Composite wall:

$q = \Delta T / R$ total

$R = \Delta x/kA$

Resistances in parallel: $1/R_{AB} = 1/R_A + 1/R_B$

Resistances in series: $R_{BC} = R_B + R_C$

Continuity equation: $A_1V_1 = A_2V_2$

Velocity: $v = Q/A$

$$\text{Velocity} = V_B = \frac{D_A^2 - V_A}{D_B^2}$$

Cross sectional area for pipe: $A = \pi/4\ (D^2)$

Bernoulli equation:

$P_1/\rho g + v_1^2/2g + z_1 = P_2/\rho g + v_2^2/2g + z_2$

Pressure different of Bernoulli equation between two section :

$P_1 - P_2 = \{(v_2^2 - v_1^2/2g) + Z_2 - Z_1\} \times \rho g$

Velocity of liquid flow from nozzle, $V = \sqrt{2gh}$

Mass flowrate of refrigerant:

$m = q / (Hcv - H_L)$

where, q = total refrigeration load (kJ/s)

Power required for compressor:

$$q_e = \dot{m}(H_{hv} - H_{cv})$$

$$COP = \frac{H_{cv} - H_L}{H_{hv} - H_{cv}}$$

INSTRUCTION:
This section consists of **FIVE (5)** structured questions. Answer **ALL** questions.

ARAHAN:
*Bahagian ini mengandungi **LIMA (5)** soalan berstruktur. Jawab **SEMUA** soalan.*

QUESTION 1
SOALAN 1

CLO1
C1

(a) State if the following units are SI base units or derived units:

Nyatakan samada unit-unit yang berikut adalah unit asas SI atau unit terbitan:

(i) $m.kg.s^{-2}$ [1 mark]
[*1 markah*]

(ii) mole [1 mark]
[*1 markah*]

CLO1
C2

(b) A sauce factory is required to produce 337 $cm^3/s.°C$ of tomato sauce. As a Food Engineer, you have to convert the units to $m^3/hr.K$ for machines requirements. Show your calculation.

Sebuah kilang sos perlu menghasilkan sebanyak 337 $cm^3/s.°C$ sos tomato. Sebagai Jurutera Makanan, anda dikehendaki menukarkan unit tersebut kepada $m^3/hr.K$ bagi keperluan mesin. Tunjukkan pengiraan anda.

[5 marks]
[*5 markah*]

CLO1
C3

(c) To prolong the shelf life of frozen minced meat produced by Mutu Bagus Sdn Bhd a modified atmosphere packaging is used which contains a mixture of gases. The mixture consists of 50% CO_2, 30% N_2 and 20% O_2. Calculate the mole fraction of each gas.

Bagi memanjangkan jangka hayat daging kisar beku, syarikat Mutu Bagus Sdn Bhd menggunakan pembungkusan atmosfera terubahsuai dimana ianya mengandungi campuran beberapa gas. Campuran tersebut terdiri daripada 50% CO_2, 30% N_2 dan 20% O_2. Kirakan pecahan mol bagi setiap gas tersebut.

[9 marks]
[*9 markah*]

CLO1
C3

(d) A tank is fully filled with lime juice. The height of the tank is 1.5m. The density for lime juice is 1038.78 kg/m^3. Find the hydrostatic pressure at the bottom of the tank.

Sebuah tangki diisi penuh dengan jus limau. Ketinggian tangki tersebut adalah 1.5m. Ketumpatan jus limau adalah 1038.78 kg/m^3. Hitungkan tekanan hidrostatik pada dasar tangki tersebut.

[4 marks]
[*4 markah*]

QUESTION 2
SOALAN 2

CLO1
C1

(a) Define the basic principle of mass balance.

Nyatakan prinsip asas bagi imbangan jisim.

[2 marks]
[*2 markah*]

CLO1
C3

(b)

Mixing Process
Proses Campuran
Pineapple juice (55% liquid, 45% solid) mixed with orange juice (35% liquid, 65% solid)
Jus nanas (55% cecair, 45% pepejal) dicampur dengan jus oren (35% cecair, 65% pepejal)

↓

Evaporation Process
Proses Penyejatan
Remove water to produce mixed fruit juice (70% liquid, 30% solid)
Singkirkan air untuk menghasilkan jus buah (70% cecair, 30% pepejal)

Figure 2(b)
Rajah 2(b)

Ahmad is a Quality Control Officer in a company that produces mixed fruit juice. He has to make sure that the mixed fruit juice goes through mixing and evaporation process before it is bottled. Using the statement in Figure 2(b), draw and label the process flow diagram involved in producing the juice.

Ahmad adalah seorang Pegawai Kawalan Kualiti di kilang yang menghasilkan jus buah campuran. Dia perlu memastikan jus tersebut menjalani proses pencampuran dan penyejatan sebelum dibotolkan. Menggunakan pernyataan di dalam Rajah 2(b), lakar dan labelkan gambarajah aliran proses tersebut.

[6 marks]
[*6 markah*]

CLO1
C3

(c) During the evaporation process of the mixed fruit juice, the sugar concentration increased from 10% to 65%. Using the process flow diagram in Figure 2(c) find the amount of water evaporated after the evaporation process.

Semasa jus buah campuran mengalami proses penyejatan, kepekatan gula di dalam jus tersebut meningkat dari 10% ke 65%. Menggunakan gambarajah aliran proses di dalam Rajah 2(c), cari jumlah air yang tersejat selepas proses penyejatan.

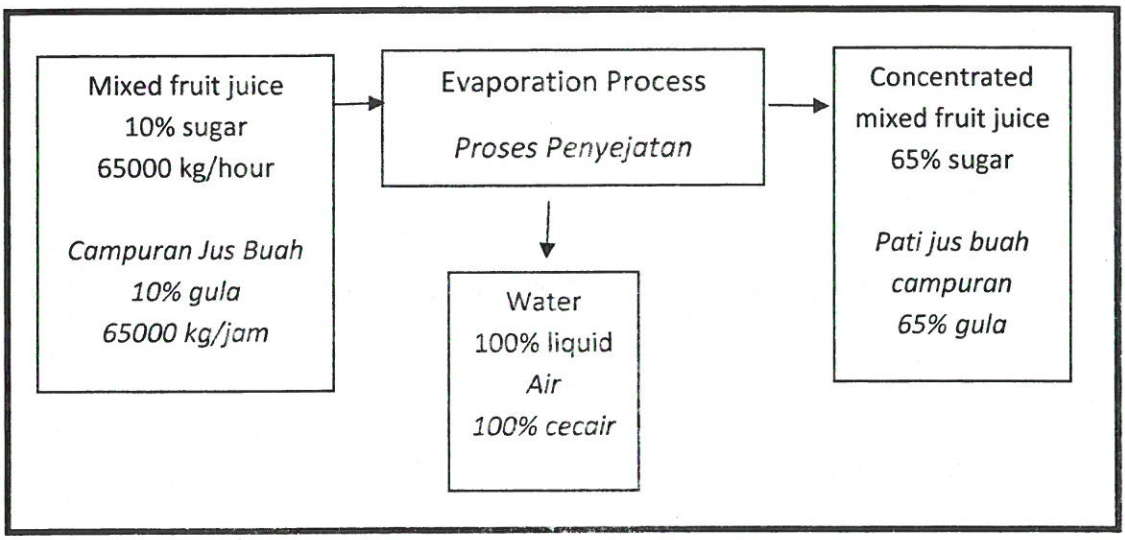


Figure 2(c)
Rajah 2(c)

[6 marks]
[*6 markah*]

CLO1
C3

(d) A tank containing 70% salt concentration is used to soak the vegetables for vegetables pickles production. The tank is already filled with 100kg of salt water at 40% salt concentration. Calculate the amount of salt required to be added into the tank so that the concentration increases from 40% to 70%.

Tangki yang mengandungi 70% kepekatan garam digunakan untuk merendam sayur-sayuran bagi penghasilan jeruk sayuran. Tangki tersebut telah terisi dengan 100kg air garam berkepekatan 40%. Kirakan jumlah garam yang perlu ditambah untuk meningkatkan kepekatan garam dari 40% ke 70%.

[6 marks]
[*6 markah*]

QUESTION 3
SOALAN 3

CLO1
C2

(a) A steam boiler at a food processing plant is operating at pressure of 12 MPa with temperature of 570 °C. Using the steam table, calculate the enthalpy for the steam produced.

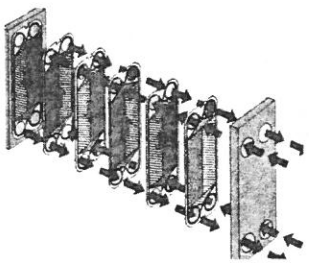
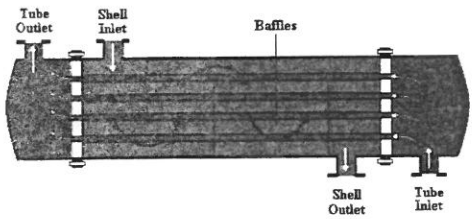
Sebuah dandang di kilang pemprosesan makanan beroperasi pada tekanan 12MPa dan pada suhu 570 °C. Menggunakan jadual stim, kira entalpi bagi wap yang terhasil.

[5 marks]
[*5 markah*]

CLO1
C3

Table 3(b)
Jadual 3(b)

(b)

Plate Heat Exchanger	Shell and Tube Heat Exchanger
	
Pressure: 1.2 MPa *Tekanan : 1.2 MPa* Steam quality: 80% *Kualiti Stim: 80%*	Temperature: 146 °C *Suhu: 146°C* Steam quality: 100% *Kualiti Stim : 100%*

In a milk factory, an assistant engineer is assigned to buy a new heat exchanger for the Ultra High Temperature (UHT) pasteurization process. By referring the specifications in Table 3(b):

Di sebuah kilang susu seorang pembantu jurutera ditugaskan untuk membeli alat penukar haba yang baharu bagi proses pempasteuran Suhu Tinggi Ultra (STU). Dengan merujuk spesifikasi di dalam Jadual 3(b):

(i) Calculate the steam enthalpy for each of the exchangers in Table 3(b).
Kirakan entalpi stim bagi setiap penukar haba di dalam Jadual 3(b).

[8 marks]
[*8 markah*]

(ii) Identify the heat exchanger that the assistant engineer should buy.
Kenalpasti penukar haba yang perlu dibeli oleh pembantu jurutera tersebut.

[1 mark]
[*1 markah*]

CLO1
C4

(c) For *hari raya* celebration, Shah cooked *rendang* in a pot made from stainless steel. The pot has a diameter of 30 cm, height 50 cm and the thickness is 5cm. The *rendang* was cooked at 80°C while the surrounding temperature is 30 °C.

The thermal conductivity of stainless steel is 21 W/m °C. Calculate the rate of heat transfer.

Shah telah memasak rendang untuk sambutan hari raya di dalam sebuah periuk keluli tahan karat. Periuk tersebut berdiameter 30 cm, ketinggiannya 50 cm dan ketebalannya 5 cm. Rendang itu dimasak pada suhu 80°C manakala suhu sekeliling adalah 30°C. Haba kekonduksian keluli tahan karat adalah 21 W/m °C. Kirakan kadar pemindahan haba.

[6 marks]
[*6 markah*]

QUESTION 4
SOALAN 4

CLO1
C1

(a) Heat transfer is important in food processing as certain foods are temperature sensitive. Define heat transfer.

Pemindahan haba di dalam pemprosesan makanan adalah penting kerana terdapat beberapa makanan yang sensitif terhadap perubahan suhu. Berikan definisi pemindahan haba.

[2 marks]
[*2 markah*]

CLO1
C2

(b) To ensure optimum flow conditions of orange juice are met, the cross sectional area of the pipes in the processing line narrowed down from 10 m^2 to 5m^2. With the information given in Figure 4b calculate the fluid velocity of the orange juice at the end of the pipe.

Bagi memastikan keadaan optimum aliran jus oren dicapai, luas keratan rentas paip di dalam kilang pemprosesan mengalami pengurangan dari 10m^2 ke 5m^2. Dengan menggunakan maklumat pada Rajah 4b kirakan halaju jus oren tersebut pada hujung paip.

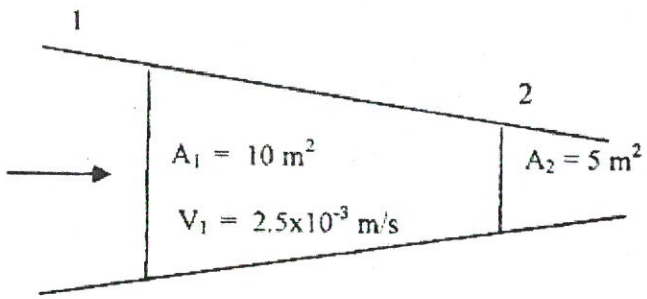


Figure 4(b)
Rajah 4(b)

[5 marks]
[*5 markah*]

(c)

CLO1
C3

Table 4(c)
Jadual 4(c)

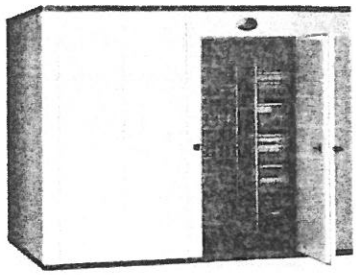


Figure 4(c)
Rajah 4(c)

Material	Thickness (m)	Area (m^2)	Thermal Conductivity (W/m°C)
Brick	3 m	60 m^2	200 W/m^0C
Cork	5 m	100 m^2	30 W/m^0C

Figure 4(c) shows the wall of a cold storage room with series of insulation by layers of brick and cork. The temperature inside the cold storage room is -4°C while the temperature outside is 21°C. By using the properties of the materials given in Table 4(c) calculate the heat loss of the cold storage room.

Rajah 4(c) menunjukkan sebuah bilik simpanan sejuk dengan beberapa siri penebat dengan lapisan bata dan gabus. Suhu di dalam bilik tersebut adalah -4°C manakala suhu luar adalah 21°C. Dengan menggunakan sifat-sifat bahan yang diberikan dalam Jadual 4(c) kirakan kadar kehilangan haba daripada bilik simpanan sejuk itu.

[7 marks]
[*7 markah*]

CLO1
C4

(d) The flow characteristics of fluid in pipes at a food processing plant can be determined by calculating the Reynold's Number. Compare the **THREE (3)** types of fluid flow by using appropriate flow diagrams.

*Sifat aliran cecair di dalam paip pada kilang pemprosesan makanan boleh ditentukan dengan mengira Nombor Reynold. Bandingkan **TIGA (3)** jenis aliran cecair dengan menggunakan gambarajah aliran yang sesuai.*

[6 marks]
[*6 markah*]

QUESTION 5
SOALAN 5

CLO1
C1

(a) Drying process is one of the methods used in food preservation. List **TWO (2)** types of dryer commonly used in food industry.

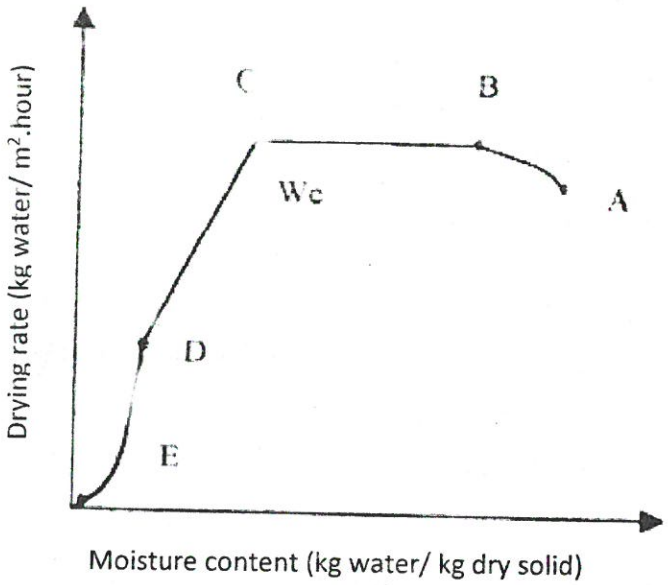
*Proses pengeringan adalah salah satu kaedah dalam pengawetan makanan. Senaraikan **DUA (2)** alat pengering yang sering digunakan di dalam industri makanan.*

[2 marks]
[*2 markah*]

CLO1
C2

(b) A drying rate curve of mango slices is plotted as in Graph 5(b) during the drying process in a drying oven. Explain the stages of drying in terms of water content and temperatures involved.

Lengkung kadar pengeringan seperti dalam Graf 5(b) diplot semasa proses pengeringan kepingan mangga di dalam oven pengering dijalankan. Terangkan peringkat-peringkat pengeringan yang berlaku dari sudut kandungan air dan suhu yang terlibat.



Graph 5(b)
Graf 5(b)

[5 marks]
[*5 markah*]

CLO1
C3

(c) Using the Psychrometric Chart, determine the relative humidity, absolute humidity and dew point for air-vapor mixture which have 60°C dry bulb temperature and 35°C wet bulb temperature.

Menggunakan Carta Psikrometrik, tentukan kelembapan relatif, kelembapan mutlak dan titik embun bagi campuran udara-wap yang mempunyai suhu bebuli kering 60°C dan suhu bebuli basah 35°C.

[6 marks]
[*6 markah*]

CLO1
C3

(d) A cold storage room's temperature is maintained at 20°C by using Freon 12 as the refrigerant in a mechanical refrigeration system. The evaporator and condenser temperature was -5°C and 40°C respectively. Cooling load is 70.34 kJ/s. Calculate:

Suhu sebuah bilik simpanan sejuk dikekalkan pada 20°C dengan menggunakan Freon 12 sebagai bahan pendingin di dalam sistem penyejukan mekanikal. Suhu penyejat dan pemeluwap masing-masing ialah -5°C dan 40°C. Beban penyejukan adalah 70.34 kJ/s. Kirakan:

(i) Mass flow rate of refrigerant.
Kadar aliran jisim bagi bahan pendingin.

(ii) Power required for the compressor if the compressor efficiency is 85%.
Kuasa yang diperlukan oleh pemampat jika kecekapan pemampat ialah 85%.

[7 marks]
[*7 markah*]

SOALAN TAMAT