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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2017/2018

COURSE NAME	:	FOOD TECHNOLOGY UNIT PROCESS 1
COURSE CODE	:	BWD 20903
PROGRAMME CODE	:	BWD
EXAMINATION DATE	:	JUNE / JULY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

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Q1 The operations carried out in the industrial processes may be performed in **THREE (3)** different ways; discontinuous/batch, continuous and semi-continuous/semi-batch. Analyse and compare the principles, advantages, and disadvantages of both operations as shown in **Figure Q1**.

(20 marks)

Q2 (a) 255 grams of water is heated from 25°C to 100°C. Calculate the amount of heat absorbed by the water. Given that the specific heat of water is 4.18 $Jg^{-1}{}^{o}C^{-1}$.

(5 marks)

(b) If air consists of 77% by weight of nitrogen and 23% by weight of oxygen. Calculate:

(i) the mean molecular weight of air

(ii) the mole fraction of oxygen

(iii) the concentration of oxygen in $molm^{-3}$ and kgm^{-3} if the total pressure is 1.5 atmosphere and the temperature is 25°C.

(Molecular weight of nitrogen is 28 $gmol^{-1}$ and oxygen is 32 $gmol^{-1}$; R constant is 0.0821 $m^3mol^{-1}K^{-1}$)

(15 marks)

Q3 (a) A heat exchanger is a device designed to efficiently transfer or exchange heat from one matter to another. 1 kgs^{-1} of air at 24°C is heated in a heat exchanger using saturated steam at 136 kNm^{-2} (1.36 bar). The flow rate of steam is 0.01 kgs^{-1} and the condensate (which is at 1.36 bar) leaves the heat exchanger at 84°C. If the specific heat capacity of air is 1.005 $kJkg^{-1}$, determine the exit temperature of air. Assume no heat is lost.

(Enthalpy of steam at 1.36 bar = 368 $kJkg^{-1}$; enthalpy of water at 84°C and 1.36 bar = 2689 $kJkg^{-1}$).

(10 marks)

(b) Calculate the rate of convection heat loss to ambient air from the side walls of a cooking vessel in the form of a vertical cylinder 0.9 m in diameter and 1.2 m high. The outside of the vessel insulation, facing ambient air, is found to be at 49°C and the air temperature is 17°C.

(Viscosity = 1.9×10^{-5} Nsm^{-2}, specific heat at constant pressure = 1.0 $kJkg^{-1}{}^{o}C^{-1}$, thermal conductivity = 0.025 $Jm^{-1}s^{-1}{}^{o}C^{-1}$, coefficient of thermal expansion = 1/308, density = 1.12 kgm^{-3})

(10 marks)

Q4 (a) Compare and contrast between Newtonian and Bingham plastic types of fluid behaviour.

(10 marks)

(b) Shear-thinning products need to be shaken in a jar or mixed at high intensity in a mixer which may aid in their mixing. Distinguish what could have happened if the mixing or shearing action is stopped after a certain period of time. Use diagrams to support your answer.

(10 marks)

Q5 (a) There are several factors affecting convection rate. Identify **FIVE (5)** factors that could affect natural convection rate.

(5 marks)

(b) Calculate the steam requirement as you start to heat 50 kg of pea soup in a jacketed pan, if the initial temperature of the soup is 18°C and the steam used is at 100 kPa gauge. The pan has a heating surface of 1 m^2 and overall heat transfer coefficient is assumed to be 300 $Jm^{-2}s^{-1}°C^{-1}$ (refer to **Table Q5(b)**).

(5 marks)

(c) Continuous-flow heat exchangers have **THREE (3)** types of flow directions; parallel, counter and cross flows. Differentiate between counter flow and cross flow. Use diagrams to aid your answer.

(10 marks)

– END OF QUESTIONS –

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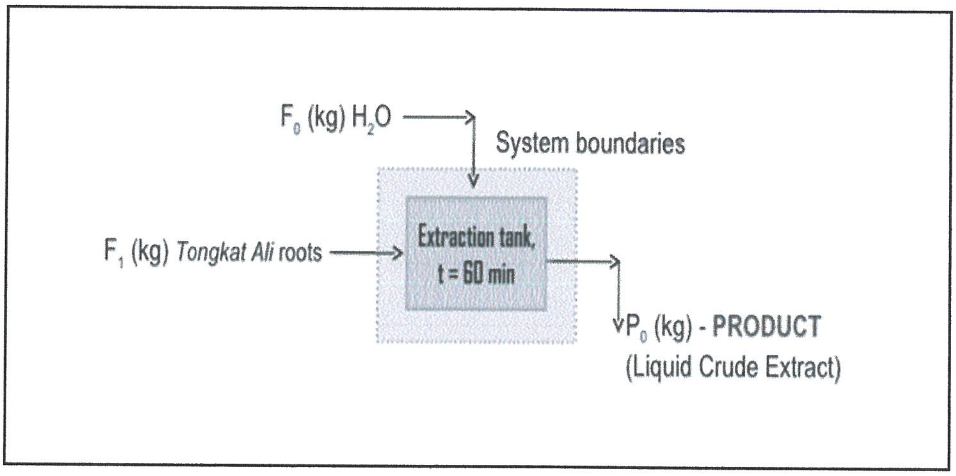
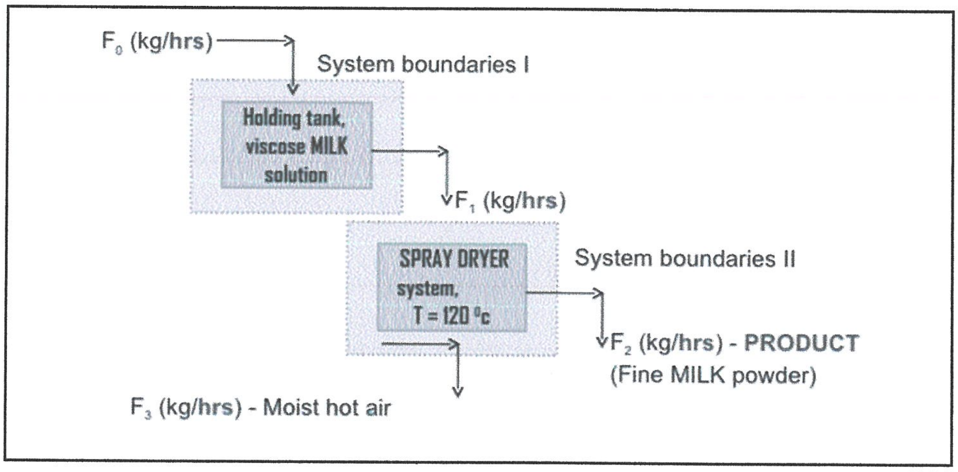


(a)



(b)

Figure Q1: (a) Operation 1 and (b) Operation 2

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Table Q5(b): Steam Table - Saturated Steam

Pressure Table

Temperature (°C)	Pressure (Absolute) (kPa)	Enthalpy (sat.vap.) ($kJkg^{-1}$)	Latent heat ($kJkg^{-1}$)	Specific volume (m^3kg^{-1})
7.0	1.0	2514	2485	129
9.7	1.2	2519	2479	109
12.0	1.4	2523	2473	93.9
14.0	1.6	2527	2468	82.8
15.8	1.8	2531	2464	74.0
17.5	2.0	2534	2460	67.0
21.1	2.5	2540	2452	54.3
24.1	3.0	2546	2445	45.7
29.0	4.0	2554	2433	34.8
32.9	5.0	2562	2424	28.2
40.3	7.5	2575	2406	19.2
45.8	10.0	2585	2393	14.7
60.1	20.0	2610	2358	7.65
75.9	40.0	2637	2319	3.99
93.5	80.0	2666	2274	2.09
99.6	100	2676	2258	1.69
102.3	119	2680	2251	1.55
104.8	120	2684	2244	1.43
107.1	130	2687	2238	1.33
109.3	140	2690	2232	1.24
111.4	150	2694	2227	1.16
113.3	160	2696	2221	1.09
115.2	170	2699	2216	1.03
116.9	180	2702	2211	0.978
118.6	190	2704	2207	0.929
120.2	200	2707	2202	0.886
127.4	250	2717	2182	0.719
133.6	300	2725	2164	0.606
138.9	350	2732	2148	0.524
143.6	400	2739	2134	0.463

Note Gauge pressure ≈ Absolute pressure + 100 kPa

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List of Formula

$$(Pr.Gr) = (c_p\mu/k)(L^3\rho^2 g\beta\Delta T/\mu^2)$$

Natural convection about vertical cylinders and planes, such as vertical retorts and oven walls

$$(Nu) = 0.53(Pr.Gr)^{0.25} \text{ for } 10^4 < (Pr.Gr) < 10^9, \quad h_c = 1.3(\Delta T/L)^{0.25}$$

$$(Nu) = 0.12(Pr.Gr)^{0.33} \text{ for } 10^9 < (Pr.Gr) < 10^{12}, \quad h_c = 1.8(\Delta T)^{0.25}$$

Natural convection about horizontal cylinders such as a steam pipe or sausages lying on a rack

$$(Nu) = 0.54(Pr.Gr)^{0.25} \text{ for laminar flow in range } 10^3 < (Pr.Gr) < 10^9$$

$$\text{for } 10^4 < (Pr.Gr) < 10^9, \quad h_c - 1.3(\Delta T/D)^{0.25}$$

$$\text{and for } 10^9 < (Pr.Gr) < 10^{12}, \quad h_c = 1.8(\Delta T)^{0.33}$$

$$A = \pi DL$$

$$\text{Heat loss rate} = h_c A(T_1 - T_2)$$

$$q = UA\,\Delta T_m$$

$$q = c_p G(T_1 - T_2)$$

$$\text{so} \quad q = UA\,\Delta T_m = c_p G(T_1 - T_2)$$

$$= UA/\ln(\Delta T_1/\Delta T_2)] \text{ x } (T_1 - T_2)$$

$$\text{but } (T_1 - T_2) \text{ can be written } (T_1 - T_b) - (T_2 - T_b),$$

$$\text{so} \quad (T_1 - T_2) = (\Delta T_1 - \Delta T_2)$$

$$\text{Thus} \quad UA\,\Delta T_m = UA(\Delta T_1 - \Delta T_2)/\ln(\Delta T_1/\Delta T_2)\,(DT_1/DT_2)$$

$$\text{so} \quad \Delta T_m = (\Delta T_1 - \Delta T_2)/\ln(\Delta T_1/\Delta T_2)$$

$$q = UA\Delta T$$

$$\text{amount of steam} = q/\lambda$$