

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES
BACHELOR OF SCIENCE (HONS) DEGREE
Part Two Examination May 2005

SCH 2218 PRINCIPLES OF PROCESS ENGINEERING (BIOLOGY
STREAM)

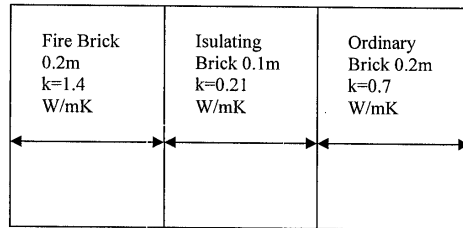
Duration of Examination 3 Hours

Instructions to Candidates:

1. Answer any four questions only.
2. All questions carry equal marks.

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- (1) A liquid is pumped at 4.5 tones/hr (1.25kg/s) through a 25mm diameter pipe, 30m long, to a tank 12m higher than the feed point.
The viscosity of the liquid = 25mNs/m²
The density of the liquid = 1840kg/m³
- (a) Calculate the Reynolds number (5)
(b) Calculate the velocity of the liquid in the pipe (5)
(c) Given that $\Delta p_f = 4\Phi L \rho u^2 / d$ where $\Phi = R / \rho u^2$ and $R / \rho u^2 = 0.006$ where 'L' is the length, 'd' diameter of the pipe 'u' velocity 'ρ' density. calculate the pressure drop in the pipe line (5)
(d) Calculate the power of the pump require to pump the liquid assuming that the pump is 50% efficient (5)
- (e) Show that Reynolds number is a dimensionless number (5)
- (2) (i) A Heat exchanger is required to cool 20kg/s of water from 360K to 340K by means of 25kg/s water entering at 300K. If the overall coefficient of heat transfer is constant at 2kW/m²K, calculate the surface area required in
(a) a counter current concentric tube (8)
(b) a co- current flow concentric tube exchanger (8)

(ii) A furnace is constructed with 0.2m of firebrick, 0.1m of insulating brick and 0.20m of building brick. The inside temperature is 1200K and the outside temperature 330K. If the thermal conductivities are as shown below, find the heat loss per unit area and the temperature at the junction of the fire brick and the insulating brick. (9)



(3) Describe how the following Equipment works

(a) A continuous distillation column (10)

(b) A multiple effect evaporator (15)

(4) (a) State Bernoulli's theorem and write the Bernoulli equation for a horizontal tapering pipe. (5)

(b) State 3 types of positive displacement rotary pumps and 2 types of positive displacement reciprocating pumps (5)

(c) State 5 types of Heat exchangers. (5)

(d) State the two types of distillation columns and the 3 types of conducting plates used in distillation columns (5)

(5) A continuous rectifying column treats a mixture consisting of 40% of benzene by mass and 60% of toluene at the rate of 4kg/s, and separates it into a product containing 97% of benzene and a liquid, and separates it into a product containing 97% of benzene and a liquid containing 98% toluene. The feed is liquid at its boiling point so the q -line is vertical. The equilibrium data is as follows

Mol Fraction of Benzene in liquid x_i	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Mol Fraction of Benzene in vapour y_i	0.22	0.38	0.51	0.63	0.7	0.78	0.85	0.91	0.96

(a) Calculate the masses of distillate and waste liquor per unit time (6)

(b) If a reflux ratio of 3.5 to 1 is employed, how many plates are required in the rectifying part of the column? (15)

(c) What is the actual number of plates if the plate efficiency is 60% (4)