Question Paper

Exam Date & Time: 26-Nov-2019 (08:30 AM - 11:30 AM)

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

THIRD SEMESTER B.TECH END SEMESTER EXAMINATIONS, NOV 2019

BIOPROCESS CALCULATIONS [BIO 2152]

Marks: 50 **Duration: 180 mins.**

A

Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) Why we need interaction between Biologist and Engineers in process Development? (4)

A)

B) In biological systems, enzymes are used to accelerate the rates of certain biological reactions. Glucoamylase is an enzyme that aids in the conversion of starch to glucose. Experiments show that 1 µg mol of glucoamylase in a 4% starch solution results in a production rate of glucose of 0.6 µg mol/(mL. min). Determine the production rate of glucose for this system in the units of lb mol/(ft^3 .day)? (3)

C) 10 kg of liquid A of specific gravity 1.17 is mixed with 5 kg of liquid B of specific gravity 0.83. Assuming that there is no volume change on mixing, what is the specific gravity of mixture? (3)

2) In a batch reactor of volume 105 L, the final desired yeast concentration is 50 g/l. The growth of baker's yeast on glucose may be simply described by the following equation: (3)

A)

$$C_6H_{12}O_6 + 3O_2 + 0.48NH_3 \rightarrow 0.48C_6H_{10}NO_3 + 4.32H_2O + 3.12CO_2$$

Using the above reaction stoichiometry:

(a) Determine the total amount of glucose required.

(b) Determine the yield coefficients Y_{XS}

(c) Determine the total amount of oxygen required.

B) A pharmacist dissolved a few milligrams of a new antibiotic drug into exactly 100 mL of distilled water and placed the solution in a refrigerator (5°C). At various time intervals, the pharmacist removed a 10-mL aliquot from the solution and measured the amount of drug contained in each aliquot. The following data were obtained. (3)

Time (h)	0.5	1	2	4	6	8	12
Antibiotic (µg/mL)	84.5	81.2	74.5	61	48	35	8.7

(a) Data follows linear equation and find the constants in the equation?
(b) How many milligrams of antibiotics were in the original solution prepared by the pharmacist?

C) If air consists of 77% by weight of nitrogen and 23% by weight of oxygen calculate: (4)

(a) the mean molecular weight of air,

(b) the mole fraction of oxygen,

(c) the concentration of oxygen in mole m^{-3} and kg m^{-3} if the total pressure is 1.5 atmospheres and the temperature is 25°C.

3) Skim milk is prepared by the removal of some of the fat from whole milk. This skim milk is found to contain 90.5% water, 3.5% protein, 5.1% carbohydrate, 0.1 % fat and 0.8% ash. If the original milk contained 4.5% fat, calculate (3)

A) its composition, assuming that fat only was removed to make the skim milk and that there are no losses in processing.

B) Potatoes are dried from 14% total solids to 93% total solids. What is the product yield from each 1000 kg of raw potatoes assuming that 8% by weight of the original potatoes is lost in peeling? (2)

C) A single cell protein product from yeast is to be dried in hot air and the moisture content reduced from 20% to 2%. Fresh air contains 0.02 kg water per kg of dry air. Find the volume of fresh air required if 1000 kg of the dried yeast is to be produced. The exit air contains 0.09 kg of water per kg of dry air. Air enters at 300 K and one atm pressure. (5)

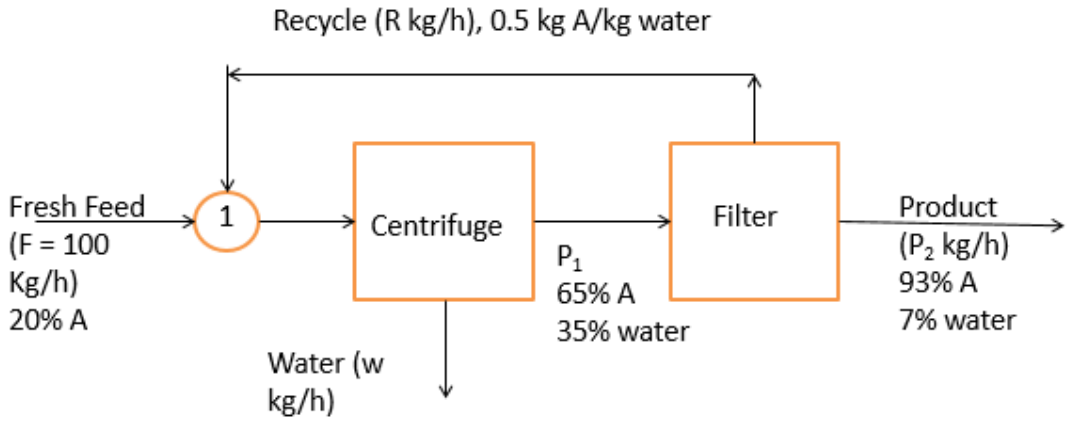
4) Xanthan gum is produced using *Xanthomonas campestris* in batch culture. Laboratory experiments have shown that for each gram of glucose utilised by the bacteria, 0.23 g oxygen and 0.01 g ammonia are consumed, while 0.75 g gum, 0.09 g cells, 0.27 g gaseous CO_2 and 0.13 g H_2O are formed. Medium containing glucose and ammonia dissolved in 20, 000 litres water is pumped into a stirred fermenter and inoculated with X. *campestris. Air* is sparged into the fermenter; the total amount of off-gas recovered during the entire batch culture is 1250 kg. Because of the high viscosity and difficulty in handling xanthan-gum solutions, the final gum concentration should not be allowed to exceed 3.5 wt%. Assume complete conversion of glucose and Ammonia (4)

A)

(a) How much glucose and ammonia are required?

(b) Calculate wt% of components in off gas.

B) Final purification stage in the preparation of certain pharmaceutical product 'A' from natural sources required centrifuging and continuous filtration as depicted in figure. Determine the flow rate of the recycle stream and product leaving the filter in kg/h. (4)



C) The specific heat of apple juice is given as 0.86 Btu lb^{-1} $°F^{-1}$. Calculate this in J $kg^{-1}°C^{-1}$ (2)

5) In determining the rate of heating of a tank of 20% sugar syrup, the temperature at the beginning was 20°C and it took 30 min to heat to 80°C. The volume of the sugar syrup was 50 ft^3 and its density 66.9 $lbft^{-3}$. The specific heat of sugar syrup is 0.9 Btu lb^{-1} F^{-1} (3)

A)

(a) Convert the specific heat to kJ kg^{-1} C^{-1}

(b) Determine the average rate of heating, that is the heat energy transferred in unit time, in SI units (kJs^{-1})

B) A stream of nitrogen flowing at a rate of 100 k mole/h is heated from 303 K to 373 K. Calculate the heat that must be transferred. Molar heat capacity is given below in polynomial form as: (3)

$C_P(N_2) = 29.5909 - 5.141*10^{-3}\ T + 11.1829*10^{-6}\ T^2 - 4.968*10^{-9}\ T^3$

C) (4)

An electric heating coil is immersed in a stirred tank. Solvent at 15 ^{o}C with heat capacity 2.1 $\frac{kJ}{kg.°C}$ is fed into the tank at a rate of 15 kg/h. Heated solvent is discharged at the same flow rate. The tank is filled initially with 125 kg cold solvent at 10 ^{o}C. The rate of heating by the electric coil is 800 W. Calculate the time required for the temperature of the solvent to reach 60 ^{o}C. Assume that heat capacity is independent of temperature.

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