| Reg. No. | | | | | | | | | | |
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# MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

*(A constituent institution of MAHE, Manipal)*

## III SEMESTER B.TECH. (BIOTECHNOLOGY)

## END SEMESTER EXAMINATIONS,

SUBJECT: Bioprocess Calculations [BIO 2104]

**REVISED CREDIT SYSTEM**

Time: 3 Hours MAX. MARKS: 50

**Instructions to Candidates:**

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

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| **1A.** | 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)? | **2** |
| **1B.** | The average molecular weight of an off – gas sample from a fermenter is calculated by two different engineers. One engineer used the correct molecular weight of $N_2$ as 28, while the other used an incorrect value of 14. They got the average molecular weight as 30.08 and the incorrect one as 18.74. Calculate the mole % of $N_2$ in the off-gas, if the remaining gases are $CO_2$ and $O_2$. | **5** |
| **1C.** | A biochemist prepared 20% NaOH (MW=40) by weight caustic soda solution. Taking density of the solution as 1.196 kg/L. find normality, molarity and molality of the solution. | **3** |
| **2A.** | Why we need interaction between Biologist and Engineers in process Development? | **4** |
| **2B.** | One kmol $CO_2$ occupies a volume of 0.381 $m^3$ at 313 K. compare the pressures given by the<br>(a) Ideal gas equation<br>(b) Van der waals equation<br>Take the van der waals constants to be a=0.365 (N $m^4/mol^2$) and b=4.28*$10^{-5}$ $m^3$/mol | **3** |
| **2C.** | If air consists of 77% by weight of nitrogen and 23% by weight of oxygen calculate:<br>(a) the mean molecular weight of air,<br>(b) the mole fraction of oxygen,<br>(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** |
| **3A.** | For the filtration of a cell broth, the constant pressure filtration was employed. During the process the following observations were made and observed.<br>Time (min): 3, 15, 45, 65, 110<br>Volume(V) in L: 90, 300, 650, 820, 1150<br>The above data follows the following equation.<br>$\frac{t}{V} = \frac{1}{K}(V + 2V_o)$ | **3** |

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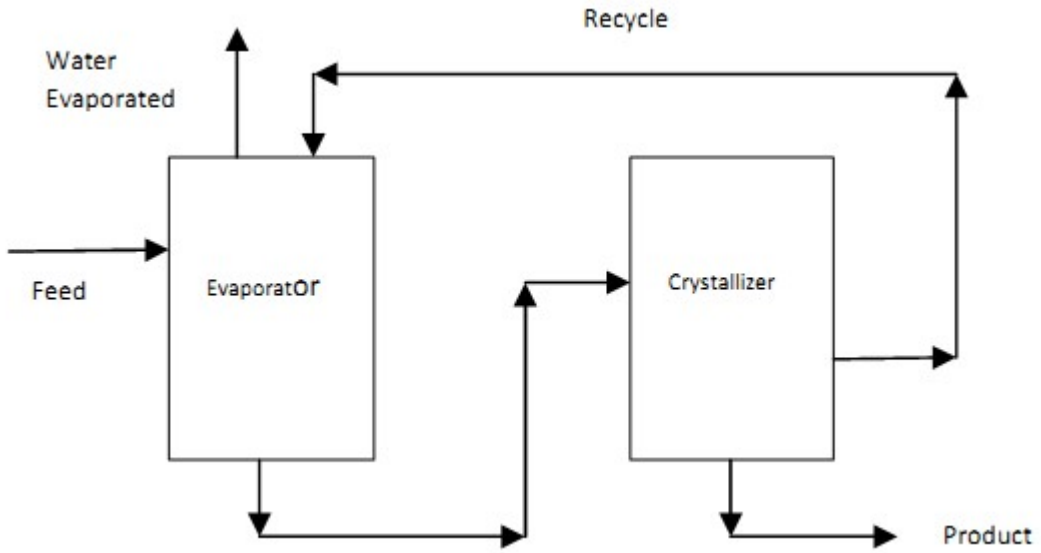
| | Calculate **K** and $\mathbf{V_o}$ by plotting the data. | |
| **3B.** | Production of recombinant protein by a genetically $CH_{1.77}O_{0.49}N_{0.24}$ engineered strain of *E.coli* is proportional to cell growth. Ammonia is used as nitrogen source for aerobic respiration of glucose. The recombinant protein has an overall formula $CH_{1.55}O_{0.31}N_{0.25}$. The yield of biomass from glucose is measured as 0.48g/g the yield of recombinant protein from glucose is about 20% that for cells.<br>(a) How much ammonia is required?<br>(b) What is the oxygen demand?<br>(c).If the biomass yield remains at 0.48 g/g, how much different are the ammonia and oxygen requirements for wild-type *E.coli* unable to synthesize recombinant protein? | **4** |
| **3C.** | A cellulose solution containing 5% cellulose by weight in water. It is to be diluted to 4% using 1% solution of cellulose in water. Determine the kilograms of 1% solution required to dilute 100 kg of the 5% solution. | **3** |
| **4A.** | In a process producing $KNO_3$ salt, 1000 kg/h of a feed solution containing 10% $KNO_3$ is fed to an evaporator which evaporates some water to produce a 50% $KNO_3$ solution. This is then fed to a crystallizer, where crystals containing 95% $KNO_3$ are removed. The saturated solution containing 35% KNO3 is recycled to the evaporator. Calculate the following:<br>(a) The amount of recycle stream, kg/h<br>(b) The amount of crystals, kg/h<br>(c) The quantity of water evaporated, kg/h<br>  | **6** |
| **4B.** | Fresh orange juice contains 12% by weight solids and the balance water. The concentrated juice contains 42% solids. Initially a single evaporation process was used for the concentration but the volatile constituents of the juice escaped with water leaving the concentrate with a flat taste. The present process overcomes this problem by bypassing the evaporation with a fraction of the fresh juice. The juice that enters the evaporator is concentrated to 58% solids and the product is mixed with the bypassed fresh juice to achieve the desired concentration of solids. Calculate the amount of concentrated juice produced per 100kg of fresh juice to the process and the bypass ratio expressed as the quantity that is bypassed to the quantity that entering the evaporator. | **4** |
| **5A.** | 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 $lb^{-1}$ $F^{-1}$<br>(a) Convert the specific heat to kJ $kg^{-1}$ $C^{-1}$<br>(b) Determine the average rate of heating, that is the heat energy transferred in unit time, in SI units ($kJs^{-1}$) | **2** |

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| **5B** | The enzyme, glucose oxidase, is used commercially to remove glucose from dehydrated egg to improve colour, flavour and shelf-life. The reaction is:<br>$C_6H_{12}O_6 + O_2 + H_2O \rightarrow C_6H_{12}O_7 + H_2O_2$<br>(glucose) (gluconic acid)<br>A continuous-flow reactor is set up using immobilised-enzyme beads which are retained inside the vessel. Dehydrated slurry containing 2% glucose, 20% water and the remainder unreactive egg solids, is available at a rate of 3,000 kg/h. Air is pumped through the reactor contents so that 18 kg oxygen are delivered per hour. The desired glucose level in the dehydrated egg product leaving the enzyme reactor is 0.2%. Determine:<br>(a) Which is the limiting substrate;<br>(b) the percentage excess substrate;<br>(c) the composition of the reactor off-gas; and<br>(d) the composition of the final egg product. | **8** |