R9

Code: 9A23303

B.Tech II Year I Semester (R09) Supplementary Examinations, May 2013

FLUID FLOW IN BIOPROCESSES

(Biotechnology)

Time: 3 hours Max Marks: 70

Answer any FIVE questions
All questions carry equal marks
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1 (a) Define unit operations and unit processes. Give two examples for each.
(b) Give applications of transport phenomenon principles in bioprocessing.

2 (a) The heat transfer coefficient for a stream to another is given by $h = \frac{16.6\, G^{0.8}\, C_p}{D^{0.2}}$ where h is heat transfer coefficient in $\frac{Btu}{hr\ ft^2 °F}$, D is flow diameter in inches, G is mass velocity $\frac{lb}{s\ ft^2}$, and Cp is specific heat $\frac{Btu}{lb\ °F}$. Convert this equation to express the heat transfer coefficient in $\frac{kcal}{hr\ m^2\ ℃}$.
(b) What are standard conditions? How many g moles of nitrogen will occupy 1000 m^3 at 112 x $10^3\ \frac{N}{m^2}$ and 400 K.

3 (a) Derive the Bernoulli equation for mechanical energy balance for flowing liquids.
(b) Water is being pumped from an open water reservoir at the rate of 2.0 kg/s at 10 ℃ to an open storage tank 1500 m away. The pipe used is schedule 40 $3\frac{1}{2}$ – in. pipe and the frictional losses in the system are 625 $\frac{J}{kg}$. The surface of the water reservoir is 20 m above the sea level of the storage tank. The pump has an efficiency of 75 %. What is the kW power required for the pump?

Nominal pipe size (in.)	Schedule number	Wall thickness inches	Outside diameter inches
$3\frac{1}{2}$	40	0.226	4.0

4 (a) Explain the concept of Newtonian and non Newtonian fluids with schematic graphs. Give the different types of non Newtonian fluids with examples in bioprocessing.
(b) Discuss the different hardware configurations available for continuous measurement of viscosity.

5 (a) Explain flow characterization by Reynolds' number.
(b) Calculate the frictional pressure drop in Pascal for olive oil at 293 K flowing through a commercial pipe having an inside diameter of 0.0525 m and a length of 76.2 m. The velocity of the fluid is 1.22 m/s. Use the friction factor method. Is the flow laminar or turbulent? Density of olive oil is 919 $\frac{kg}{m^3}$. Viscosity of olive oil is 84 cP.

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6 (a) Define Fanning friction factor. Derive the equation to calculate skin friction loss in straight pipes.

(b) A column of 0.084 m^2cross section and 1.85 m high is packed with spherical particles of diameter 2 mm. When a pressure difference of 1.0886 x $10^6 \frac{N}{m^2}$ is maintained across the bed a 60 % aqueous sucrose solution at 20℃ flows through the bed at a rate of 1.85 kg/s. At this temperature the viscosity of the solution is 56.5 cP and its density is 1286 $\frac{kg}{m^3}$. What is the void fraction of the bed?

7 (a) Discuss the common devices for minimizing leakage while permitting relative motion.

(b) An orifice meter with flange taps is to be installed in a 100-mm line to measure the flow of water. The maximum flow rate is expected to be 50 $\frac{m^3}{h}$ at 15℃. The manometer used to measure the differential pressure is to be filled with mercury, and water is to fill the leads above the surfaces of the mercury. The water temperature will be 15℃ throughout. If the maximum manometer reading is to be 1.25 m, what diameter, to the nearest millimeter, should be specified for the orifice? What will be the power to operate the meter at full load if the permanent loss in pressure is 81 % of the differential? Density of water 999 $\frac{kg}{m^3}$. Take C_o = 0.61, and g = 9.80665 $\frac{m}{s^2}$. Viscosity of water at 15℃ is 0.001147 $\frac{kg}{m\,s}$.

8 (a) What is net positive suction head (NPSH)? How is it calculated?

(b) Write about positive displacement pumps and give their applications in bioprocessing.

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