

中國文化大學 104 學年度日間學士班暑假轉學招生考試試題

系組：化學工程與材料工程學系三年級

日期節次：104 年 7 月 11 日第 2 節

科目：質能均衡

Problem 1: (25%)

普蘭特數 (N_{Pr}) 為一無因次群，在熱傳計算中十分重要。其定義為 $C_p \mu / k$ ，其中 C_p 為溶液之熱容， μ 為流體黏滯度，而 k 為熱傳導係數。一特定流體之 $C_p = 0.583 \text{ J}/(\text{g} \cdot ^\circ\text{C})$ ， $k = 0.286 \text{ W}/(\text{m} \cdot ^\circ\text{C})$ ，且 $\mu = 1936 \text{ lb}_m/(\text{ft} \cdot \text{h})$ 。試計算此流體之 N_{Pr} 。

其中： $1 \text{ W} = 1 \text{ J/s}$

$$1 \text{ h} = 3600 \text{ s}$$

$$1 \text{ m} = 3.2808 \text{ ft}$$

$$1 \text{ kg} = 2.20462 \text{ lb}$$

Problem 2: (25%)

A $0.5 \frac{\text{mole}}{\text{l}}$ aqueous solution of H_2SO_4 flows into a process unit at a rate of $1.25 \frac{\text{m}^3}{\text{min}}$. The specific gravity of the solution is 1.03. Calculate

- (1) the mass concentration of H_2SO_4 (in kg/m^3).
- (2) the mass flow rate of H_2SO_4 (in kg/s)
- (3) the mass fraction of H_2SO_4 (in %).

where $MW_{\text{H}_2\text{SO}_4} = 98 \frac{\text{g}}{\text{mole}}$

$$\rho_{\text{H}_2\text{O}} = 10^3 \frac{\text{kg}}{\text{m}^3}$$

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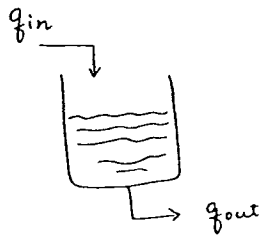
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Problem 3: (25%)

A well mixed tank has a maximum capacity of 100 gal and it is initially half full. The ^{volumetric} flow rate of water into the tank q_{in} is constant. The volumetric flow rate of water out is proportional to the total volume of the water in the tank and q_{out} can be expressed as,

$$q_{out} = kV$$



Volume of tank = 100 gal

Initial Amount of H₂O = 50 gal

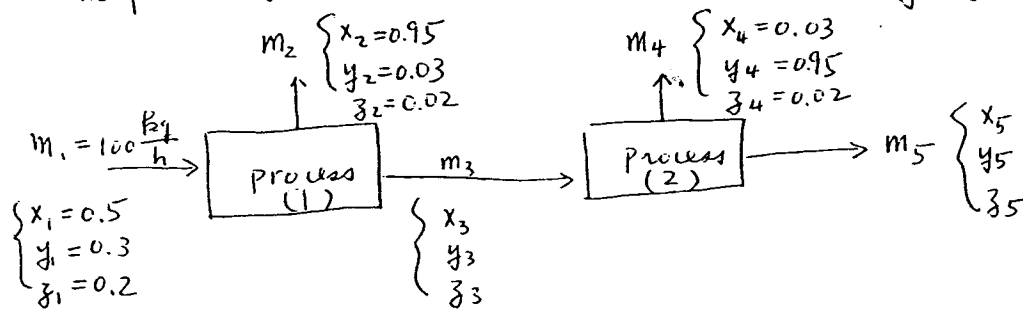
$q_{in} = 2 \text{ gal/min}$

$k = 0.1 \text{ min}^{-1}$

- (A) Is this process batch, continuous or semi batch?
- (B) Is it a steady or an unsteady state flow system?
- (C) Decide whether the amount of water in the tank increases, decreases or remains the same?
- (D) If it increases, how much time (min) is required to fill the tank to 60 gal. If it decreases, how much time (min) is required to decrease the water in the tank to 30 gal?

Problem 4: (25%)

The process flowsheet is shown in the following Figure: | - L - A



where $0.03 m_4 = x_3 m_3 (0.95)$

Determine $m_2, m_3, x_3, y_3, z_3, m_4, m_5, x_5, y_5, z_5$