※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (a) What conditions should an ideal plug flow reactor (PFR) follow? How to achieve it in the reactor design and operation **(5%)**

   (b) What conditions should an ideal continuous-stirred reactor (CSTR) follow? How to achieve it in the reactor design and operation? **(5%)**

2. **(10%)** Two identical plug flow reactors are used to carry out two gas-phase reactors separately:

   (a) $A \rightarrow 2B$

   (b) $A \rightarrow B$

   These two reactions have the same rate constant, and the feed conditions are the same in these two reactors. Without deriving any design equation, how do you judge which reactor will achieve the higher conversion.

3. For a reactor system composed of n ideal and isothermal CSTRs with the same space time of τ_i connected in series (n is a positive integer),

   (a) Please derive the expression for the conversion (x_A) of a first-order and liquid phase reaction, $A \rightarrow B$, carried out in this reactor system. Pure A is fed, and the rate constant is k. **(10%)**

   (b) Use the Lavenspiel plot to illustrate that an ideal PFR could be described using this reactor system with n approaches to infinity. **(5%)**

4. Calculate *the ratio of the volume of a CSTR to the volume of a PFR* required to achieve the same fractional conversion of 0.99 for the reactant A with an identical feed rate for each reactor, if the liquid phase reaction $A \rightarrow$ products is

   (a) first-order with respect to A. **(5%)**

   (b) second-order with respect to A **(10%)**

5. **(10%)** A reversible exothermic reaction needs to be carried out in continuous-stirred tank reactors. The heat of reaction should be managed.

   (a) Explain the importance of temperature controlling.

   (b) Raise three practical methods to do the job, and explain how it works.

6. For the elementary liquid phase reaction $A \xrightarrow{k_1} B \xrightarrow{k_2} C$ in a CSTR with feed contains only A, please derive and plot:

   (a) Concentration profile of B. **(7%)**

   (b) Selectivity of B to C, as functions of space time τ in a CSTR. **(8%)**

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(c) How do you determine the feed rate v0 in order to maximize the selectivity of B to C? **(5%)**

7. An ideal gas mixture is charged to a tubular reactor at the rate of 10 kmoles/hr. The reactor is operated isothermally at 500K and the pressure is 6 atm. The reactor is 10 cm in inner diameter. The second-order irreversible reaction

$$A + B \rightarrow D$$

that is taking place in the reactor has a specific reaction rate of 6 m^3/mole/hr at 500K. The feed composition is: 40% A, 40% B, and 20% inert.

(a) Derive the design equation for this reactor. **(10%)**

(b) What reactor length is necessary for 80% conversion? **(10%)**