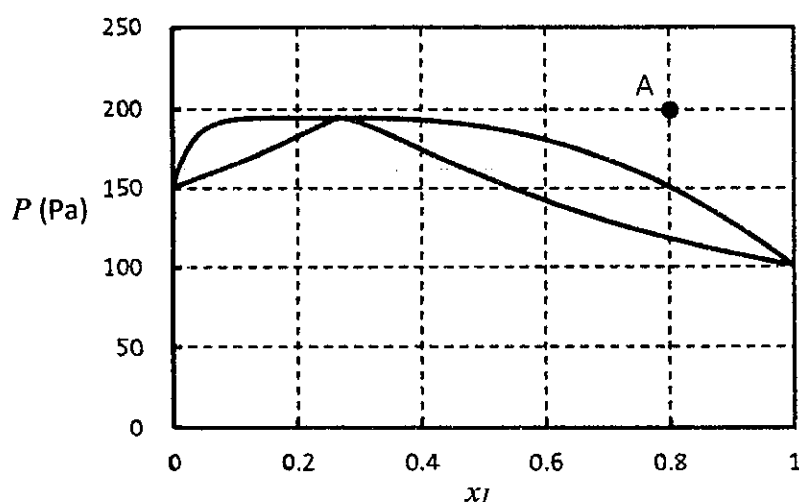


※ 注意：請於試卷內之「非選擇題作答區」標明題號依序作答。

1. True or False questions (no explanation is required)
 - (a) An electric heater converts electricity directly to heat. Is it true or false that this process is not reversible? (2pt)
 - (b) Species A can react to form species B, and vice versa, that is $A \leftrightarrow B$. Is it true or false that the reaction process involving species A and B must be reversible? (2pt)
 - (c) Is it true or false that a system will always evolve to a state of the lowest Gibbs free energy spontaneously? (2pt)
 - (d) Is it true or false that heat cannot be completely converted to work? (2pt)
 - (e) Is it true or false that the entropy of a system can only increase and not decrease? (2pt)

2. The vapor-liquid equilibrium diagram (Pxy) of a binary mixture at 300 K is given in the figure below. Determine the minimum work needed to separate one mole the mixture indicated as point A in the figure to the pure fluids under constant temperature and pressure conditions. (10pt)



3. Given the following thermodynamic relation

$$dU = TdS - PdV$$

where U is internal energy, T is temperature, P is pressure, V is volume, and S is entropy

- (a) Starting from the equation above, show that $dU = C_V dT + \left(-p + T \left(\frac{\partial P}{\partial T}\right)_V\right) dV$ with C_V being the constant volume heat capacity (5pts)
- (b) Use the equation in (a) and show that, for an ideal gas, the internal energy and heat capacity depend only on temperature and not volume (5pts)
- (c) Starting from the equation in (a), derive the expression for calculating the change in entropy from (T_1, V_1) to (T_2, V_2) , i.e., $\Delta S = S(T_2, V_2) - S(T_1, V_1)$ for an ideal gas (5pts)
- (d) An ideal gas is compressed adiabatically from temperature T_1 and volume V_1 to a smaller volume V_2 under a constant external pressure P_{ext} . What is the work done to the ideal gas? (5pts)
- (e) Following problem (d), what is the final temperature of the ideal gas after compression? (5pts)
- (f) Following problem (d), what is the entropy generation from this compression process? (5pts)

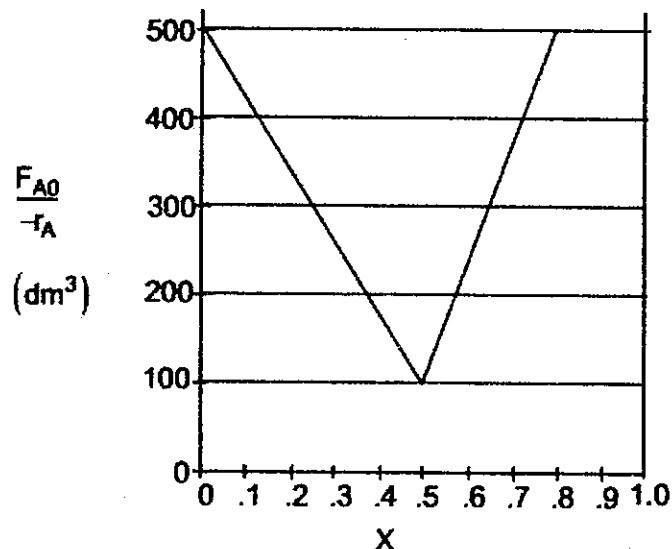
見背面

4. The adiabatic exothermic irreversible gas phase reaction



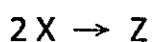
is to be carried out in a flow reactor for an equimolar feed of A and B

X: molar fraction of A



- What is ϵ , the volume change parameter? Hint: Equimolar feed of A and B and A is the limiting reactant. (5pt)
- What PFR volume is necessary to achieve 50% conversion? (5pt)
- What CSTR volume is necessary to achieve 50% conversion? (5pt)
- What CSTR volume must be added to raise the conversion in Part (c) to 80%? (5pt)
- What PFR volume must be added to raise the conversion in Part (c) to 80%? (5pt)

5. For the isothermal, elementary gas-phase reaction



how does the PFR volume required for a given conversion change with increasing mole fraction, y_{X0} , of X when the inlet concentration of X and inlet total volumetric flow rate remains constant?

There is no pressure drop and only X and Inert I enter the reactor.

5.1 Circle the correct answer. (5pt)

- V increases
- V decreases
- No change in V
- Insufficient information to answer definitively

5.2 Please explain your answer in 5.1 with equation (10pt)

6. Consider the reaction $A \rightarrow B$

If the diameter of a PBR is **doubled** while keeping the turbulent flow mass flow rate \dot{m} constant, what can be said about that factor by which the rate of pressure drop (dy/dW) will be lowered?

Hint: Ergun Equation (10pt)

試題隨卷繳回