中原大學108學年度碩士班考試入學

108/3/6 10:10 AM~11:40 AM

誠實是我們珍視的美德，
我們喜愛「拒絕作弊，堅守正直」的你！

化學工程學系

科目：熱力學及動力學 （共2頁，第1頁）

■可使用計算機(僅限於四則運算、三角函數及對數等基本功能，可程式之功能不可使用)
□不可使用計算機

(10%) Problem 1: Short description

(1) Please describe why chemical engineers use "enthalpy" instead of "internal energy" in energy balance calculation? List at least two reasons.

(2)Please explain the terms "heat of mixing", "volume change of mixing" and state a method to measure these two parameters in a simple apparatus.

(20 %) Problem 2: Calculation

A combined cycle plant is composed of a gas turbine unit and a heat recovery steam turbine unit. The maximum temperature of the gas turbine unit is 1800K and the river nearby provide cooling water at 300K. The rated capacity of the power plant is 900MW and the "thermal efficiency" is 60%.

(1) Please calculate the "maximum thermal efficiency" and the "efficiency factor" of the power plant.

(2) Please calculate the heat discarded to the environment.

(3) The recovery steam turbine unit needed emergency maintenance but energy crisis requires the gas turbine unit to run continuously. The efficiency factor would drop to 50% of the original value. Please calculate the extra amount of waste heat discarded into the environment.

(20 %) Problem 3(4point each)

3. The Excess Gibbs energy of a binary liquid mixture at T and P is given by

$G^E = 2.4\ RT\ x_1x_2$

(1) Derive $\ln \gamma_1$ and $\ln \gamma_2$

(2) Show that these expressions are combined in accord with summability relations.

(3) Show that these expressions satisfy Gibbs Duhem equation.

(4) Roughly plot G^E/RT, $\ln \gamma 1$ and $\ln \gamma 2$ and G^E/ x_1x_2RT on the x_1-G/RT graph(x axis represents x_1 and y axis represents G/RT dimensionless group). Label $\ln \gamma_1^{\infty}$ and $\ln \gamma_2^{\infty}$.

(5) Does this binary mixture show positive or negative deviation from ideal solution? Please explain it and predict if the bubble point pressure would be higher or lower than the ideal solution prediction.

中原大學 108 學年度碩士班考試入學

108/3/6 10:10 AM~11:40 AM

化學工程學系

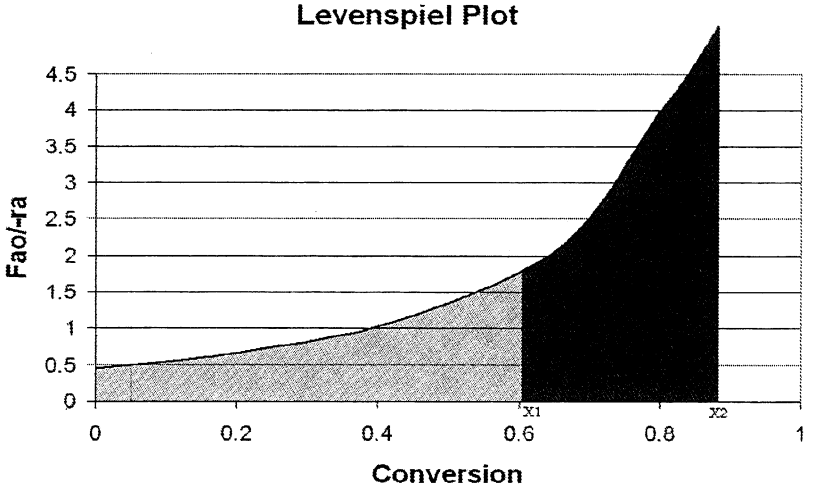
誠實是我們珍視的美德，
我們喜愛「拒絕作弊，堅守正直」的你！

科目：熱力學及動力學 （共 2 頁，第 2 頁）

■可使用計算機(僅限於四則運算、三角函數及對數等基本功能，可程式之功能不可使用)
□不可使用計算機

(20%) Problem 4

Please calculate needed reactor volumes based on the Levenspiel plot for reaction conversion of 88%. The first reactor is PFR (X from 0 to 0.61); the second reactor is CSTR (X from 0.61 to 0.88). [Note: $X = 0.88$, $Fa_0/-ra = 5.3$]



(20%) Problem 5

Consider the following reactions and try to optimize the condition to maximum the selectivity ($S_{D/U}$) in terms of reaction temperature, concentration and contact pattern. D is the desired product. (20%)

Case I

$A + B \rightarrow D$ $\quad -r_A = k_1 \exp(-10000\ K/T)\ C_A^2 C_B$

$A + B \rightarrow U$ $\quad -r_A = k_2 \exp(-3000\ K/T)\ C_A C_B^2$

Case II

$A + B \rightarrow D$ $\quad -r_A = k_1 \exp(-1000\ K/T)\ C_A C_B^2$

$A + B \rightarrow U$ $\quad -r_A = k_2 \exp(-5000\ K/T)\ C_A^2 C_B$

(10%) Problem 6

For a series of elementary reactions: $A \xrightarrow{k1} B \xrightarrow{k2} C$ in a constant volume batch reactor. Derive the relationship between concentration of B and the reaction time. (i.e., $C_B(t) = ?$)