

INSTRUCTION:

This section consists of **FOUR (4)** structured questions. Answer **ALL** questions.

ARAHAN:

Bahagian ini mengandungi **EMPAT (4)** soalan berstruktur. Jawab **SEMUA** soalan.

QUESTION 1**SOALAN 1**

- CLO1 a) List **THREE (3)** operation modes of a batch reactor.
*Senaraikan **TIGA (3)** mod operasi reaktor kelompok.*
- [3 marks]
[3 markah]
- CLO1 b) Reactors in batch process are necessarily operated in a transient state. Explain:
Reaktor dalam proses kelompok semestinya dikendalikan dalam keadaan sementara. Terangkan:
- i. **ONE (1)** advantage and disadvantage of batch reactor.
***SATU (1)** kelebihan dan kekurangan reaktor kelompok.*
- [4 marks]
[4 markah]
- ii. **TWO (2)** applications of batch reactor in chemical industry.
***DUA (2)** kegunaan reaktor kelompok dalam industri kimia.*
- [4 marks]
[4 markah]
- CLO1 c) Nitric oxide (NO) is a colourless toxic gas that is an important component of the air pollution generated by automotive engines and thermal power-generating plants. The oxidation reaction of nitric oxide will produce nitrogen dioxide.
Nitrik oksida (NO) ialah gas toksik tidak berwarna yang merupakan komponen penting dalam pencemaran udara yang dijana oleh enjin automotif dan loji penjana kuasa haba. Tindak balas pengoksidaan nitrik oksida akan menghasilkan nitrogen dioksida.

- i. Write the balanced chemical equation, rate law and overall order of the above reaction.

Tuliskan persamaan kimia seimbang, hukum kadar dan susunan keseluruhan tindak balas di atas.

[6 marks]

[6 markah]

- ii. Calculate the rate of disappearance of oxygen and rate of formation of nitrogen dioxide if the rate of disappearance of nitrogen monoxide is $5 \frac{\text{mol}}{\text{m}^3 \cdot \text{s}}$.

Kirakan kadar kehilangan oksigen dan kadar pembentukan nitrogen dioksida jika kadar kehilangan nitrogen monoksida ialah $5 \frac{\text{mol}}{\text{m}^3 \cdot \text{s}}$.

[8 marks]

[8 markah]

QUESTION 2

SOALAN 2

- CLO1 a) State the design operation of a Continuous Stirred Tank Reactor (CSTR) in terms of reactant and open system.

Nyatakan operasi reka bentuk Reaktor Tangki Kacau Berterusan (CSTR) dari segi reaktan dan sistem terbuka.

[3 marks]

[3 markah]

- CLO1 b) A Continuous Stirred Tank Reactor (CSTR) is a reaction tank in which reagents, reactants and often solvents flow into the reactor while the products of the reaction concurrently exit the tank. Discuss:

Reaktor Tangki Kacau Berterusan (CSTR) ialah tangki tindak balas di mana reagen, bahan tindak balas dan selalunya pelarut mengalir ke dalam reaktor manakala produk-produk tindak balas keluar serentak dari tangki. Bincangkan:

- i. **TWO (2)** advantages of a CSTR in the petrochemical industry.

DUA (2) kelebihan CSTR dalam industri petrokimia.

[4 marks]

[4 markah]

- ii. **TWO (2)** applications of a CSTR in the petrochemical industry.

DUA (2) kegunaan CSTR dalam industri petrokimia.

[4 marks]

[4 markah]

CLO2

- c) The elementary liquid phase reaction of $A + 2B \rightarrow 3C$ takes place in a Continuous Stirred Tank Reactor (CSTR) in series with the total feed at CSTR 1 is 1085 mol/s. Both CSTR 1 and CSTR 2 can hold up to 125 L each with the conversion of CSTR 1 is 80% and CSTR 2 is 90%.

Tindak balas fasa cecair asas $A + 2B \rightarrow 3C$ berlaku dalam Reaktor Tangki Kacau Berterusan (CSTR) secara bersiri dengan jumlah suapan pada CSTR 1 ialah 1085 mol/s. Kedua-dua CSTR 1 dan CSTR 2 boleh menampung sehingga 125 L setiap satu dengan penukaran CSTR 1 ialah 80% dan CSTR 2 ialah 90%.

- i. Write the rate of reaction for all species in the elementary liquid phase reaction.

Tuliskan kadar tindak balas untuk semua spesies dalam tindak balas fasa cecair asas.

[6 marks]

[6 markah]

- ii. Calculate the reaction rate of CSTR 1 and CSTR 2 as well as the percentage conversion in CSTR 2.

Kirakan kadar tindak balas CSTR 1 dan CSTR 2 serta peratusan penukaran dalam CSTR 2.

[8 marks]

[8 markah]

QUESTION 3

SOALAN 3

- CLO1 a) List the design operation of a Plug Flow Reactor model (PFR) in terms of axial direction and radial direction.
Senaraikan operasi reka bentuk model Reaktor Aliran Palam (PFR) dari segi arah paksi dan arah jejari.
- [3 marks]
[3 markah]
- CLO1 b) A Plug Flow Reactor (PFR) sometimes called continuous tubular reactor, (CTR) is normally the name given to a model used in chemical engineering to describe chemical reactions in continuous, flowing systems of cylindrical geometry. Explain:
Reaktor Aliran Palam (PFR) kadangkala dipanggil reaktor tiub berterusan, (CTR) biasanya merupakan nama yang diberikan kepada model yang digunakan dalam kejuruteraan kimia untuk menerangkan tindak balas kimia dalam sistem geometri silinder yang berterusan dan mengalir. Terangkan:
- i. **TWO (2)** advantages in terms of maintenance.
DUA (2) kelebihan dari segi penyelenggaraan.
- [4 marks]
[4 markah]
- ii. **TWO (2)** disadvantages in terms of temperature.
DUA (2) kekurangan dari segi suhu.
- [4 marks]
[4 markah]
- CLO2 c) In a Plug Flow Reactor (PFR), the gas phase reaction of $2\text{NO}_2 \rightarrow \text{N}_2\text{O}_4$ is run isothermally at 600 K with initial flow rate of 11,500 gmol/s. The reaction has a rate constant of 10 s^{-1} with the final conversion of 85%.
Dalam Reaktor Aliran Palam (PFR), tindak balas fasa gas $2\text{NO}_2 \rightarrow \text{N}_2\text{O}_4$ dijalankan secara isoterma pada 600 K dengan kadar aliran awal 11,500 gmol/s. Tindak balas mempunyai pemalar kadar 10 s^{-1} dengan penukaran akhir sebanyak 85% .

- i. Write the rate law and relative rate of reaction.

Tuliskan undang-undang kadar dan kadar tindak balas relatif.

[6 marks]

[6 markah]

- ii. Calculate the size of the PFR in m^3 if the initial concentration reactant is 0.50 gmol/L.

Kirakan saiz PFR dalam m^3 jika bahan tindak balas kepekatan awal ialah 0.50 gmol/L.

[8 marks]

[8 markah]

QUESTION 4

SOALAN 4

- CLO1 a) Identify **THREE (3)** parameters that are related to bubble column reactor.
*Kenal pasti **TIGA (3)** parameter yang berkaitan dengan reaktor turus gelembung.*

[3 marks]

[3 markah]

- CLO1 b) Fluidized bed reactors are the most popular configurations employed from laboratory to commercial scale. It is widely used in petroleum and chemical processing industries. Discuss:

Reaktor lapisan terbendalir adalah konfigurasi yang paling popular digunakan dari makmal hingga skala komersial. Ia digunakan secara meluas dalam industri pemprosesan petroleum dan kimia. Bincangkan:

- i. **TWO (2)** advantages of fluidized bed reactor.

***DUA (2)** kelebihan reaktor lapisan terbendalir.*

[4 marks]

[4 markah]

- ii. the catalyst and reactor type for maleic anhydride and polymerization of ethylene or propylene processes.

jenis pemangkin dan reaktor bagi anhidrida maleik dan pempolimeran proses etilena atau propilena.

[4 marks]

[4 markah]

CLO2

- c) Homogeneous reactions are chemical reactions in which the reactants and products are in the same phase, while heterogeneous reactions have reactants in two or more phases. Write:

Tindak balas homogen ialah tindak balas kimia di mana bahan tindak balas dan produk berada dalam fasa yang sama, manakala tindak balas heterogen mempunyai bahan tindak balas dalam dua atau lebih fasa. Tuliskan:

- i. **THREE (3)** applications of homogeneous reaction in tubular reactor.

TIGA (3) aplikasi tindak balas homogen dalam reaktor tiub.

[6 marks]

[6 markah]

- ii. The characteristics of heterogeneous reaction in terms of catalytic, complexity, external energy and phase.

Ciri-ciri tindak balas heterogen dari segi pemangkin, kerumitan, tenaga luar dan fasa.

[8 marks]

[8 markah]

SOALAN TAMAT