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# UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua  
Sidang Akademik 2005/2006

April/Mei 2006

## **EBP 314/3 – Teknologi Penghasilan Resin**

Masa : 3 jam

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Sila pastikan bahawa kertas peperiksaan ini mengandungi TUJUH muka surat yang bercetak sebelum anda memulakan peperiksaan.

Kertas soalan ini mengandungi TUJUH soalan.

Jawab LIMA soalan. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.

Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru.

Semua jawapan hendaklah dijawab dalam Bahasa Malaysia.

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1. [a] Plot pelan awal dan susun atur konsep mestilah dibangunkan semasa kerja fasa 0 / fasa 1 bagi mengenal pasti keperluan dan gambaran keseluruhan. Jelaskan secara ringkas keperluan pertimbangan umum, pertimbangan keselamatan dan pertimbangan penyenggaraan di dalam garis panduan konsep susun atur loji.

(60 markah)

- [b] Pemilihan bahan yang tepat dan sesuai adalah penting di dalam penghasilan sesuatu produk dengan mengikut bentuk dan sifat-sifat. Jelaskan:

- (i) Aliran turutan aktiviti pengeluaran produk.
- (ii) Carta aliran alternatif selari.
- (iii) 5 perkara yang perlu di ambil kira dalam pemilihan bahan.

(40 markah)

2. [a] Secara praktikal adalah sukar untuk menghasilkan monomer vinil klorida yang benar-benar tulen:

- (i) Untuk beberapa tahun awal, laluan utama penghasilan vinil klorida adalah melalui penambahan hidroklorik asid kepada asetilena. Jelaskan secara ringkas proses tersebut.
- (ii) Dengan perkembangan di dalam industri petrokimia terdapat perubahan daripada asetilena kepada etilena untuk menghasilkan monomer vinil klorida. Jelaskan secara ringkas proses baru tersebut.
- (iii) Pembangunan seterusnya melibatkan laluan proses asetilena dan etilena digabungkan. Jelaskan proses tersebut.

(60 markah)

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[b] Merujuk kepada proses pempolimeran pukal penghasilan PVC seperti yang disarankan oleh Pechiney St. Gobain:

- (i) Jelaskan secara ringkas proses pempolimeran satu peringkat.
- (ii) Jelaskan secara ringkas 2 peringkat proses pempolimeran terubahsuai.

(40 markah)

3. [a] Pada 1953 Celanese Corporation daripada Amerika telah melaporkan penghasilan vinil asetat daripada gas petroleum. Perihalkan proses penyediaan monomer tersebut.

(20 markah)

[b] Jelaskan juga proses penyediaan monomer vinil asetat secara:

- (i) Tindakbalas etilena dan asetik asid
- (ii) Pengoksidaan etilena dan
- (iii) Proses satu peringkat dari etilena.

(40 markah)

[c] (i) Pada penukaran 30% dalam proses pempolimeran polivinil asetat, pemindahan rantai kepada polimer atau monomer mungkin berlaku. Berikan mekanisme yang mungkin.

(ii) Jelaskan secara ringkas sistem pempolimeran polivinil asetat tipikal secara emulsi.

(40 markah)

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4. Polietilena merupakan resin yang lazim dihasilkan secara komersil di dalam industri penghasilan resin. Terdapat beberapa proses utama dan kaedah yang digunakan.

[a] Berikan 4 proses pempolimeran tersebut dan nyatakan juga kaedah-kaedah yang sesuai untuk proses-proses tersebut.

(30 markah)

[b] Proses pempolimeran tekanan rendah fasa gas adalah lebih digemari berbanding fasa lain dalam menghasilkan polietilena:

(i) Lakarkan carta alir proses tersebut.

(ii) Jelaskan setiap peringkat yang berlaku dalam proses.

(30 markah)

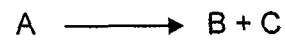
[c] Merujuk kepada gambarajah reaktor hamparan terbendalir untuk proses pempolimeran polietilena fasa gas:

(i) Mengapakah pengawalan suhu yang tepat di dalam reaktor tindakbalas adalah penting untuk proses ini dan bagaimanakah ia dapat di kawal?

(ii) Bagaimanakah penyelesaian masalah tindakbalas yang tidak terkawal di dalam reaktor dilakukan?

(40 markah)

5. Etilena telah disuapkan ke dalam reaktor pada 100 kmol/j kadar aliran molar di mana tindakbalas dekomposisi yang berikut berlaku:



- [a] Jika penukaran polietilena ialah 25%, apakah komposisi dan kadar aliran produk daripada reaktor.

(30 markah)

Proses mudah ini adalah dikira membazir merujuk kepada amaun bahan yang tidak bertindakbalas keluar bersama produk. Proses ini kemudian dimodifikasikan dengan mengasingkan etilena yang tidak bertindakbalas daripada aliran reaktor produk dan dikitar semula dalam reaktor utama. Kadar aliran etilena dikekalkan 100 kmol/j.

- [b] Jika 50% etilena daripada aliran reaktor produk dikitar semula, tentukan kadar aliran kitar semula dan pecahan keseluruhan propilena yang bertindakbalas di dalam proses. (Nilai yang akhir ini ialah penukaran berkesan (effective conversion) polipropilena di dalam proses).

(40 markah)

- [c] Apakah penukaran berkesan jika kitar semula mengandungi:

- (i) 80% etilena di dalam aliran produk reaktor.
- (ii) 100% etilena di dalam aliran produk reaktor.

(30 markah)

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6. Penghasilan resin polistirena bermula dengan penyediaan monomer stirena.

[a] Terdapat 3 kaedah umum untuk penyediaan monomer stirena, satu kaedah secara sintesis makmal dan dua kaedah penyediaan secara komersil. Berikan kaedah penyediaan monomer stirena secara:

- (i) Sintesis makmal menggunakan etilena.
- (ii) Penyediaan secara industri.

(40 markah)

[b] Dalam proses penyediaan polistirena:

- (i) Lakarkan carta alir pempolimeran secara proses menara dan
- (ii) Jelaskan secara ringkas proses tersebut.

(40 markah)

[c] Tidak termasuk polistirena hentaman tinggi, polistirena boleh didapati di dalam beberapa gred dan ianya boleh diklasifikasikan kepada 4 kumpulan. Jelaskan.

(20 markah)

7. [a] Dalam penghasilan poliolefin terdapat tiga tempat di mana sebahagian dari monomer akan hilang. Kenal pasti tempat-tempat tersebut.

(20 markah)

- [b] MTR telah membangunkan proses berasaskan membran yang dikenali sebagai VaporSep untuk memisahkan serta menjalankan proses perolehan semula hidrokarbon di dalam bolong loji poliolefin.

- (i) Jelaskan sifat-sifat membran yang digunakan di dalam teknik ini.

(20 markah)

- (ii) Perihalkan juga penggunaan teknik VaporSep di dalam:

- I. Bahagian penulenan bahan mentah.
- II. Bahagian tindakbalas kimia.
- III. Penulenan dan kemas produk.

(60 markah)

# TRANSLATION

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## UNIVERSITI SAINS MALAYSIA

Second Semester Examination  
Academic Session of 2005/2006

April/May 2006

### **EBP 314/3 – Resin Manufacturing**

Time : 3 hours

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Please ensure that this paper consists of SIX printed pages before you proceed with the examination.

This paper contains 7 questions.

Answer any FIVE questions. If a candidate answer more than five questions, only the first five answered will be examined and awarded marks.

Answer to any question must start on a new page.

All questions must be answered in Bahasa Malaysia.

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1. [a] The initial plant plot and the conceptual flow design must be developed in phase 0 / phase 1 to identify the requirement and overall overview. Briefly describe general consideration, safety consideration and maintenance consideration in a conceptual plant layout guideline.  
(60 marks)
- [b] A precise and suitable material selection is very important in producing a product based on the shape and properties required. Explain:
- (i) Typical flow sequence activity of product manufacturing.
  - (ii) Parallel alternative flowchart.
  - (iii) 5 considerations required in materials selection.
- (40 marks)
2. [a] In practical, it is very difficult to produce pure vinyl chloride monomer:
- (i) For so many years the main route in producing vinyl chloride monomer is through the addition of hydrochloric acid to acetylene. Explain briefly the new route process.
  - (ii) Due to the development of petrochemical industry the route production of vinyl chloride monomer has changed from acetylene to ethylene. Explain briefly the new route process.
  - (iii) Further development in producing vinyl chloride monomer involved in the combination of the route process of acetylene and ethylene.
- (60 marks)
- [b] Referring to the production of PVC through the bulk polymerization process proposed by Pechiney St. Gobain:
- (i) Explain briefly the one step polymerization process.
  - (ii) Explain briefly the modified two steps polymerization process.
- (40 marks)

3. [a] In 1953, Celanese corporation of America has reported the production of vinyl acetate monomer from light petroleum gases. Describe the process. (20 marks)
- [b] Also explain the preparation vinyl acetate monomer through:
- (i) The reaction of acetic acid and ethylene.
  - (ii) Ethylene oxidation.
  - (iii) One step process from ethylene.
- (40 marks)
- [c] (i) At 30% conversion in the polymerization of polyvinyl acetate, there are possibility of chain transfer to monomer and the polymer. Provide the probable mechanism.
- (ii) Describe briefly the typical emulsion polymerization system in producing polyvinyl acetate resin. (40 marks)
4. Polyethylene is the most common polymer resin produced commercially. There are few main processes and methods used.
- [a] Give 4 main processes and the suitable methods used for the processes. (30 marks)
- [b] Gas phase polymerization process is more preferred than other polymerisation process to produced polyethylene:
- (i) Draw the process flow chart.
  - (ii) Explain every steps of the process. (30 marks)

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- [c] Referring to the fluidized bed reaction reactor for low pressure gas phase polymerization in production of polyethylene:
- (i) Why a precise temperature control in the reaction reactor is very important and how it is control?
  - (ii) How can a runaway reaction be contained?
- (40 marks)

5. Reactant, ethylene, is fed at a molar flow rate of 100kmol/h into a reactor in which the following decomposition reaction occurs:



- [a] If the conversion of ethylene is 25%, what will be the composition and flow rate of the product stream from the reactor.
- (30 marks)

This simple process is wasteful in terms of the amount of unreacted material leaving with the product. The process is therefore modified with some of this unreacted ethylene being separated from the reactor product stream and recycled back into the reactor. The flow rate of ethylene into the process is maintained at 100kmol/h.

- [b] If 50% of the ethylene in the reactor product stream is recycled, determine the recycle flow rate and the overall proportion of ethylene that reacts within the process. (This latter figure is the effective conversion of ethylene within the process).
- (40 marks)

- [c] What will be the effective conversion if the recycle contains:
- (i) 80% of the ethylene in the reactor product stream.
  - (ii) 100% of the ethylene in the reactor product stream.
- (30 marks)

6. Manufacturing of polystyrene resin begin with the preparation of styrene monomer.

- [a] There are three general methods of interest for the preparation of styrene monomer, one for the laboratory synthesis and the other two for commercial production. Provide methods of styrene preparation by:
- (i) Laboratory synthesis using ethylene.
  - (ii) Industrial preparation.
- (40 marks)

- [b] In the manufacturing of polystyrene:
- (i) Draw the tower process polymerization flowchart and
  - (ii) Describe briefly the process.
- (40 marks)

- [c] Except for high impact polystyrene, polystyrene can be found with several grades and can be classified into four groups. Explain.
- (20 marks)

7. [a] In manufacturing of polyolefin resin, there are three places where some of the monomers is lost. Identify the places.

(20 marks)

- [b] MTR has developed a membrane base recovery process known as Vaporsep to separate and recovered hydrocarbon from a reaction vessel in a polyolefin plant.

- (i) Explain the properties of the membrane use in this technique.

(20 marks)

- (ii) Also describe the Vaporsep technique used in the:

- I. Raw material purification.
- II. Chemical reaction.
- III. Purification and product finishes.

(60 marks)