
UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2009/2010

November 2009

EBB 427/3 – Technology & Application of Engineering Polymer *[Teknologi & Penggunaan Polimer Kejuruteraan]*

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains THIRTEEN printed pages before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi TIGA BELAS muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper consists of TWO questions from PART A and FIVE questions from PART B.

[Kertas soalan ini mengandungi DUA soalan dari BAHAGIAN A dan LIMA soalan dari BAHAGIAN B.]

Instruction: Answer **TWO** questions from PART A and **THREE** questions from PART B. If candidate answers more than five questions only the first five questions answered in the answer script would be examined.

Arahan: Jawab **DUA** soalan dari BAHAGIAN A dan **TIGA** soalan dari BAHAGIAN B. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]

The answers to all questions must start on a new page.

[Mulakan jawapan anda untuk semua soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.

[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

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PART A / BAHAGIAN A

1. [a] Briefly explain the definition of hydrocarbon polymers, heterochain polymers and carbon-chain polymers. Please give 2 examples of each type of these polymers.

Terangkan secara ringkas definasi polimer hidrokarbon, polimer hetero rantaian dan polimer rantaian-karbon. Nyatakan 2 contoh bagi setiap kumpulan polimer tersebut.

(30 marks/markah)

- [b] Compare mechanical properties of high density polyethylene (HDPE), polystyrene and polycarbonate. Explain the differences in performance in view of molecular structure, crystallinity and clarity. Which one has the best properties for skylight roofing and give you reason.

Bandingkan sifat mekanikal bagi polietilena berketumpatan tinggi (HDPE), polistirena dan polikarbonat. Terangkan perbezaan dalam prestasi polimer-polimer ini dari segi struktur molekul, kehabluran dan kejelasan. Yang mana satukah menunjukkan sifat-sifat yang baik untuk aplikasi sebagai bumbung langit cahaya dan berikan alasan anda.

(50 marks/markah)

- [c] Which type of backbone substituents stiffen the polymer chains? And why?

Pengganti tulang belakang yang manakah akan memberi kekakuan kepada rantaian polimer? Dan kenapa?

(20 marks/markah)

2. [a] Define the terms “shelf life” and “pot life” with respect to the processing of thermosetting resins.

Takrifkan “hayat simpanan” dan “hayat pot” berdasarkan kepada pemrosesan resin termoset.

(15 marks/markah)

- [b] Write a short note on the following types of epoxy resins:

Tuliskan nota ringkas bagi tajuk-tajuk mengenai epoksi berikut:

- (i) Diglycidyl ether of bisphenol A (DGEBA) epoxy
- (ii) Novolac epoxy
- (iii) Polyglycol epoxy
- (iv) Cyclic aliphatic epoxy
- (v) Acyclic aliphatic epoxy
- (vi) Glycidyl amine epoxy

(60 marks/markah)

- [c] There are several factors that influence the selection of thermosetting adhesive. List and describe each factor that influences your selection in choosing the effective thermosetting adhesive.

Terdapat beberapa faktor yang mempengaruhi pemilihan perekat termoset. Senarai dan terangkan setiap faktor yang mempengaruhi pemilihan perekat yang efektif.

(25 marks/markah)

PART B / BAHAGIAN B

3. [a] Judge why a vulcanized rubber compound is used to make the following:
- (i) O-ring seal
 - (ii) Earthquake bearing

Kenalpasti kenapa sebatian getah tervulkan di gunakan dalam penghasilan:

- (i) *Kedap cincin – O*
- (ii) *Bearing gempabumi*

(30 marks/markah)

- [b] With aid of diagrams, compare the differences of the designs of an extruder screw for nylon and polyethylene. Discuss the shape of a temperature profile normally used for nylon and polyethylene when using a general-purpose screw.

Dengan bantuan gambarajah, bandingkan perbezaan dalam rekabentuk skru penyempitan bagi nilon dan polietilena. Bincangkan bentuk profil suhu yang biasa digunakan untuk nilon dan polietilena sekiranya menggunakan skru tujuan-umum.

(50 marks/markah)

- [c] Figure 1 shows changes in shape that occur between the die orifice and the finished part, explain why the shape of the exit orifice is slightly different from the shape of the final part.

Gambarajah 1 menunjukkan perubahan dalam bentuk diantara bukaan dai dan produk siap, terangkan kenapa bentuk bukaan dai berbeza sedikit dengan bentuk produk akhir.

Figure 1: Changes in shape that occur between the die orifice and the finished part

Rajah 1: Perubahan dalam bentuk di antara bukaan dai dan produk siap

(20 marks/markah)

4. [a] Landfill and incineration are two options for disposing of solid waste. Compare these two methods and suggest the most suitable method of disposing of solid waste in Malaysia.

Tapak pelupusan dan pembakaran merupakan dua pilihan bagi pelupusan sisa buangan pepejal. Bandingkan dua kaedah ini dan cadangkan kaedah yang sesuai bagi melupuskan sisa buangan pepejal di Malaysia.

(30 marks/markah)

- [b] Explain what may happen to the properties of a rubber material if the carbon black is poorly mixed into the batch.

Terangkan apakah yang akan berlaku kepada sifat-sifat getah sekiranya hitam karbon tidak tercampur sekata di dalam gaulan getah.

(20 marks/markah)

- [c] A deep cup (20cm deep x 10cm diameter) is to be formed. Compare thermoforming, blow molding and injection molding as processes for making the cup. What technical and economical considerations should be considered in determining which method is best?

Cawan bersaiz (20sm dalam x 10sm diameter) akan dihasilkan. Bandingkan kaedah pembentukan haba, acuan tiupan dan suntikan acuan sebagai proses dalam menghasilkan cawan ini. Apakah pertimbangan dari segi teknikal dan ekonomi yang perlu diambilkira dalam mengenalpasti kaedah yang terbaik?

(50 marks/markah)

5. [a] The addition of a vinyl liquid monomer into unsaturated polyester compound will not only facilitate the curing process but also, reduce its viscosity without compromising the final properties of a polyester. List and describe five types of available vinyl liquid monomers that are commonly used for an unsaturated polyester system.

Penambahan larutan monomer vinil terhadap kompaun poliester tak tepu tidak hanya membantu proses pematangan tetapi juga mengurangkan kelikatan tanpa menjejaskan sifat akhir poliester. Senarai dan terangkan lima jenis larutan vinil monomer yang biasa digunakan untuk sistem poliester tak tepu.

(25 marks/markah)

- [b] Figures 2-4 show the effect of viscosity, mass and temperature on the curing process of a typical thermosetting resin. For each figure, state your comment on how each parameter affect the curing process.

Rajah 2-4 menunjukkan kesan kelikatan, jisim dan suhu terhadap proses pematangan resin termoset. Untuk setiap rajah, berikan komen bagaimana setiap parameter mempengaruhi proses pematangan.

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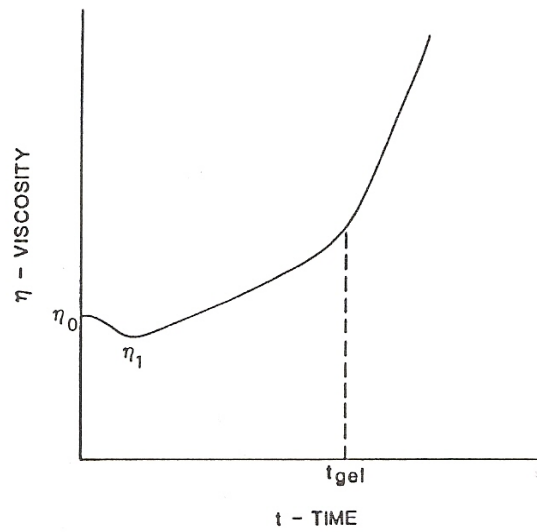


Figure 2: Viscosity versus time at constant temperature for a liquid thermosetting system

Rajah 2: Kelikatan melawan masa pada suhu tetap untuk sistem cecair termoset

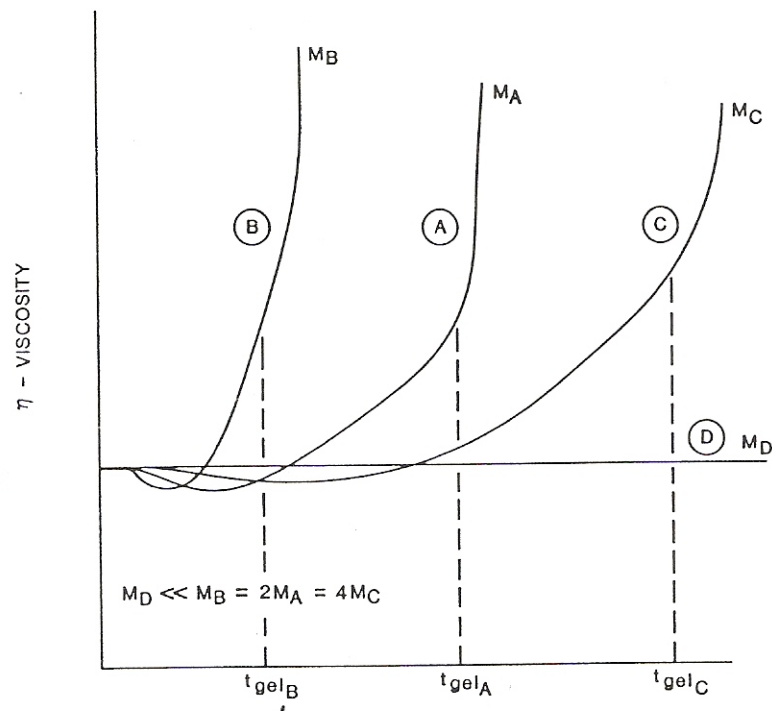


Figure 3: Influence of ambient cure temperature on the gel time of thermosets

Rajah 3: Pengaruh suhu pematangan terhadap masa gel termoset

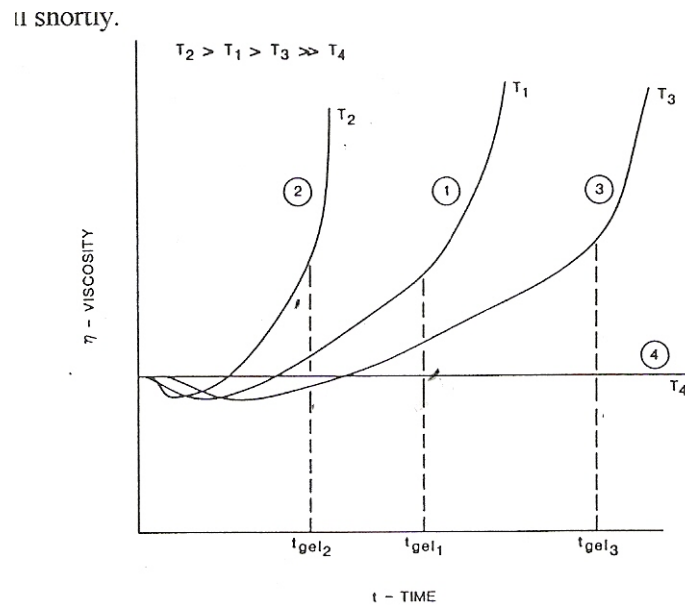


Figure 4: Influence of mass on the gel time of thermosets

Rajah 4: Pengaruh jisim terhadap masa gel termoset

(50 marks/markah)

- [c] State the differences between resole and novolac phenolic resin.

Jelaskan perbezaan di antara resin resol dan novolak.

(25 marks/markah)

6. [a] Prepregs are commonly used in fabrication of advanced composites based on the thermosetting resin system due to cost, performance and ease of processing. Explain how the use of prepregs could address the above issues.

Prapreg digunakan dengan meluas di dalam fabrikasi komposit maju berasaskan resin termoset kerana faktor harga, prestasi dan kesediaan pemprosesan. Terangkan bagaimana penggunaan prapreg dapat menangani isu tersebut.

(30 marks/markah)

- [b] Properties of phenolic resin can be improved by adding several fillers such as wood flour, cellulose (cotton flock), minerals fillers (mica, clay), silica (SiO_2), graphite fibre and glass fibre. Based on each of the fillers stated above, describe the expected enhancement in properties by adding each of them in phenolic resin.

Sifat-sifat resin fenolik boleh ditingkatkan dengan penambahan beberapa pengisi antaranya seperti serbuk kayu, selulos (cotton flock), pengisi mineral (mica, clay), silika (SiO_2), gentian grafit dan gentian kaca. Berdasarkan kepada penambahan setiap pengisi di atas, terangkan peningkatan-peningkatan sifat yang dijangkakan terhadap resin fenolik.

(30 marks/markah)

- [c] Table 1 shows comparative mechanical properties of DETA and TETA cured epoxy castings at 25 °C. Comment on the differences between the properties listed in Table 3 by emphasizing the difference between DETA and TETA properties.

Jadual 1 menunjukkan perbandingan sifat-sifat mekanikal bagi epoksi yang dimatangkan menggunakan DETA dan TETA pada suhu 25°C. Komen mengenai perbezaan-perbezaan sifat mekanikal yang diperolehi berdasarkan sifat-sifat semulajadi DETA dan TETA.

Table 1: Comparative mechanical properties of DETA and TETA cure epoxy castings at 25 °C

Jadual 1: Perbandingan sifat-sifat mekanikal bagi epoksi yang dimatangkan menggunakan DETA dan TETA pada suhu 25°C

Property / Sifat	DETA (10-11 phr)	TETA (13-14 phr)
Heat deflection temperature, °C / <i>Suhu lenturan panas, °C</i>	95-124	98-124
Flexural strength, psi / <i>Kekuatan lenturan, psi</i>	14,500 to 17,000	13,900 to 17,700
Compressive strength, psi / <i>Kekuatan mampatan, psi</i>	16,500	16,300
Tensile strength, psi / <i>Kekuatan tensil, psi</i>	11,400	11,400
Ultimate elongation, % / <i>Pemanjangan %</i>	5.5	4.4

(40 marks/markah)

7. [a] Describe structure-property interrelation in the case of polystyrene, and how to improve its toughness.

Terangkan perkaitan antara sifat-struktur dalam kes polistirena, dan bagaimana untuk memperbaiki keliatannya.

(20 marks/markah)

- [b] Discuss the differences between injection molding and extrusion based on the following points:
- (i) shape of product
 - (ii) operation of screw
 - (iii) mixing efficiency

Bincangkan perbezaan di antara suntikan acuan dan penyemperitan berdasarkan butiran berikut:

- (i) *bentuk produk*
- (ii) *operasi skru*
- (iii) *keberkesanan pencampuran*

(30 marks/markah)

- [c] The pultrusion process in manufacture of fibre reinforced composites has several advantages especially where the building and construction industries are concerned. Describe the pultrusion process with the aid of a schematic diagram of a standard pultrusion machine and label each component.

Proses pultrusi bagi penghasilan komposit diperkuat gentian mempunyai beberapa kelebihan terutamanya di dalam industri pembinaan dan bangunan. Terangkan proses pultrusi dengan menggunakan bantuan gambarajah skematik yang berlabel bagi mesin pultrusi biasa.

(50 marks/markah)