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# UNIVERSITI SAINS MALAYSIA

First Semester Examination  
Academic Session 2008/2009

November 2008

## **EBP 308/3 - Rubber: Processing and Product** **[Getah: Pemprosesan dan Produk]**

Duration : 3 hours  
[Masa : 3 jam]

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

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

This paper contains SEVEN questions.

*[Kertas soalan ini mengandungi TUJUH soalan.]*

**Instructions:** Answer FIVE questions. If a candidate answers more than five questions only the first five questions in the answer sheet will be graded.

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

Answer to any question must start on a new page.

*[Mulakan jawapan anda untuk setiap 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.]*

1. [a] What do you understand about thermoplastic elastomers (TPEs)? Discuss briefly 3 essential characteristics of TPEs.

*Apakah yang anda faham berkenaan elastomer termoplastik (TPEs)? Bincang secara ringkas 3 ciri-ciri penting TPEs.*

(40 marks/markah)

- [b] Using a suitable diagram, explain the morphology of olefin based elastomeric alloys. What are the advantages of using Santoprene as a TPE?

*Dengan menggunakan rajah yang sesuai, terangkan morfologi aloi olefin berasaskan elastomer. Apakah kelebihan-kelebihan menggunakan Santoprene sebagai TPE?*

(30 marks/markah)

- [c] What do you know about Block Copolymer of Thermoplastic Elastomers? Discuss briefly their two commercial available products.

*Apakah yang anda tahu berkenaan Kopolimer Blok Elastomer Termoplastik? Bincangkan secara ringkas dua produk berkaitan yang boleh didapati secara komersial.*

(30 marks/markah)

2. [a] Explain how elastomers can be classified into chemical saturation of the polymer chain and service performance.

*Jelaskan bagaimana elastomer boleh dikelaskan kepada ketepuan kimia rantai polimer dan prestasi servis.*

(50 marks/markah)

- [b] Write the differences between ethylene propylene monomer (EPM) and ethylene propylene diene monomer (EPDM) in term of chemistry, vulcanization agents and vulcanizates properties.

*Tuliskan perbezaan di antara etilena propilena monomer (EPM) and etilena propilena diena monomer (EPDM) dari segi sifat kimia, agen-agen pemvulkanan dan sifat-sifat vulkanizat.*

(30 marks/markah)

- [c] What are the main applications of chloroprene rubber (CR)?

*Apakah kegunaan-kegunaan utama getah kloroprena?*

(20 marks/markah)

3. [a] Discuss 'step by step' how two rubbers can be selected to produce a suitable rubber-rubber blend in manufacturing of fuel hoses.

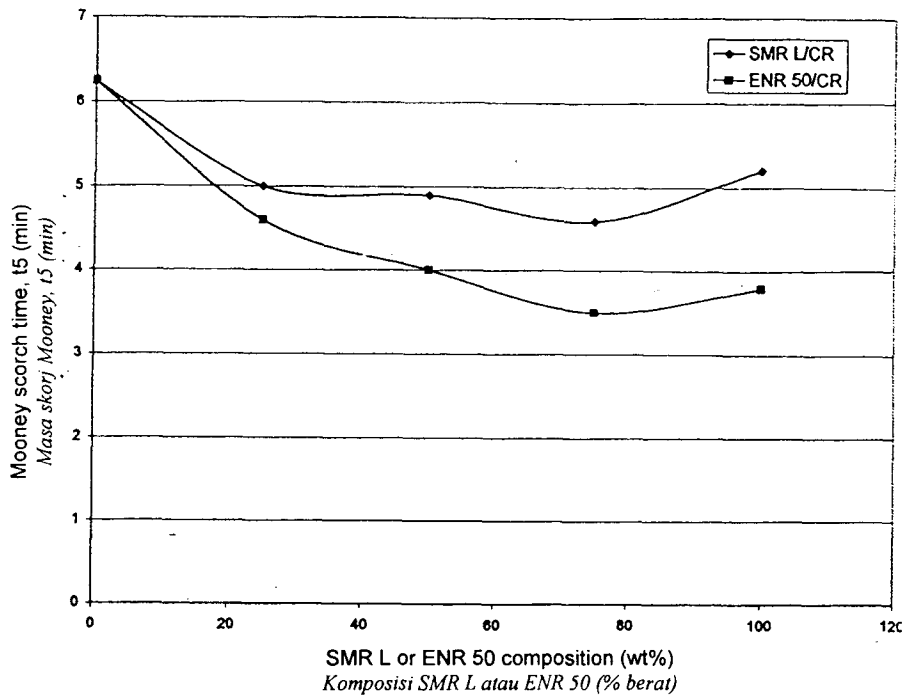
*Bincangkan 'langkah demi langkah' bagaimana dua jenis getah boleh dipilih untuk menghasilkan adunan getah-getah yang sesuai untuk pembuatan hos bahanapi.*

(30 marks/markah)

- [b] Figure 1 shows the comparison of Mooney scorch time versus blend composition for SMR L/CR and ENR 50/CR blends at 130°C. Figure 2 shows the comparison of modulus at 100% elongation and M100 versus blend composition for SMR L/CR and ENR 50/CR blends. Explain the results obtained in Figure 1 and Figure 2.

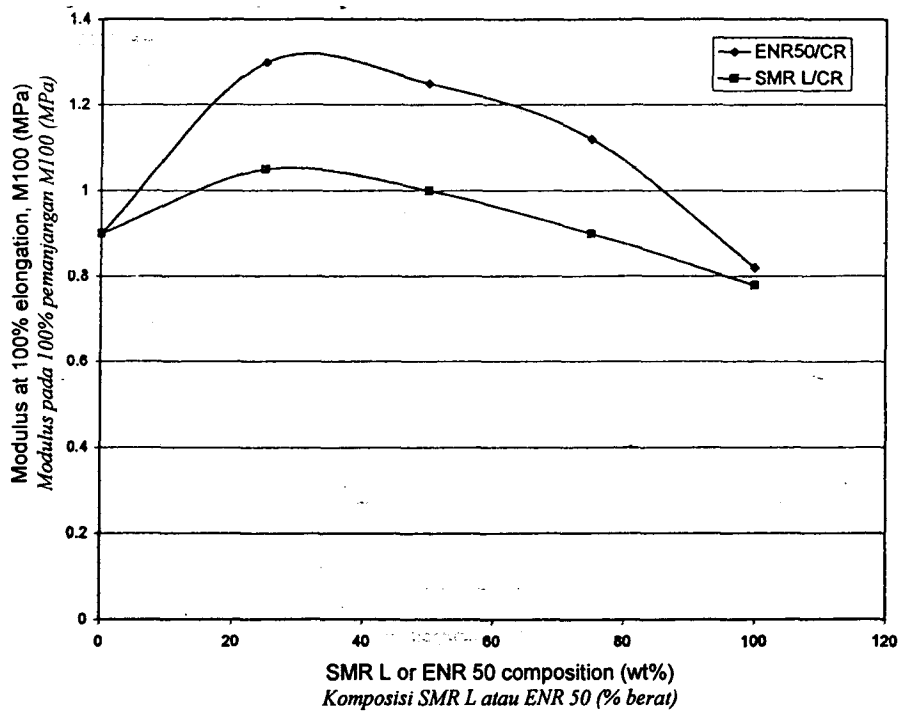
*Rajah 1 menunjukkan perbandingan masa skorj Mooney melawan komposisi adunan untuk adunan-adunan SMR L/CR dan ENR 50/CR pada 130°C. Rajah 2 menunjukkan perbandingan modulus pada 100% pemanjangan dan M100 melawan komposisi adunan untuk adunan-adunan SMR L/CR dan ENR 50/CR. Jelaskan keputusan-keputusan yang diperolehi di dalam Rajah 1 dan Rajah 2.*

(70 marks/markah)



**Fig. 1 - The comparison of Mooney scorch time versus blend composition for SMR L/CR and ENR 50/CR blends at 130°C**

**Rajah 1 - Perbandingan masa skorj Mooney melawan komposisi adunan bagi adunan-adunan SMR L/CR dan ENR 50/CR pada 130°C**



**Fig. 2 - The comparison of M100 versus blend composition for SMR L/CR and ENR 50/CR blends**

**Rajah 2 - Perbandingan M100 melawan komposisi adunan untuk adunan-adunan SMR L/CR dan ENR 50/CR**

4. For each of the following elastomers, write short notes about:

- (a) Chemistry
- (b) Compounding
- (c) Vulcanizate properties
- (d) Application
  - (i) Styrene butadiene rubber (SBR)
  - (ii) Polybutadiene rubber (BR)
  - (iii) Butyl rubber (IIR)

*Untuk setiap elastomer berikut, tuliskan nota ringkas berkaitan dengan:*

- (a) *Sifat kimia*
- (b) *Penyebatian*
- (c) *Sifat vulkanizat*
- (d) *Kegunaannya*
  - (i) *Getah stirena butadiena (SBR)*
  - (ii) *Getah polibutadiena (BR)*
  - (iii) *Getah butil (IIR)*

(100 marks/markah)

5. [a] By using a suitable diagram, explain 2 types of tyre construction.

*Dengan menggunakan rajah yang sesuai, jelaskan 2 jenis pembinaan tayar.*

(25 marks/markah)

[b] What are the 2 main sources of 'tyre noise' and how to minimize it?

*Apakah 2 sumber utama 'kebisingan tayar' dan bagaimana untuk meminimalkannya?*

(25 marks/markah)

- [c] Explain the differences between Direct Vulcanization Process (DVP) shoes and Direct Injection Process (DIP) shoes.

*Jelaskan perbezaan di antara kasut Proses Pemvulkanan Terus (DVP) dan kasut Proses Suntikan Terus (DIP).*

(25 marks/markah)

- [d] Discuss briefly the use of crosslinkable polyethylene (XLPE) as cable insulation.

*Bincangkan secara ringkas penggunaan polietilena tersambungsilang sebagai penebat kabel.*

(25 marks/markah)

6. [a] Discuss 3 methods of rubber recycling.

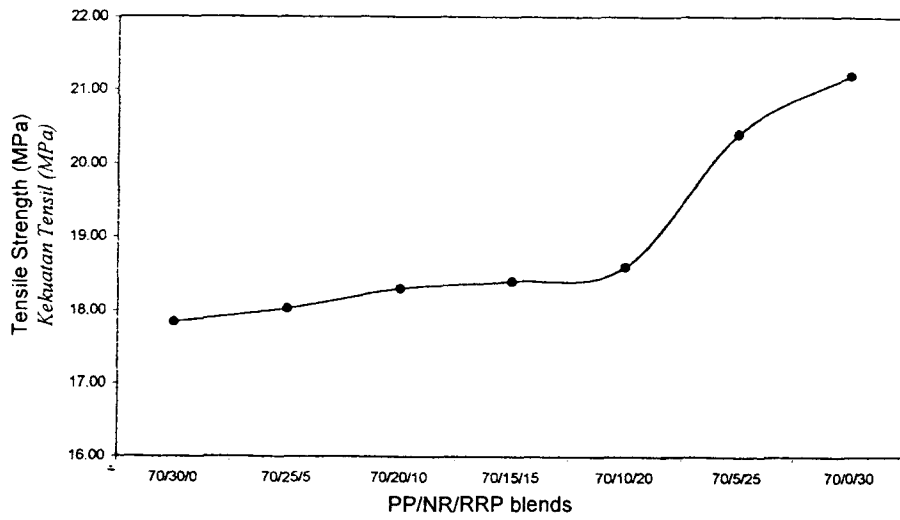
*Bincangkan 3 kaedah pengitaran semula getah.*

(40 marks/markah)

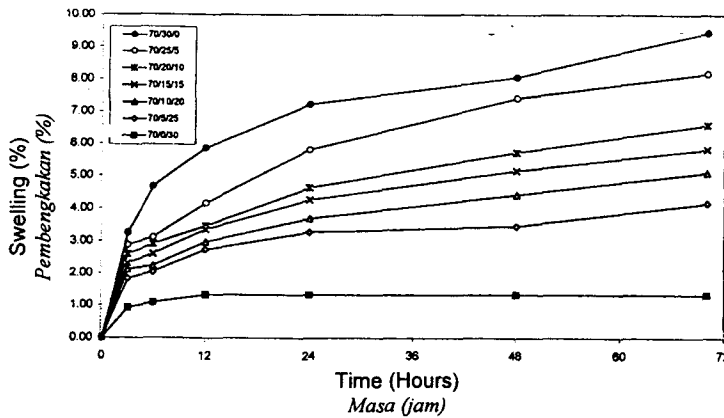
- [b] Figure 3 shows the effect of partial replacement of NR with RRP on tensile strength of PP/NR/RRP blends. Figure 4 shows the % swelling-time curves of PP/NR/RRP blends with different blend ratio in ASTM # 3 oil. Discuss the results obtained in Figure 3 and Figure 4.

*Rajah 3 menunjukkan kesan penggantian separa NR dengan RRP ke atas kekuatan tensil adunan-adunan PP/NR/RRP. Rajah 4 menunjukkan lengkungan % pembengkakan-masa bagi adunan-adunan PP/NR/RRP dengan pelbagai nisbah adunan di dalam minyak ASTM # 3. Bincangkan keputusan yang diperolehi di dalam Rajah 3 dan Rajah 4.*

(60 marks/markah)



**Fig. 3 - The effect of partial replacement of NR with RRP on tensile strength of PP/NR/RRP blends**  
**Rajah 3 - Kesan penggantian separa NR dengan RRP ke atas kekuatan tensil adunan-adunan PP/NR/RRP**



**Fig. 4 - % swelling-time curves of PP/NR/RRP blends with different blend ratio in ASTM #3 oil**  
**Rajah 4 - Lengkungan % pembengkakan-masa bagi adunan-adunan PP/NR/RRP dengan pelbagai nisbah adunan di dalam minyak ASTM #3**



7. Explain briefly

- (a) Main applications of acrylonitrile butadiene rubber (NBR)
- (b) Curing systems of polyurethane rubber (AU/EU)
- (c) Differences between chlorosulphonated polyethylene rubber (CSM) and ethylene vinyl acetate (EAM)
- (d) Chemistry of silicone rubber

*Jelaskan secara ringkas*

- (a) *Kegunaan-kegunaan utama getah akrilonitril butadiena (NBR)*
- (b) *Sistem-sistem pematangan bagi getah poliuretana (AU/EU)*
- (c) *Perbezaan di antara getah klorosulfonat (CSM) dan etilena vinil asetat (EAM)*
- (d) *Sifat kimia getah silikon*

(100 marks/markah)

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