UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session of 2007/2008

October/November 2007

EBP 308 – Rubber: Processing And Product
[Getah: Pemprosesan Dan Produk]

Duration: 3 hours
[Masa: 3 jam]

Please ensure that this paper consists of ELEVEN printed pages before you proceed with the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEBELAS muka surat yang bercetak sebelum anda memulakan peperiksaan.]

This paper contains SEVEN questions.
[Kertas soalan ini mengandungi TUJUH soalan.]

Instruction: Answer **FIVE** (5) questions. If a candidate answers more than five questions, only the first five questions answered will be examined and awarded marks.
***[Arahan:** Jawab **LIMA** (5) soalan. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]*

Answers 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] Give the advantages and disadvantages of thermoplastic elastomers (TPEs) in comparison with vulcanized rubbers.

Berikan kelebihan dan kekurangan elastomer termoplastik (TPE) berbanding getah tersambung silang.

(40 marks/*markah*)

[b] Discuss briefly the two major groups of commercially available TPEs.

Bincangkan secara ringkas dua kumpulan elastomer termoplastik utama yang terdapat secara komersial.

(30 marks/*markah*)

[c] What do you understand about Olefin-Based Elastomeric Alloys? Discuss briefly two commercial available products, i.e. Santoprene and Alcryn.

Apakah yang anda faham dengan aloi elastomer berasaskan olefin? Bincangkan secara ringkas dua daripada produk yang terdapat secara komersial, contohnya Santoprene dan Alcryn.

(30 marks/*markah*)

2. [a] Elastomers may be classified in groups according to different aspects such as chemical saturation of the polymer chain, oil resistance, flame resistance and service performance. Explain how elastomers can be classified.

Elastomer boleh dikelaskan mengikut kumpulan berdasarkan aspek-aspek yang berbeza iaitu ketepuan kimia rantai polimer, rintangan minyak, rintangan api dan prestasi servis. Jelaskan bagaimanakah pengelasan ini dilakukan.

(70 marks/*markah*)

[b] (i) Give three types of curing systems which can be used to cure butyl rubbers (IIR).

Berikan 3 jenis sistem pematangan yang boleh digunakan untuk mematangkan getah butil (IIR).

(ii) What are the main applications of butyl rubbers (IIR).

Apakah kegunaan-kegunaan utama getah butil (IIR).

(30 marks/*markah*)

3. [a] Explain the advantages of rubber-rubber blends in manufacturing of various rubber products in comparison with using only a single rubber.

Jelaskan kelebihan pengadunan getah-getah di dalam penghasilan pelbagai produk getah berbanding hanya menggunakan satu jenis getah sahaja.

(30 marks/*markah*)

[b] Figure 1 shows the variation of tensile strength versus filler loading of SMR L/ENR 25 blends whereas Figure 2 shows the tensile strength comparison between SMR L/ENR 25 blends and SMR L/SBR blends for 3 types of filler at loading of 40 phr. Table 1 shows the physical properties of carbon black, silica and calcium carbonate. Explain the results obtained in Figure 1 and Figure 2.

Rajah 1 menunjukkan perubahan kekuatan tensil melawan pembebanan pengisi untuk adunan SMR L/ENR 25 manakala Rajah 2 menunjukkan perbandingan kekuatan tensil di antara adunan SMR L/ENR 25 dan SMR L/SBR untuk 3 jenis pengisi pada pembebanan 40 bsg. Jadual 1 pula menunjukkan sifat-sifat fizikal hitam karbon, silika dan kalsium karbonat yang digunakan. Jelaskan keputusan yang diperolehi di dalam Rajah 1 dan 2.

(70 marks/*markah*)

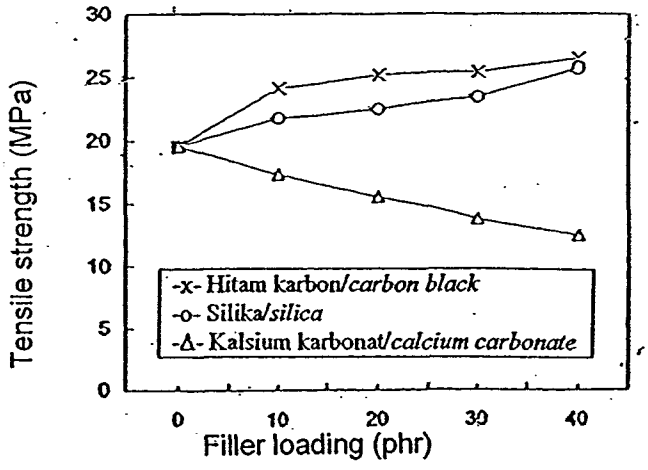

Figure 1 – Tensile strength variation with filler loading of SMR L/ENR 25 blends
Rajah 1 – Perubahan kekuatan tensil dengan pembebanan pengisi untuk adunan SMR L/ENR 25

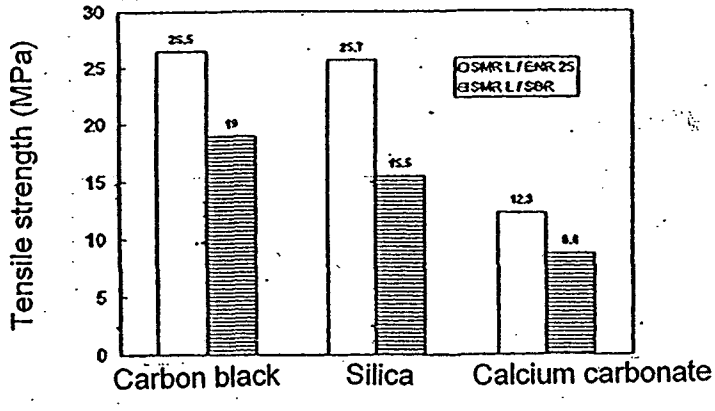

Figure 2 – Tensile strength comparison between SMR L/ENR 25 and SMR L/SBR blends for various filler at 40 phr loading
Rajah 2 – Perbandingan kekuatan tensil di antara adunan SMR L/ENR 25 dan adunan SMR L/SBR untuk pelbagai pengisi pada pembebanan 40 bsg

Table 1 – Physical Properties of Carbon Black, Silica and Calcium Carbonate
Jadual 1 – Sifat-Sifat Fizikal Hitam Karbon, Silika dan Kalsium Karbonat

	Carbon Black *Hitam Karbon*	**Silica** *Silika*	**Calcium Carbonate** *Kalsium Karbonat*
Surface area (m^2/g) *Luas Permukaan (m^2/g)*	78	50	3.6
Density (g/cm^3) *Ketumpatan (g/cm^3)*	1.8	2.0	1.0

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

[a] Chemistry

[b] Compounding

[c] Vulcanizate properties and

[d] Application

(i) Ethylene Propylene Rubbers (EPM and EPDM)

(ii) Acrylonitrile Butadiene Rubbers (NBR)

(iii) Ethylene Vinyl Acetate Rubbers (EAM)

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

[a] Sifat kimia

[b] Penyebatian

[c] Sifat vulkanizat dan

[d] Kegunaannya

(i) Getah Etilena Propilena (EPM dan EPDM)

(ii) Getah Akrilonitril Butadiena (NBR)

(iii) Getah Etilena Vinil Asetat (EVA)

(100 marks/*markah*)

5. [a] A series of styrene butadiene rubber (SBR) / epoxidized natural rubber (ENR 50) blends were prepared. Discuss the characteristics of each rubber and the possible advantages obtained from these rubber blends.

Satu siri adunan getah stirena butadiena (SBR) / getah asli terepoksida (ENR 50) telah disediakan. Bincangkan ciri-ciri setiap getah dan kelebihan yang mungkin diperolehi daripada pengadunan dua getah ini.

(20 marks/*markah*)

[b] Figure 3 shows the relationship between tan δ @ MH and ENR 50 composition (%R) for various SBR / ENR 50 blends at different curing temperatures. Explain the results obtained.

Rajah 3 menunjukkan perhubungan di antara tan δ @ MH dan komposisi ENR 50 (%R) untuk pelbagai adunan SBR / ENR 50 pada suhu pematangan yang berbeza. Jelaskan keputusan yang diperolehi.

(40 marks/*markah*)

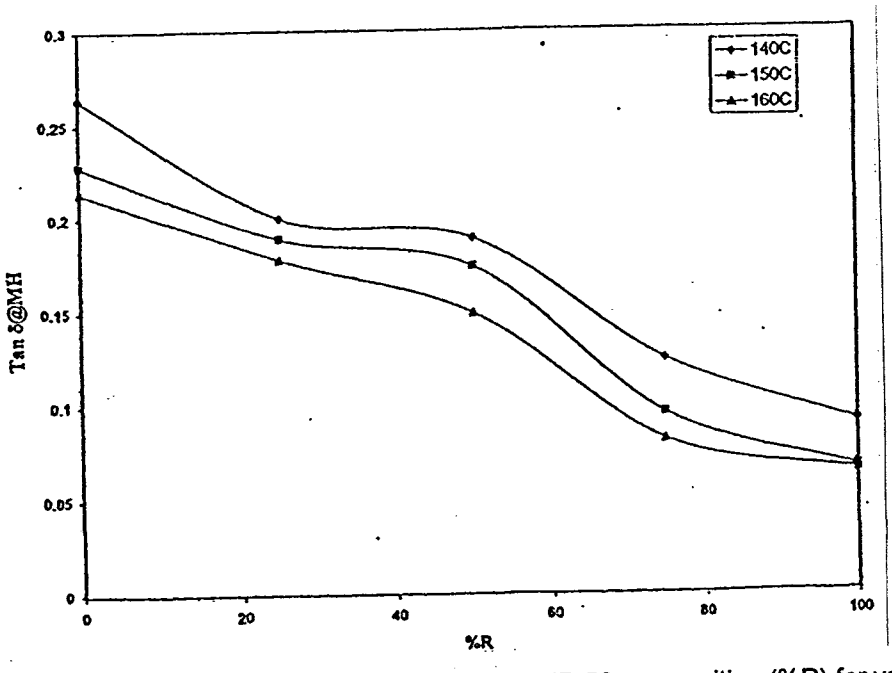

Figure 3: The relationship between tan δ at MH and ENR 50 composition (%R) for various SBR/ENR 50 blends at different curing temperatures.

Rajah 3: Perhubungan di antara tan δ @ MH dan komposisi ENR 50 (%R) untuk pelbagai adunan SBR/ENR 50 pada suhu pematangan yang berbeza.

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[c] The difference in scorch time between experimental and calculated values by interpolation is given by Z:

Perbezaan masa skorj di antara nilai-nilai eksperimen dan yang dihitung secara interpolasi boleh diberikan oleh Z:

$Z = \tau_2$ (experimental/*eksperimen*) - τ_2 (interpolated/*interpolasi*)

A plot of Z versus the blend ratio of SBR / ENR 50 for three curing temperatures is shown in Figure 4. Based on Figure 4, explain the effect of temperature and ENR 50 composition on Z values.

Suatu plot Z melawan nisbah adunan bagi adunan SBR / ENR 50 untuk tiga suhu pematangan ditunjukkan di dalam Rajah 4. Berdasarkan Rajah 4, terangkan kesan suhu dan komposisi ENR 50 ke atas nilai-nilai Z.

(40 marks/*markah*)

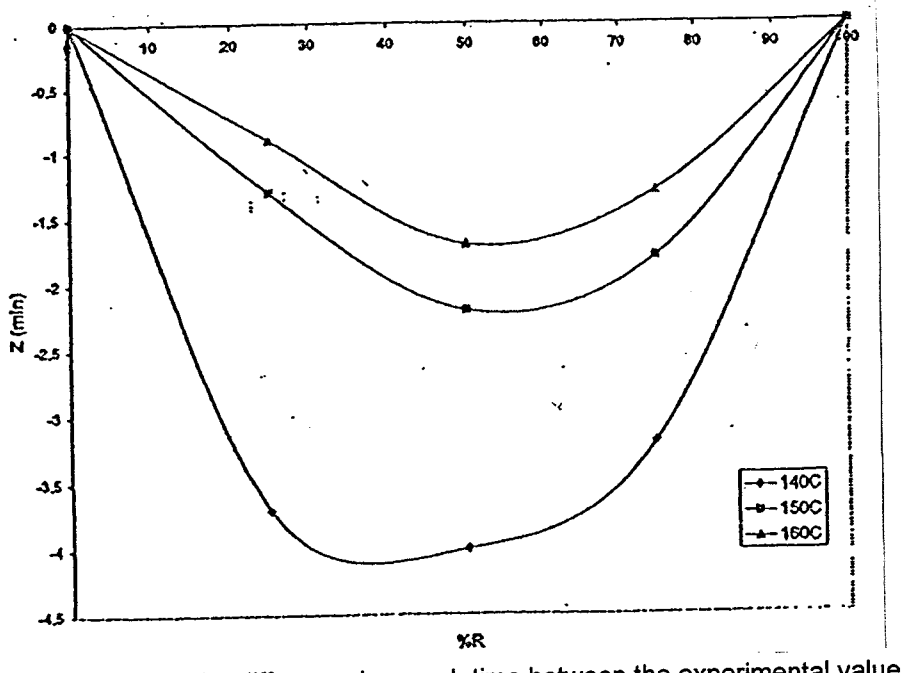

Figure 4: Variation of the difference in scorch time between the experimental value and interpolated value (Z) of the various SBR/ENR 50 blends at different curing temperatures.
Rajah 4: Perubahan perbezaan masa skorj di antara nilai-nilai eksperimen dan interpolasi (Z) untuk pelbagai adunan SBR/ENR 50 pada suhu pematangan yang berbeza.

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6. [a] Explain the importance of recycling various rubber wastes. Using any rubber waste such as catheter, tyres, gloves, etc discuss how these rubber wastes can be recycled and converted into two valuable products.

Jelaskan kepentingan pengitaran semula pelbagai sisa getah. Menggunakan mana-mana sisa getah seperti "catheter", tayar, sarung tangan dan sebagainya, bincangkan bagaimana sisa-sisa buangan getah ini boleh dikitar semula dan ditukarkan menjadi dua produk yang berguna.

(40 marks/*markah*)

[b] Figure 5 shows the comparison relationship between tensile strength and rubber composition of polypropylene / natural rubber (PP/NR) blends and PP / recyle rubber powder (PP/RRP) blends. Figure 6 shows the swelling percentage curves versus time of PP/NR/RRP blends using different sulphur concentration. Discuss the results obtained in Figure 5 and Figure 6.

Rajah 5 menunjukkan perbandingan perhubungan di antara kekuatan tensil dan komposisi getah bagi adunan polipropilena / getah asli (PP/NR) dan adunan PP / serbuk getah kitar semula (PP/RRP). Rajah 6 menunjukkan lengkungan peratus pembengkakan melawan masa bagi adunan PP/NR/RRP menggunakan kepekatan sulfur yang berbeza. Bincangkan keputusan yang diperolehi di dalam Rajah 5 dan Rajah 6.

(60 marks/*markah*)

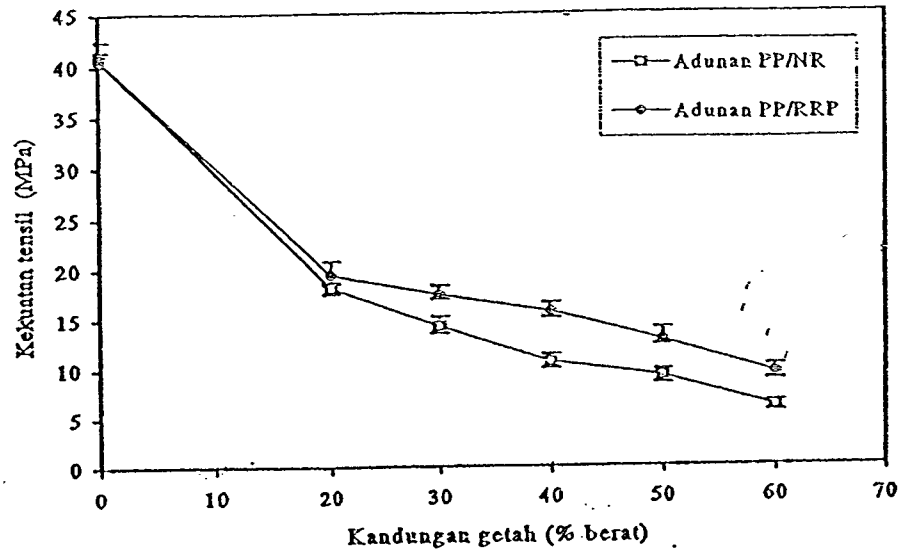

Figure 5: Tensile strength versus rubber composition.
Rajah 5: Kekuatan tensil melawan kandungan getah.

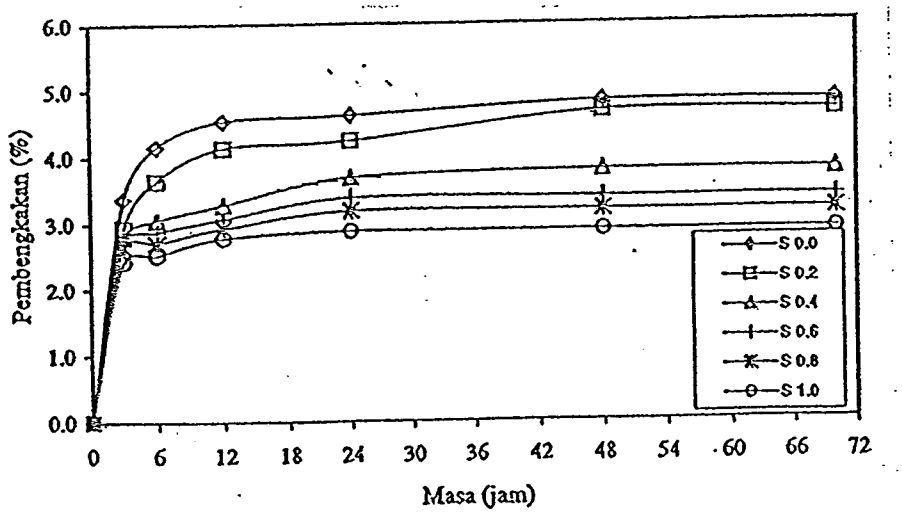

Figure 6: Swelling percentage curve versus time of PP/NR/RRP blends with different sulphur concentration.
Rajah 6: Lengkungan peratusan pembengkakan melawan masa untuk adunan PP/NR/RRP dengan kepekatan sulfur yang berbeza.

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7. [a] Using a suitable diagram explain the 4 main functions of the pneumatic tyre.

Dengan menggunakan rajah yang sesuai, jelaskan 4 fungsi utama tayar pneumatik.

(25 marks/*markah*)

[b] What is the meaning of "Rolling Resistance" of tyre and how to minimize it?

Apakah yang dimaksudkan dengan "Rintangan Putaran" tayar dan bagaimana untuk meminimakannya?

(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 4 polymeric materials which are normally used for cable insulation.

Bincangkan secara ringkas 4 bahan-bahan polimer yang lazimnya digunakan untuk penebatan kabel.

(25 marks/*markah*)

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