
UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2011/2012

Januari 2012

EBP 308/3 – Rubber: Processing & Product
[Getah: Pemprosesan & Produk]

Duration : 3 hours
[Masa : 3 jam]

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

[Sila pastikan bahawa kertas peperiksaan ini mengandungi DUA 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 **ALL** 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 **SEMUA** 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.]

PART A:**BAHAGIAN A:**

1. [a] A series of styrene butadiene rubber (SBR) / recycled acrylonitrile butadiene rubber (NBR_r) 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 akrilonitril butadiena terkitar semula (NBR_r) telah disediakan. Bincangkan ciri-ciri setiap getah dan kelebihan yang mungkin diperolehi daripada pengadunan dua getah ini.

(20 marks/markah)

- [b] Table 1 shows the cure characteristics of SBR/NBR_r blends with and without ENR-50 as a compatibilizer. Discuss the effects of different blend ratio and ENR-50 on the results obtained in Table 1.

Table 1: Cure characteristics of SBR/NBR_r blends with and without ENR-50

Blend (phr/phr)	Cure times, t ₂		Scorch time, t ₉₀		Minimum torque, M _L		Maximum Torque, M _H	
	Without ENR	With ENR	Without ENR	With ENR	Without ENR	With ENR	Without ENR	With ENR
(95/5)	19.43	11.16	5.98	2.96	2.31	2.28	19.58	20.12
(85/15)	18.00	10.76	5.19	2.63	2.79	2.69	18.50	19.59
(75/25)	16.28	10.74	3.72	1.77	3.15	3.11	17.58	19.24
(65/35)	15.60	10.61	2.67	1.47	3.61	3.20	16.49	18.91
(50/50)	12.28	10.05	1.82	1.36	4.07	3.42	15.6	18.56

Jadual 1 menunjukkan ciri-ciri pematangan adunan SBR/NBR, dengan dan tanpa ENR 50 sebagai pengserasi. Bincangkan kesan nisbah adunan yang berbeza dan ENR 50 untuk keputusan yang didapati dalam Jadual 1.

Jadual 1: Sifat pematangan adunan SBR/NBRr dengan dan tanpa ENR-50

Adunan (bsg/bsg)	Masa pematangan, t_2		Masa skorj, t_{90}		Minimum tork, M_L		Maksimum tork, M_H	
	Tanpa ENR	Dgn. ENR	Tanpa ENR	Dgn. ENR	Tanpa ENR	Dgn. ENR	Tanpa ENR	Dgn. ENR
(95/5)	19.43	11.16	5.98	2.96	2.31	2.28	19.58	20.12
(85/15)	18.00	10.76	5.19	2.63	2.79	2.69	18.50	19.59
(75/25)	16.28	10.74	3.72	1.77	3.15	3.11	17.58	19.24
(65/35)	15.60	10.61	2.67	1.47	3.61	3.20	16.49	18.91
(50/50)	12.28	10.05	1.82	1.36	4.07	3.42	15.6	18.56

(80 marks/markah)

2. [a] List and briefly describe the 8 groups of Nomenclature of Rubbers based on ISO 1629. What is the importance of the nomenclatures and their relation in classification of elastomers?.

Senaraikan dan jelaskan secara ringkas 8 kumpulan Tatanama Elastomer berdasarkan ISO 1629. Apakah kepentingan tatanama ini dan hubungkaitnya dalam pengkelasan elastomer-elastomer?

(30 marks/markah)

- [b] There are 4 classification types of elastomers according to different aspect (i) chemical saturation of polymer chain, (ii) oil resistance, (iii) flame resistance and (iv) service performance. Describe how elastomers can be classified and give examples of elastomers for each aspect discussed.

Terdapat 4 jenis pengkelasan elastomer yang berdasarkan kepada perbezaan aspek-aspek (i) ketepuan kimia rantai polimer, (ii) rintangan minyak, (iii) rintangan api dan (iv) prestasi servis. Jelaskan bagaimana pengkelasan elastomer-elastomer ini dan berikan contoh elastomer bagi setiap aspek yang dibincangkan.

(70 marks/markah)

PART B:

BAHAGIAN B:

3. [a] What do you know about thermoplastic elastomers (TPE_s)? Give the advantages and disadvantages of TPE_s.

Apa yang anda tahu tentang elastomer termoplastik (TPE_s)? Berikan kelebihan dan kekurangan TPE.

(40 marks/markah)

- [b] There are two major groups of commercially available TPE_s. Discuss one example of each group. Explain the morphology difference between these two groups.

Terdapat dua kumpulan komersil utama TPE. Bincangkan satu contoh untuk setiap kumpulan. Jelaskan perbezaan morfologi di antara dua kumpulan ini.

(30 marks/markah)

- [c] Using a suitable diagram, compare the relationship between cost and performance of Santoprene with other rubbers and thermoplastics.

Menggunakan rajah yang sesuai, bandingkan perhubungan di antara kos dan prestasi Santoprena dengan pelbagai getah dan termoplastik lain.

(30 marks/markah)

4. [a] Explain briefly the four main classes of tyres.

Jelaskan secara ringkas 4 kelas utama tayar.

(25 marks/markah)

- [b] Discuss the relationship between the usage of fuel and rolling resistance of tyre. In the manufacturing of tyre, what should be done to obtain low rolling resistance of tyre?

Bincangkan hubungan di antara penggunaan bahan api dengan rintangan putaran tayar. Di dalam pembuatan tayar apakah yang perlu dilakukan bagi memperolehi rintangan putaran yang rendah?

(25 marks/markah)

- [c] The normal rubber used in cable insulation are ethylene propylene rubber (EPR) and silicone rubber. Explain the reason.

Getah-getah yang lazim digunakan di dalam penebatan kabel ialah getah etilena propilena (EPR) dan getah silikon. Jelaskan sebab-sebabnya.

(25 marks/markah)

- [d] Explain the importance of elastomer sheath in manufacturing of cable.

Terangkan kepentingan sarung elastomer (elastomer sheath) dalam pembuatan kabel.

(25 marks/markah)

5. [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 2 (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 2 (dua) produk yang berguna.

(40 marks/markah)

- [b] Figure 1 shows the Young's modulus versus blend composition of polypropylene/recycled acrylonitrile butadiene rubber (PP/rNBR) and dynamic vulcanized PP/rNBR-DV blends. Figure 2 shows the effect of blend composition on the swelling percentage of PP/NBRr and PP/NBR-DV blends in IRM 903 oil for 70 hours. Discuss the results obtained in Figure 1 and Figure 2.

Rajah 1 menunjukkan modulus Young melawan komposisi adunan bagi adunan polipropilena/getah akrilonitril butadiena kitar semula (PP/rNBR) dan adunan PP/rNBR-DV tervulkan dinamik. Rajah 2 menunjukkan kesan komposisi adunan ke atas peratus pembengkakan bagi adunan PP/NBRr dan PP/NBR-DV dalam minyak IRM 903 selama 70 jam. Bincangkan keputusan yang diperolehi dalam Rajah 1 dan Rajah 2.

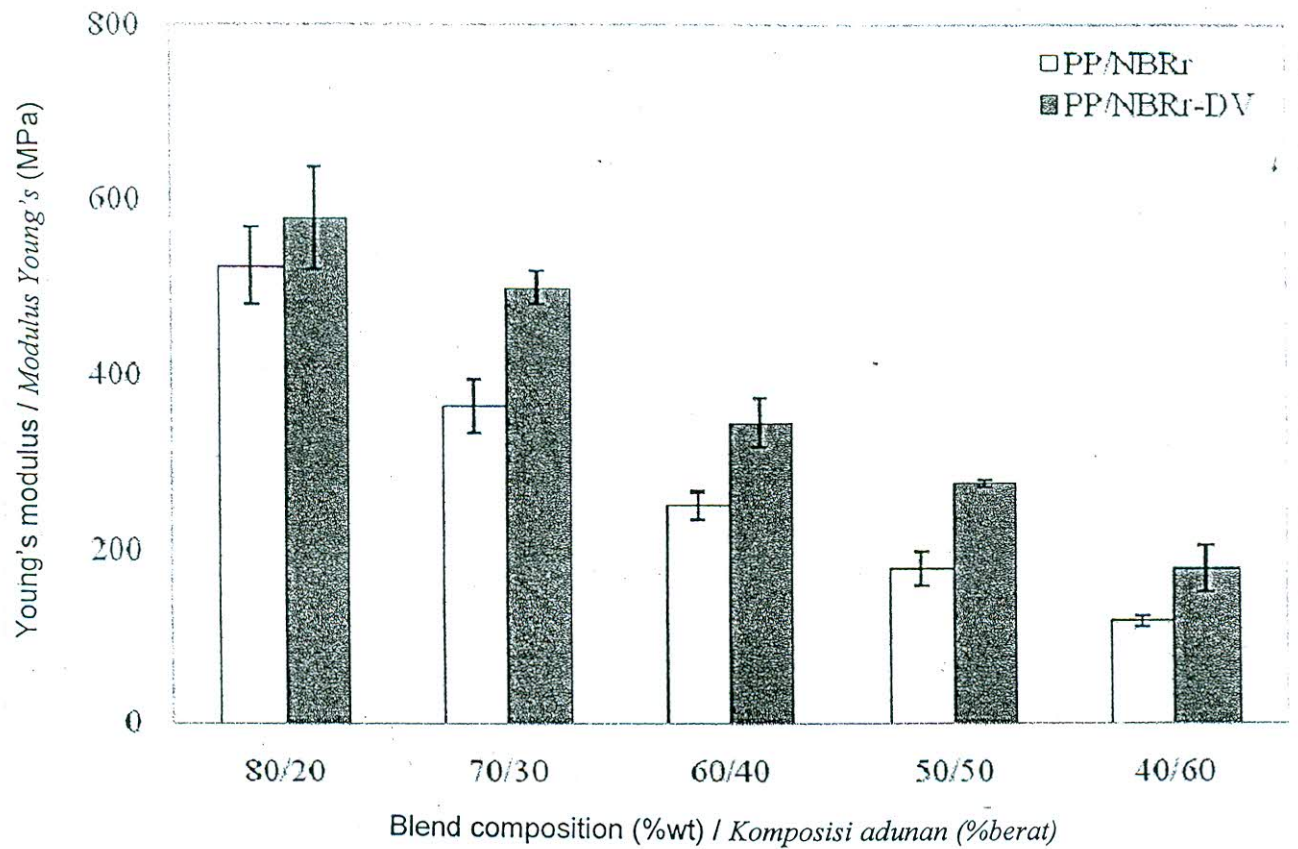


Figure 1: Young's modulus vs. blend composition of PP/NBR_r and PP/NBR_r-DV

Rajah 1: Modulus Young melawan komposisi adunan bagi adunan-adunan PP/NBR_r dan PP/NBR_r-DV

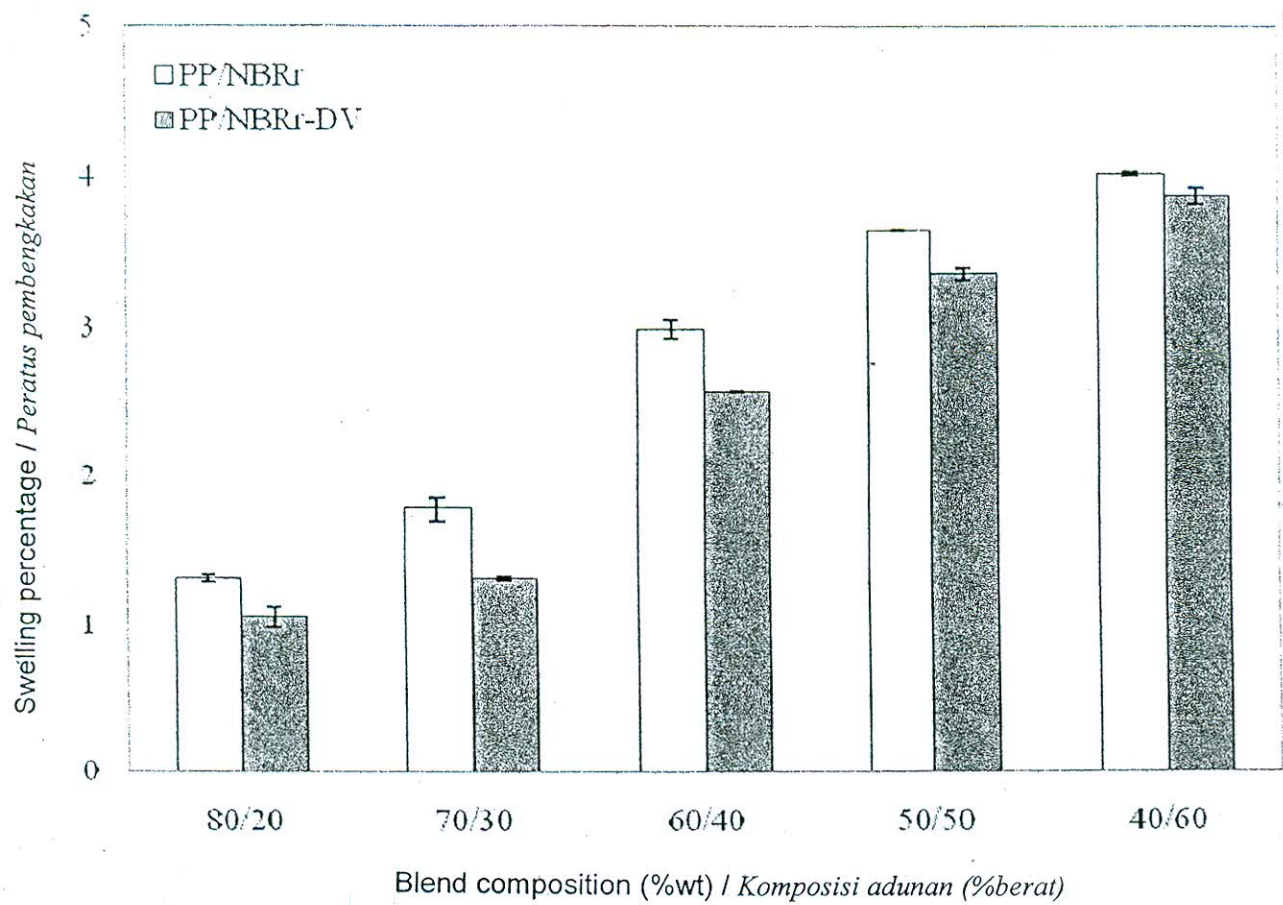


Figure 2: Swelling percentage vs. blend composition of PP/NBR_r and PP/NBR_r-DV blends

Rajah 2: Peratus pembengkakan melawan komposisi adunan bagi adunan-adunan PP/NBR_r dan PP/NBR_r-DV

(60 marks/markah)

6. [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 bahan api.

(30 marks/markah)

- [b] Figure 3 shows the comparison of Mooney scorch time versus blend composition for SMR L/CR and ENR 50/CR blends at 130°C. Figure 4 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 3 and Figure 4.

Rajah 3 menunjukkan perbandingan masa skorj Mooney melawan komposisi adunan untuk adunan-adunan SMR L/CR dan ENR 50/CR pada 130°C. Rajah 4 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 3 dan Rajah 4.

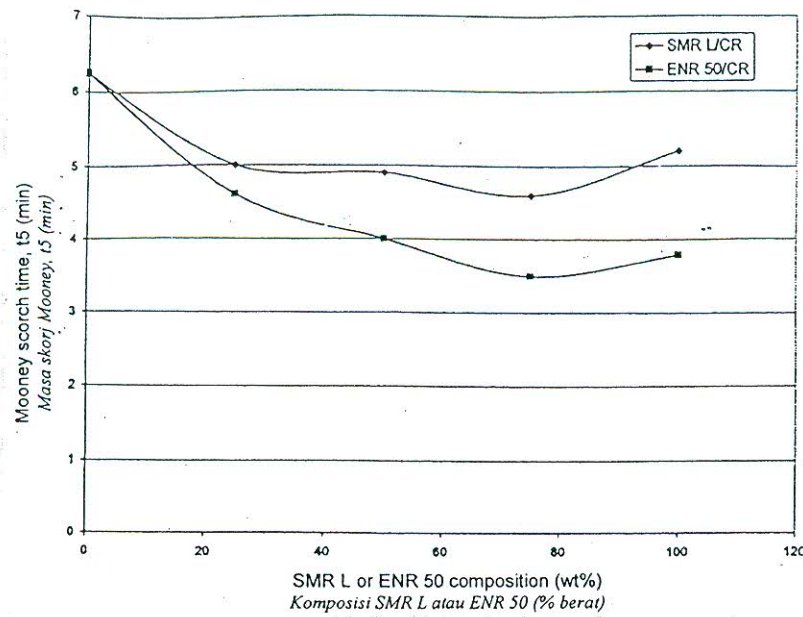


Figure 3: The comparison of Mooney scorch time versus blend composition for SMR L/CR and ENR 50/CR blends at 130°C

Rajah 3: Perbandingan masa skorj Mooney melawan komposisi adunan bagi adunan-adunan SMR L/CR dan ENR 50/CR pada 130°C

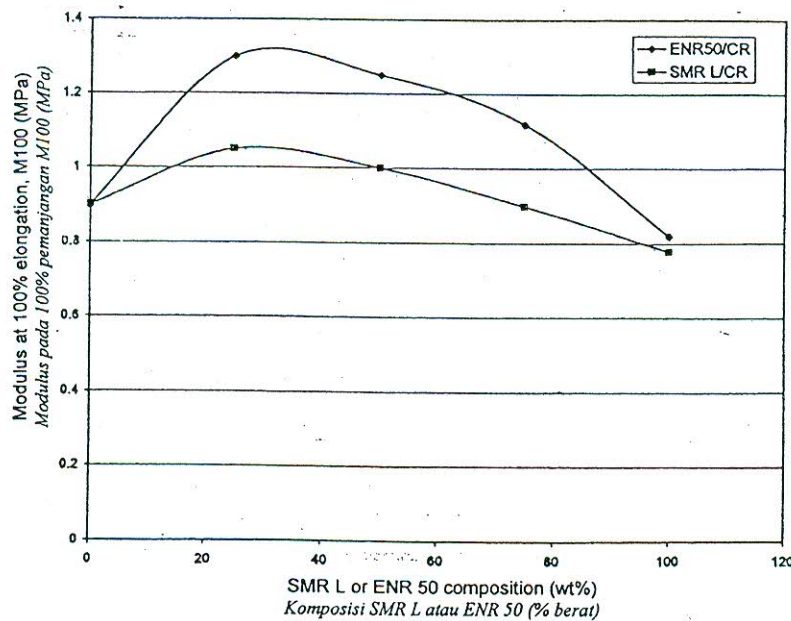


Figure 4: The comparison of M100 versus blend composition for SMR L/CR and ENR 50/CR blends

Rajah 4: Perbandingan M100 melawan komposisi adunan untuk adunan-adunan SMR L/CR dan ENR 50/CR

(70 marks/markah)

... 12/-

7. Explain briefly:

Jelaskan secara ringkas:

- [a] Differences between chlorosulphonated rubber (CSM) and ethylene vinyl acetate (AEM).

Perbezaan antara getah klorosulfonat (CSM) dengan etilena vinil asetat (AEM).

(25 marks/markah)

- [b] 3 common methods of cross-linking for synthesis of crosslinked polyethylene (PEX).

3 kaedah paut-silang yang biasa bagi penghasilan polietilena terpaut-silang (PEX).

(25 marks/markah)

- [c] Curing systems of polyurethane rubber (AU/EU).

Sistem-sistem pematangan bagi getah poliuretana (AU/EU).

(25 marks/markah)

- [d] Main applications of styrene butadiene rubber (SBR).

Kegunaan-kegunaan utama getah stirena butadiena (SBR).

(25 marks/markah)