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# UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Pertama  
Sidang Akademik 2006/2007  
*First Semester Examination  
Academic Session 2006/2007*

Oktober/November 2006

## **EBP 308/3 – Getah: Pemprosesan Dan Produk** *EBP 308/3 – Rubber: Processing And Product*

Masa: 3 jam  
Time: 3 hours

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

Kertas soalan ini mengandungi TUJUH soalan.  
*This paper contains SEVEN questions.*

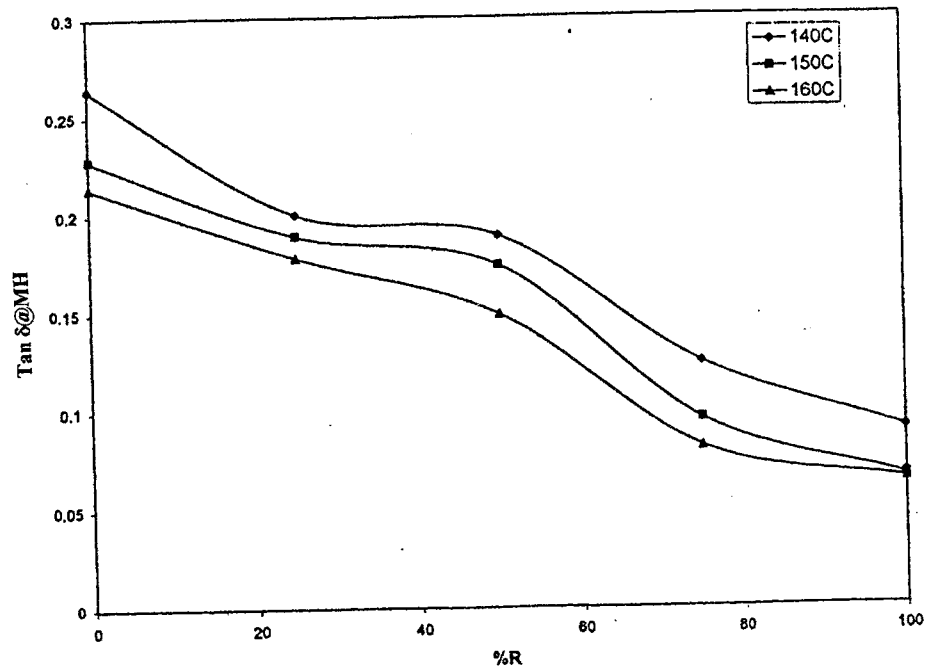
Jawab LIMA soalan. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.  
*Answer any FIVE questions. If candidate answers more than five questions only the first five questions answered in the answer script would be examined.*

Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru.  
*Answer to each and every question must start on a new page.*

Jawab semua soalan dalam Bahasa Malaysia.  
*All questions must be answered in Bahasa Malaysia.*

1. [a] Apa yang anda tahu tentang elastomer termoplastik (TPE)? Berikan kelebihan dan kekurangan TPE.  
(40 markah)
- [b] Terdapat dua kumpulan komersial utama TPE. Bincangkan satu contoh untuk setiap kumpulan. Jelaskan perbezaan morfologi di antara dua kumpulan ini.  
(30 markah)
- [c] Menggunakan rajah yang sesuai, bandingkan perhubungan di antara kos dan prestasi santoprene dengan pelbagai getah dan termoplastik lain.  
(30 markah)
2. [a] Elastomer boleh dikelaskan mengikut kumpulan berdasarkan perbezaan aspek-aspek seperti ketepuan kimia rantai polimer, rintangan minyak, rintangan api dan prestasi servis. Jelaskan bagaimana elastomer-elastomer ini boleh dikelaskan kepada empat kumpulan ini.  
(70 markah)
- [b] Jelaskan mengapa getah kloroprena (CR) dan getah sintetik poliisoprena (IR) berupaya untuk menghablur bila diregangkan tetapi tidak bagi getah stirena butadiena (SBR).  
(30 markah)

4. [a] 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 markah)
- [b] Rajah 1 menunjukkan perhubungan di antara  $\tan \delta @ \text{MH}$  dan komposisi ENR 50 (%R) untuk pelbagai adunan SBR / ENR 50 pada suhu pematangan yang berbeza. Jelaskan keputusan yang diperolehi. (40 markah)



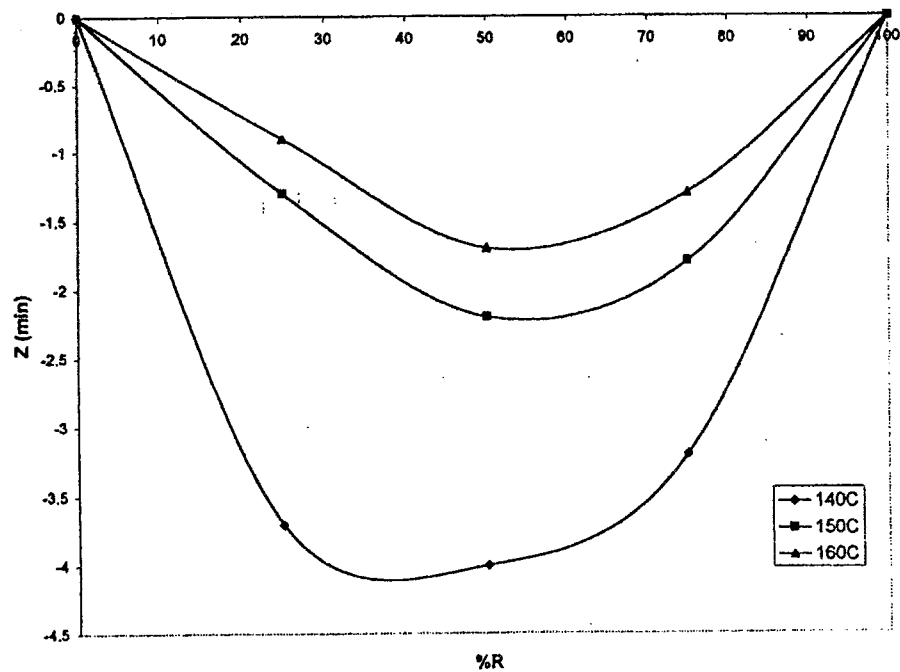
Rajah 1: Perhubungan di antara  $\tan \delta @ \text{MH}$  dan komposisi ENR 50 (% R) untuk pelbagai adunan SBR / ENR 50 pada suhu pematangan yang berbeza.

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

$$Z = \tau_2 (\text{eksperimen}) - \tau_2 (\text{interpolasi})$$

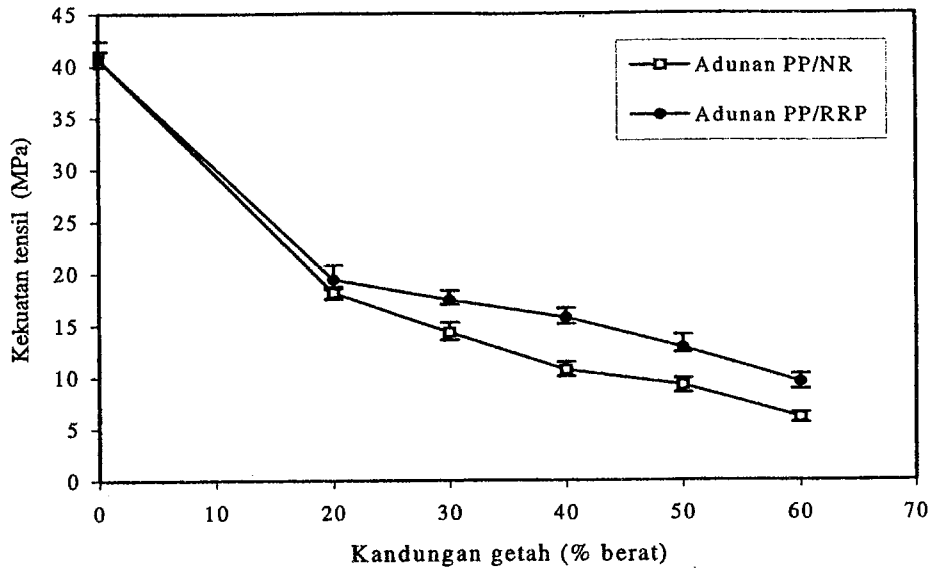
Suatu plot Z melawan nisbah adunan bagi adunan SBR / ENR 50 untuk tiga suhu pematangan ditunjukkan di dalam Rajah 2. Berdasarkan Rajah 2, terangkan kesan suhu dan komposisi ENR 50 ke atas nilai-nilai Z.

(40 markah)

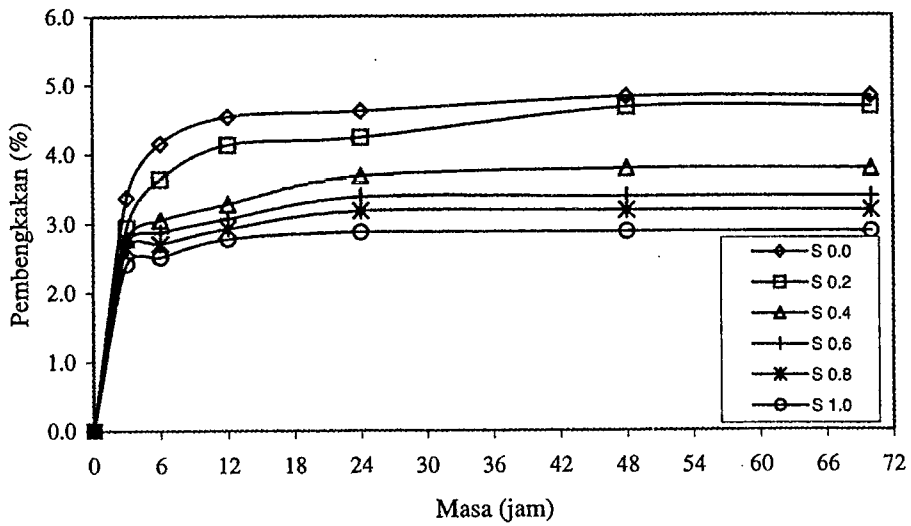


Rajah 2: Perubahan perbezaan masa skorj di antara nilai-nilai eksperimen dan interpolasi (Z) untuk pelbagai adunan SBR / ENR 50 pada suhu pematangan yang berbeza.

5. [a] Jelaskan secara ringkas 4 kelas utama tayar. (25 markah)
- [b] 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 markah)
- [c] Di antara bahan getah yang lazim digunakan di dalam penebatan kabel ialah getah etilena propilena (EPR) dan getah silikon. Jelaskan sebab-sebabnya. (25 markah)
- [d] Terangkan kepentingan sarung elastomer (elastomer sheath) di dalam pembuatan kabel. (25 markah)
6. [a] 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 markah)
- [b] Rajah 3 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 4 menunjukkan lengkungan peratus pembengkakan melawan masa bagi adunan PP/NR/RRP menggunakan kepekatan sulfur yang berbeza. Bincangkan keputusan yang diperolehi di dalam Rajah 3 dan Rajah 4. (60 markah)



Rajah 3: Kekuatan tensil melawan kandungan getah



Rajah 4: Lengkungan peratusan pembengkakan melawan masa untuk adunan PP/NR/RRP dengan kepekatan sulfur yang berbeza

1. [a] *What do you know about thermoplastic elastomers (TPE<sub>s</sub>)? Give the advantages and disadvantages of TPE<sub>s</sub>.*

*(40 marks)*

[b] *There are two major groups of commercially available TPE<sub>s</sub>. Discuss one example of each group. Explain the difference morphology between these two groups.*

*(30 marks)*

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

*(30 marks)*

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*

*(70 marks)*

[b] *Discuss why chloroprene rubber (CR) and synthetic polyisoprene rubber (IR) are able to crystallize on stretching but not styrene-butadiene rubber (SBR).*

*(30 marks)*

4. [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.

(20 marks)

- [b] Figure 1 shows the relationship between  $\tan \delta @ \text{MH}$  and ENR 50 composition (% R) for various SBR / ENR 50 blends at different curing temperatures. Explain the results obtained.

(40 marks)

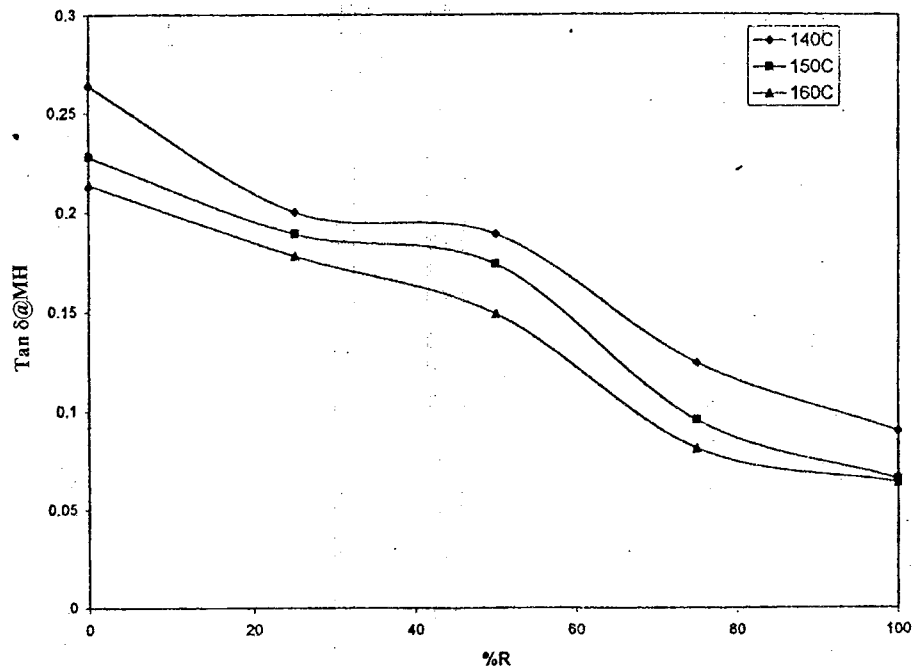


Figure 1: The relationship between  $\tan \delta$  at MH and ENR 50 composition (% R) for various SBR/ENR 50 blends at different curing temperatures.

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

$$Z = \tau_2 (\text{experimental}) - \tau_2 (\text{interpolated})$$

A plot of Z versus the blend ratio of SBR/ENR 50 for three curing temperatures is shown in Figure 2. Based on Figure 2, explain the effect of temperature and ENR 50 composition on Z values.

(40 marks)

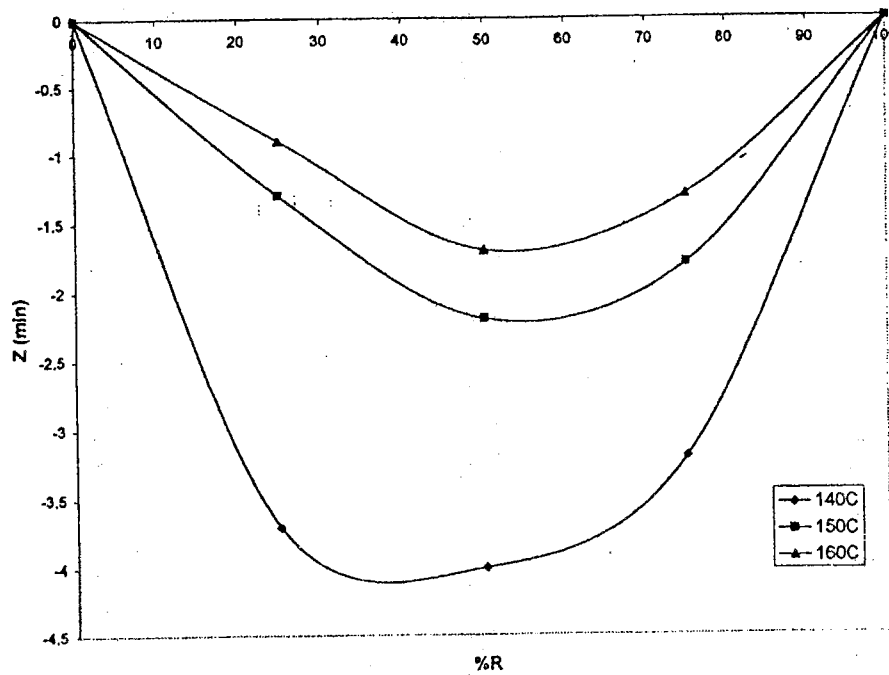


Figure 2: Variation of the difference in scorch time between the experimental value and interpolated value (Z) of the various SBR/ENR 50 blends at different curing temperatures.

5. [a] *Explain briefly the four main classes of tyre.*  
(25 marks)
- [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?*  
(25 marks)
- [c] *The normal rubbers used in cable insulation are ethylene propylene rubber (EPR) and silicone rubber. Explain the reason.*  
(25 marks)
- [d] *Explain the importance of elastomer sheath in manufacturing of cable.*  
(25 marks)
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 2 valuable products.*  
(40 marks)
- [b] *Figure 3 shows the comparison relationship between tensile strength and rubber composition of polypropylene / natural rubber (PP/NR) blends and PP/recycle rubber powder (PP/RRP) blends. Figure 4 shows the swelling percentage curves versus time of PP/NR/RRP blends using different sulphur concentration. Discuss the results obtained in Figure 3 and Figure 4.*  
(60 marks)

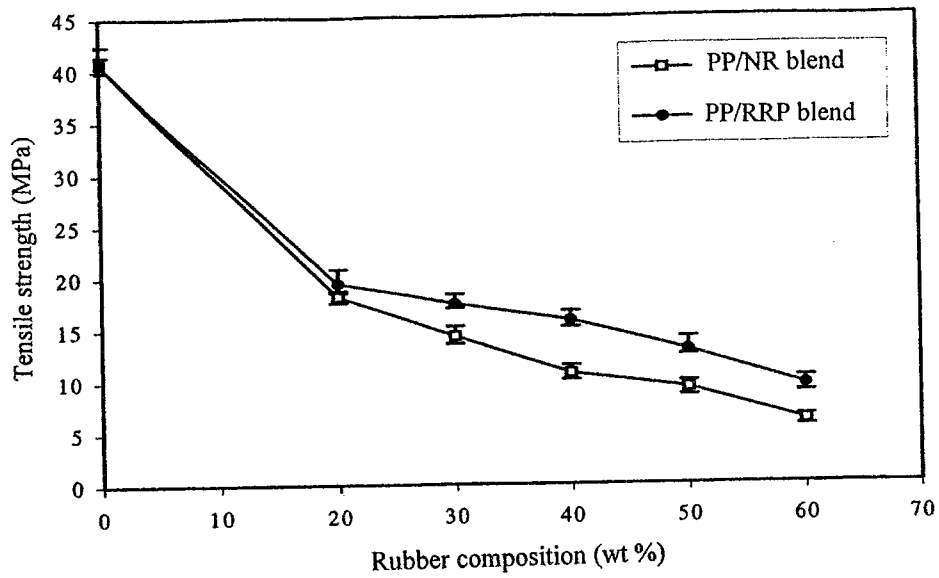


Figure 3: Tensile strength versus rubber composition

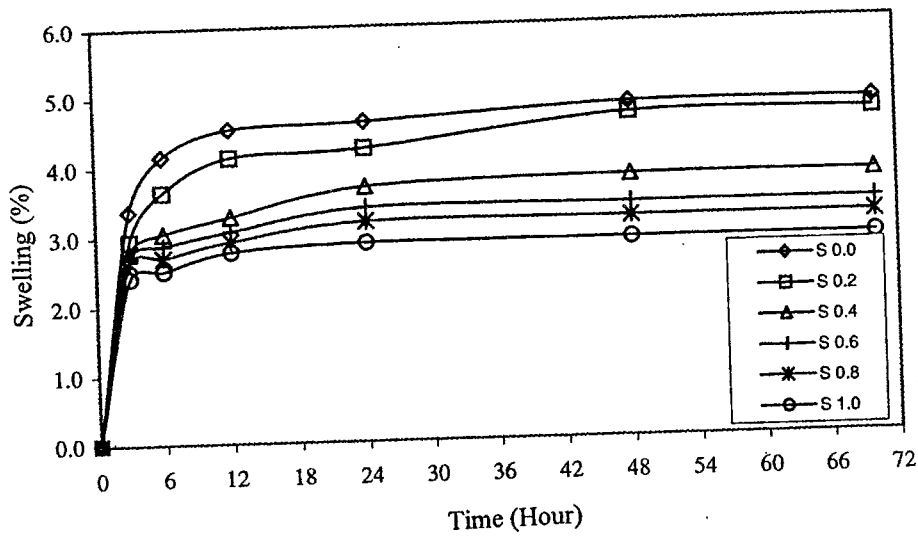


Figure 4: Swelling percentage curve versus time of PP/NR/RRP blends with different sulphur concentration