
UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2006/2007
*Peperiksaan Semester Kedua
Sidang Akademik 2006/2007*

April 2007

EBP 307E/2 - Polymer Rheology *EBP 307E/2 - Reologi Polimer*

Time : 2 hours
Masa : 2 jam

Please ensure that this paper consists of EIGHT printed pages before you proceed with the examination.

This paper contains SIX questions. THREE questions in PART A and THREE questions in PART B.

Answer FOUR questions. Answer TWO questions from PART A and TWO questions from PART B. If a candidate answer more than four questions, only the first four answers will be examined and awarded marks.

Answer to any question must start on a new page.

All questions must be answered in English. However, ONE question can be answered in Bahasa Malaysia.

Sila pastikan bahawa kertas peperiksaan ini mengandungi LAPAN muka surat yang bercetak sebelum anda memulakan peperiksaan.

Kertas soalan ini mengandungi ENAM soalan. TIGA soalan di BAHAGIAN A dan TIGA soalan di BAHAGIAN B.

Jawab EMPAT soalan. Jawab DUA soalan dari BAHAGIAN A dan DUA soalan dari BAHAGIAN B. Jika calon menjawab lebih daripada empat soalan hanya empat soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.

Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru.

Jawab semua soalan dalam Bahasa Inggeris. Walau bagaimanapun, SATU soalan dibenarkan dijawab dalam Bahasa Malaysia.

PART A

BAHAGIAN A

1. [a] Define rheology. Briefly discuss five benefits that one can obtained from the study of rheology.

(60 marks)

- [b] For a typical long-chain, entangled polymer, sketch the shear viscosity as a function of shear rate (log-log graph). Briefly comments the three models, i.e. Power-law, Carreau, and modified Cross in fitting the flow behavior of the polymer.

(40 marks)

1. [a] *Takrifkan reologi. Secara ringkas bincangkan faedah yang boleh diperolehi daripada kajian reologi.*

(60 markah)

- [b] *Bagi polimer rantai panjang dan kusut, lakarkan kelikatan ricih sebagai fungsi kadar ricih (graf log-log). Secara ringkas komen padanan tiga model iaitu hukum kuasa, Carreau dan Cross terubahsuai terhadap kelakuan aliran polimer tersebut.*

(40 markah)

3. Obtain the expressions for shear stress and shear rate at wall for a Power-law fluid flow through a tube of cylindrical cross section (Figure 1). State your assumptions.

(100 marks)

3. Dapatkan ungkapan bagi tegasan ricih dan kadar ricih pada dinding untuk bendalir hukum kuasa yang mengalir melalui tiub yang berkeratan rentas silinder (Rajah 1). Nyatakan anggapan-anggapan anda.

(100 markah)

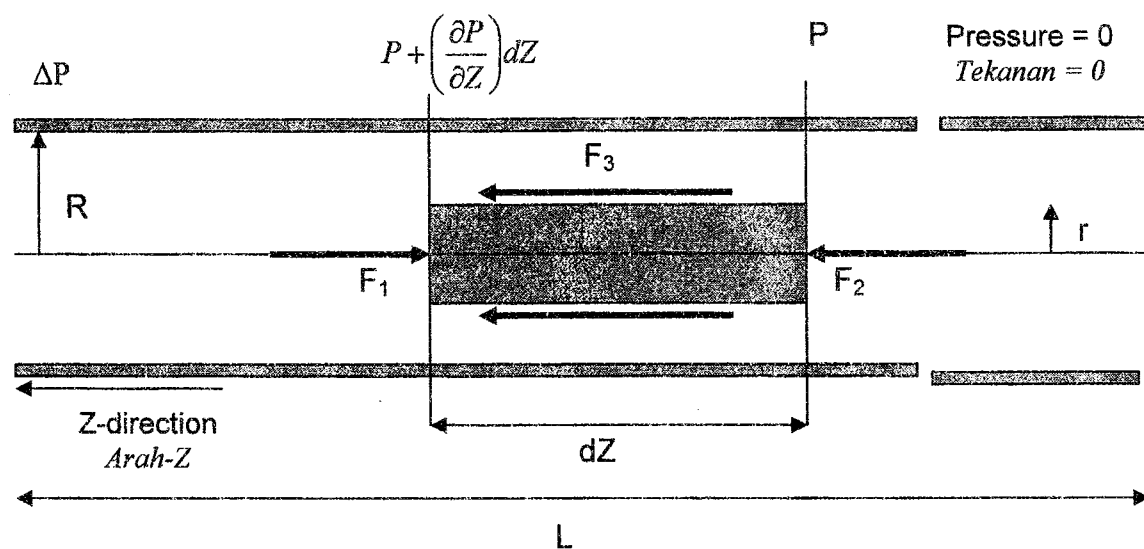


Figure 1 - Power-law fluid flow through a tube of cylindrical cross section
Rajah 1 - Aliran bendalir hukum kuasa melalui suatu tiub berkeratan rentas silinder

PART B**BAHAGIAN B**

4. [a] List external factors that govern rheological behaviour of polymers and discuss **TWO** of these factors in detail. Use appropriate diagram if necessary.

(50 marks)

- [b] Calculate the rheological parameters (i.e. shear stress, shear rate and viscosity) if MFI result gives a value of 35 g/10min. The MFI test was conducted at 220°C using a standard 2.16 kg load. All geometries (i.e. length and diameter) of the standard capillary die are in accordance with ASTM D1238.

Given,

Piston diameter = 1.8 cm

Polymer melt density = 0.78 g/cm³

(50 marks)

4. [a] *Senaraikan faktor-faktor luaran yang mempengaruhi sifat reologi polimer dan bincangkan DUA daripada faktor-faktor tersebut secara terperinci. Gunakan diagram yang sesuai jika perlu.*

(50 markah)

- [b] *Kirakan parameter-parameter reologi (iaitu tegasan ricih, kadar ricih dan kelikatan) sekiranya keputusan ujian MFI memberikan nilai 35 g/10min. Ujian MFI tersebut dilaksanakan pada suhu 220°C menggunakan suatu beban piawai 2.16 kg. Kesemua geometri (iaitu panjang dan diameter) dai kapilari piawai adalah memenuhi ASTM D1238.*

Diberikan,

Diameter piston = 1.8 cm

Ketumpatan leburan polimer = 0.78 g/cm³

(50 markah)

5. [a] Give differences between torque rheometer and cone-and-plate rheometer as rheological instruments.

(40 marks)

- [b] Explain why Rabinowitsch correction procedure need to be implemented on rheological data obtained from capillary rheometer and show how it is implemented.

(20 marks)

- [c] If changes in rheological behaviour of a thermoset polymer (i.e. before crosslinking) need to be measured, what are the factors that need to be considered in conducting the procedure?

Give your opinion on what is the suitable reometer for the task and why did you choose that particular rheometer?

(40 marks)

- [a] *Beri perbezaan-perbezaan antara reometer tork dan reometer kon-dan-plat sebagai alat reologi.*

(40 markah)

- [b] *Terangkan mengapa prosedur pembetulan Rabinowitsch perlu dilaksanakan kepada data reologi yang diperolehi dari reometer kapilari dan tunjukkan bagaimana prosedur tersebut dilaksanakan.*

(20 markah)

- [c] *Sekiranya perubahan sifat reologi suatu polimer termoset (iaitu sebelum berlaku sambung-silang) hendak diukur, apakah faktor-faktor yang perlu dipertimbangkan dalam melaksanakan prosedur tersebut?*

Berikan pendapat anda, apakah jenis reometer yang sesuai bagi tujuan tersebut dan mengapakah anda memilih reometer tersebut?

(40 markah)

6. [a] Extrudate swell is one type of typical viscoelasticity phenomenon that occurs during extrusion process. Elaborate on the reason of its occurrence and implications towards processing procedure. Use appropriate example if necessary.

(30 marks)

- [b] Give a description on co-axial cylinder rheometer. List down the advantages and disadvantages of this rheometer.

(40 marks)

- [c] "The use of shear rheometer are often greater than that of elongational rheometer. However, the latter is important in certain field of rheological studies of polymers."

Discuss this statement by giving **ONE** example in rheological studies of polymers where the use of elongational rheometer is required.

(30 marks)

6. [a] *Pembengkakan ekstrudat merupakan satu jenis fenomena kelikatkenyalan yang lazimnya berlaku dalam proses pengestrudan. Huraikan sebab terjadinya fenomena tersebut dan implikasinya terhadap prosedur pemprosesan. Gunakan contoh yang sesuai jika perlu.*

(30 markah)

- [b] *Berikan penerangan tentang reometer silinder sepaksi. Senaraikan kelebihan dan kekurangan reometer jenis ini.*

(40 markah)

- [c] *"Penggunaan reometer ricih selalunya mengatasi penggunaan reometer pemanjangan. Namun, reometer pemanjangan adalah penting dalam lapangan-lapangan tertentu kajian reologi polimer."*

*Bincang kenyataan tersebut dengan memberikan **SATU** contoh dalam kajian reologi polimer yang memerlukan penggunaan reometer pemanjangan.*

(30 markah)