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Unit 8 - Week 6

Course outline

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Assignment 6

The due date for submitting this assignment has passed. **Due on 2018-03-07, 23:59 IST.**

Submitted assignment

Based on the data given in the question , answer the following questions up to 5

1) The following data were obtained for several different natural rubber/carbon black samples (Dick et al, Polymer Testing, 1999): ***1 point***

Sample Number	Mooney viscosity, ml (100 °C)	G', kPa (2.8 % strain, 0.1 Hz, 100 °C)
1	40	40
2	41	50
3	45	60
4	60	70
5	110	80

State True/False:

Mooney viscosity is linearly related to storage modulus.

- True
- False

No, the answer is incorrect.
Score: 0

Accepted Answers:
False

2) The above data do not support the statement from the paper: "Two lots of natural rubber/carbon black can have very similar Mooney viscosities, but mix and process very differently. Storage modulus at low and high strains can be correlated well with mixing and process ability." ***1 point***

- True
- False

No, the answer is incorrect.
Score: 0

Accepted Answers:
False

3) The paper states that 2.8 % strain is in the linear viscoleastic limit. Therefore, for sample 3, G' at the strain of 1 % and 0.1 Hz, 100 °C will be 60 kPa. ***1 point***

- True

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- False

No, the answer is incorrect.
Score: 0

Accepted Answers:
True

4) Consider the following statement from the paper: "Higher severity strain condition is necessary with natural rubber/carbon black samples which contain higher carbon black loadings. These higher strains are necessary in order to destroy carbon black aggregate and aggregate networks." ***1 point***

Testing in the non-linear viscoelasticity will be helpful in determining the effect of carbon black aggregation and how the aggregates break down.

- True
- False

No, the answer is incorrect.
Score: 0

Accepted Answers:
True

5) Mooney viscosity, therefore, will not be adequate for characterizing complete rheological response of samples such as 1 and 2. ***1 point***

- True
- False

No, the answer is incorrect.
Score: 0

Accepted Answers:
True

6) ***2 points***

Based on the working condition and analysis procedure, the following method/s are generally suitable for the measurement of only the zero shear viscosity

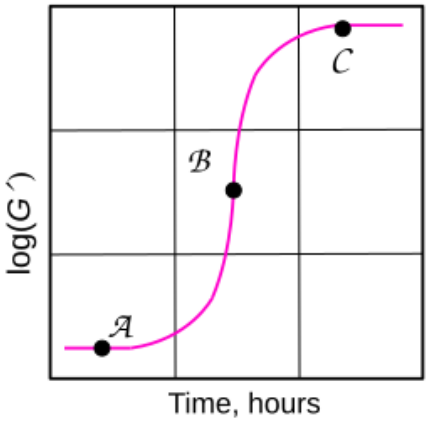
- Dynamic mechanical analyzer
- Falling ball viscometer
- Extensional rheometer
- Ubbelohde viscometer

No, the answer is incorrect.
Score: 0

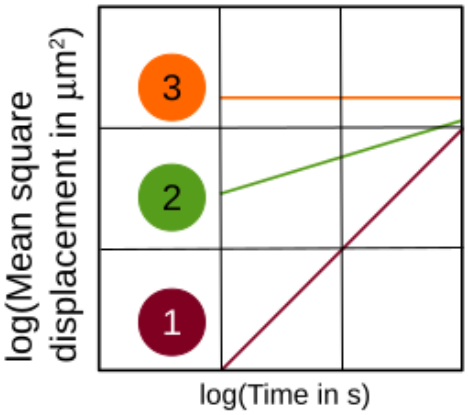
Accepted Answers:
Falling ball viscometer
Ubbelohde viscometer

7) ***2 points***

In microrheology, mean square displacement (MSD) of microscopic particles is measured. The following graph shows G' for a crosslinking polymer. With time, the storage modulus increases and becomes constant when reaction gets completed. The MSD was measured by stopping the reaction at three time instants, $\mathscr{A}$, $\mathscr{B}$ and $\mathscr{C}$ as shown in the figure.



The measured MSDs are shown in the following figure,



Match the time instants with the MSD data.

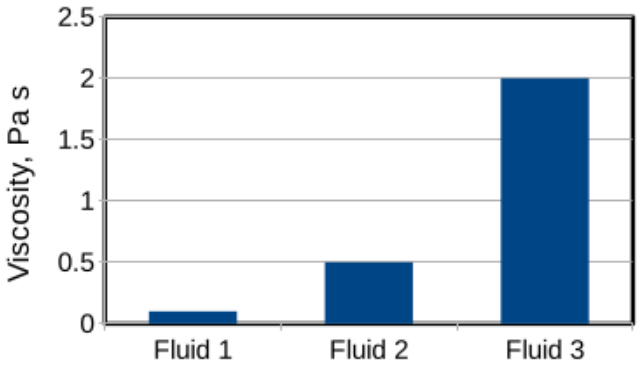
- A-1,B-2,C-3
- A-1,B-3,C-2
- A-2,B-3,C-1
- A-3,B-1,C-2

No, the answer is incorrect.
Score: 0

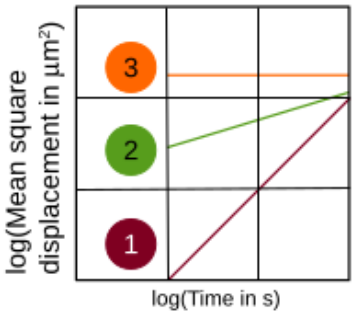
Accepted Answers:
A-1,B-2,C-3

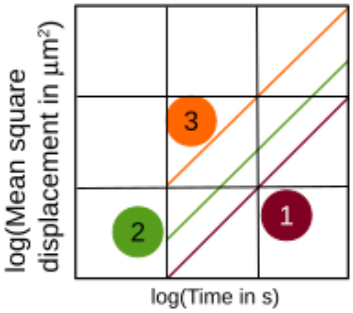
8) ***2 points***

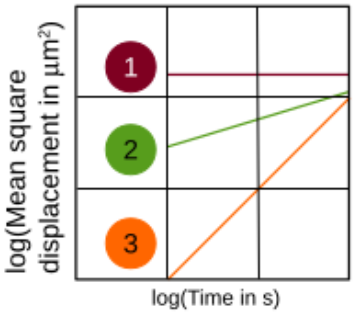
The following graph shows the viscosity of 3 different Newtonian fluids.

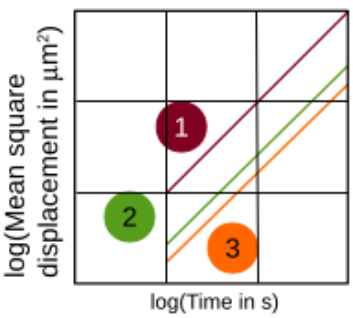


Which of the following measurements correspond with the mean square displacement measurements for fluids 1, 2 and 3?



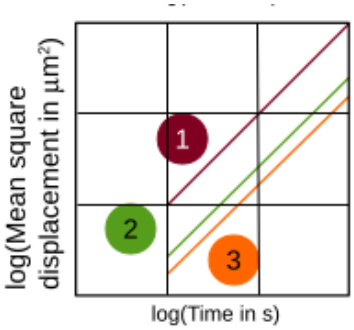






No, the answer is incorrect.
Score: 0

Accepted Answers:



9) In a rotational rheometer, torque, degree of rotation and rotation rate can be controlled/measured. For viscoelastic measurement using the rotational rheometer, *2 points*

- Both controlled variable and measured variables MUST be dependent on time.
- If the controlled variable is kept constant, but measured variable MUST be measured as a function of time.
- Both controlled variable and measured variable can be functions of time.
- Both controlled variable and measured variable can be constant with respect to time.

No, the answer is incorrect.
Score: 0

Accepted Answers:
If the controlled variable is kept constant, but measured variable MUST be measured as a function of time.
Both controlled variable and measured variable can be functions of time.

10 Consider a parallel plate rotational geometry ($2R$ =25 mm diameter, H = 1 mm gap) when a strain rate of 10 1/s is applied. The strain rate given here is called the rim strain rate, or the strain rate at $r = R$. Assume that the nominal viscosity of sample is 1 Pa s and the density is 1000 kg/m^3. Estimate the Reynolds number at the rim. (to 2 decimal places)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(Type: Range) 0.05,0.50

2 points

Based on the data given in the question 11, answer the following up to question 13

11 Oscillatory shear measurements are very common using rotational rheometers. A concentric cylinder geometry is being used for these measurements, with the following dimensions inner diameter D_i =49 mm, outer diameter D_o =50 mm. The nominal relaxation time of the material being characterized is 0.5 s. *1 point*

The measurements could be considered in terms of strain amplitude or strain rate amplitude. If the strain applied is $\gamma_{r\theta} = \gamma^0_{r\theta} \sin \omega t$, the amplitude of strain rate will be

- $\omega \frac{D_o - D_i}{(D_o + D_i)/2}$
- ω
- $\gamma_{r\theta}^0 \omega$
- $\frac{\omega}{\gamma_{r\theta}^0}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\gamma_{r\theta}^0 \omega$

12) Estimate the Deborah number at 5 % strain at the frequency of 1 Hz. (to 2 decimal places)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(Type: Range) 0.40,0.60

2 points

13) Estimate the Weissenberg number at 2 % strain at the frequency of 100 Hz. (to 2 decimal places)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(Type: Range) 0.90,1.10

2 points

14) Following extract is taken from Barnes and Bell, Korea-Australia Rheology Journal, 2003: ***2 points***

All modern controlled-stress instruments collect and log precise measurements of the torque, position and rotation rate of the spindle, and are thus able to be used for creep, flow curve and oscillatory experiments. However, if one has sophisticated electrical control system in conjunction with these data-logging facilities, it is, in principle, possible to use various rapid electronic feedback strategies in order to produce other mode of testing, i.e.,
- controlled-strain, so that various strain/time patterns can be achieved, so by increasing the rotational position linearly to produce steady-state flow or in an oscillatory fashion to produce a sinusoidal strain pattern. Logging the stress signal needed to achieve these particular patterns is the akin to measuring the stress in a controlled strain experiment.
- applying and holding a given rotational position and monitoring the torque, then monitoring the stress needed to hold the particular value of strain is akin to performing a stress-relaxation experiment.
- loop tests with a triangular shear-rate / time profile, to mimic thixotropic loop tests for measuring thixotropy (however, this is not always desirable, since both time and shear rate are varying).
Pick the correct statement/s from below. In a stress-controlled rheometer,

- it is natural to carry out constant stress experiments.
- stress relaxation experiments cannot be done.
- stress relaxation experiments can be carried out using feed-back strategies.
- Oscillatory tests with sinusoidal strain can be done without

feedback strategies.

No, the answer is incorrect.
Score: 0

Accepted Answers:
it is natural to carry out constant stress experiments.
stress relaxation experiments can be carried out using feed-back strategies.

15) Flow caused due to pressure gradient is called Poiseuille flow. ***1 point***

- True
- False

No, the answer is incorrect.
Score: 0

Accepted Answers:
True

16) Viscosity is considered a material function which characterizes steady response ***2 points***

- Sample in sheared in a rotational rheometer geometry, and torque and degree of rotation are recorded when they become constant.
- Sample in sheared in a rheometer geometry, and stress rate and degree of rotation are recorded when they become constant.
- Sample in sheared in a rheometer geometry, and stress and rotation rate are recorded when they become constant.
- Sample in sheared in a rheometer geometry, stress is recorded as soon as the rotation rate becomes constant.

No, the answer is incorrect.
Score: 0

Accepted Answers:
Sample in sheared in a rheometer geometry, and stress and rotation rate are recorded when they become constant.

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