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NPTEL

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Courses » Rheology of Complex Materials

Announcements **Course** Ask a Question Progress Mentor

Unit 12 - Week 10

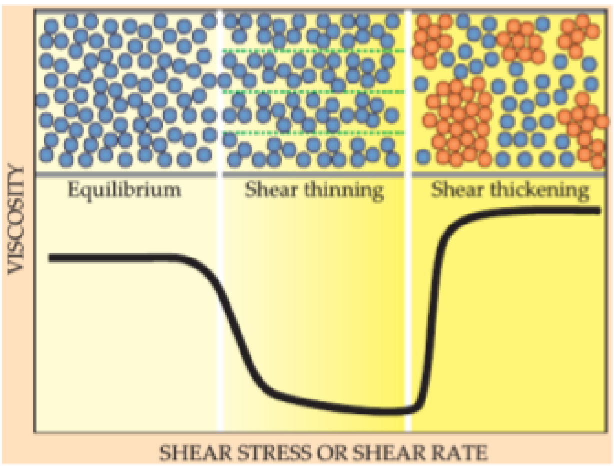
Assignment 10

The due date for submitting this assignment has passed. **Due on 2018-04-04, 23:59 IST.**

Submitted assignment

1) *2 points*

The following graph shows a sketch of viscosity of suspensions, and possible microstructure at different shear rates [Wagner and Brady, Physics Today, 2009].



Match the following

Regime	Mechanism
I. Low shear rates	a. Large clusters
II. Intermediate shear rates	b. Closely interacting particles
III. High shear rates	c. Aligned clusters of particles

- I-b,II-c,III-a
- I-c,II-b,III-a
- I-b,II-a,III-c
- I-a,II-c,III-b

No, the answer is incorrect.
Score: 0

Accepted Answers:
I-b,II-c,III-a

2) *2 points*

Week 12

DOWNLOAD VIDEOS

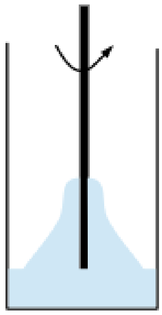
Interaction Session

MATLAB: Introduction

MATLAB: Vector and Matrix Operations

MATLAB: Advanced Topics

We had discussed the rod climbing effect in the beginning of the course. In this experiment, a rod is rotated in θ direction, and due to normal stresses the free interface of viscoelastic fluid rises in the center, as if the fluid *climbs* on the rod. Now that we have discussed normal stress differences and governing equations, we can carry out some preliminary steady state analysis.



Following are the governing equations in cylindrical coordinates (steady state),

$$\rho\left[v_r\frac{\partial v_r}{\partial r}+\frac{v_\theta}{r}\frac{\partial v_r}{\partial \theta}-\frac{v_\theta^2}{r}+v_z\frac{\partial v_r}{\partial z}\right]=-\frac{\partial p}{\partial r}+\left[\frac{1}{r}\frac{\partial(r\tau_{rr})}{\partial r}+\frac{1}{r}\frac{\partial \tau_{\theta r}}{\partial \theta}+\frac{\partial \tau_{zr}}{\partial z}-\frac{\tau_{\theta\theta}}{r}\right]$$

$$\rho\left[v_r\frac{\partial v_\theta}{\partial r}+\frac{v_\theta}{r}\frac{\partial v_\theta}{\partial \theta}+v_z\frac{\partial v_\theta}{\partial z}+\frac{v_r v_\theta}{r}\right]=-\frac{1}{r}\frac{\partial p}{\partial \theta}+\left[\frac{1}{r^2}\frac{\partial\left(r^2\tau_{r\theta}\right)}{\partial r}+\frac{1}{r}\frac{\partial \tau_{\theta\theta}}{\partial \theta}+\frac{\partial \tau_{z\theta}}{\partial z}+\frac{\tau_{\theta r}-\tau_{r\theta}}{r}\right]$$

$$\rho\left[v_r\frac{\partial v_z}{\partial r}+\frac{v_\theta}{r}\frac{\partial v_z}{\partial \theta}+v_z\frac{\partial v_z}{\partial z}\right]=-\frac{\partial p}{\partial z}+\left[\frac{1}{r}\frac{\partial(r\tau_{rz})}{\partial r}+\frac{1}{r}\frac{\partial \tau_{\theta z}}{\partial \theta}+\frac{\partial \tau_{zz}}{\partial z}\right]-\rho g$$

The LHS of r component can be reduced to

- $\rho\left[v_r\frac{\partial v_r}{\partial r}+\frac{v_\theta}{r}\frac{\partial v_r}{\partial \theta}-\frac{v_\theta^2}{r}+v_z\frac{\partial v_r}{\partial z}\right]$
- $\rho\left[\frac{v_\theta}{r}\frac{\partial v_r}{\partial \theta}-\frac{v_\theta^2}{r}+v_z\frac{\partial v_r}{\partial z}\right]$
- $\rho\left[-\frac{v_\theta^2}{r}\right]$
- 0

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\rho\left[-\frac{v_\theta^2}{r}\right]$

3) The RHS of r component can be reduced to *2 points*

- $-\frac{\partial p}{\partial r}+\left[\frac{1}{r}\frac{\partial(r\tau_{rr})}{\partial r}+\frac{1}{r}\frac{\partial \tau_{\theta r}}{\partial \theta}+\frac{\partial \tau_{zr}}{\partial z}-\frac{\tau_{\theta\theta}}{r}\right]$
-
- 0
- $-\frac{\partial p}{\partial r}+\left[\frac{1}{r}\frac{\partial \tau_{\theta r}}{\partial \theta}+\frac{\partial \tau_{zr}}{\partial z}\right]$

No, the answer is incorrect.
Score: 0

Accepted Answers:

4) The LHS of θ component can be reduced to *2 points*

- 0
- $\rho\left[v_r\frac{\partial v_\theta}{\partial r}+\frac{v_\theta}{r}\frac{\partial v_\theta}{\partial \theta}+v_z\frac{\partial v_\theta}{\partial z}+\frac{v_r v_\theta}{r}\right]$
- $\rho\left[\frac{v_\theta}{r}\frac{\partial v_\theta}{\partial \theta}\right]$
- $\rho\left[\frac{v_r v_\theta}{r}\right]$

No, the answer is incorrect.
Score: 0

Accepted Answers:
0

5) The RHS of θ component can be reduced to *2 points*

- $-\frac{1}{r}\frac{\partial p}{\partial \theta}+\left[\frac{1}{r^2}\frac{\partial\left(r^2\tau_{r\theta}\right)}{\partial r}+\frac{1}{r}\frac{\partial \tau_{\theta\theta}}{\partial \theta}+\frac{\partial \tau_{z\theta}}{\partial z}+\frac{\tau_{\theta r}-\tau_{r\theta}}{r}\right]$
- $\left[\frac{1}{r^2}\frac{\partial\left(r^2\tau_{r\theta}\right)}{\partial r}\right]$
- $-\frac{1}{r}\frac{\partial p}{\partial \theta}$
- 0

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\left[\frac{1}{r^2}\frac{\partial\left(r^2\tau_{r\theta}\right)}{\partial r}\right]$

6) The z component equation will reduce to *2 points*

- $\rho\left[v_r\frac{\partial v_z}{\partial r}+\frac{v_\theta}{r}\frac{\partial v_z}{\partial \theta}+v_z\frac{\partial v_z}{\partial z}\right]=-\frac{\partial p}{\partial z}+\left[\frac{1}{r}\frac{\partial(r\tau_{rz})}{\partial r}+\frac{1}{r}\frac{\partial \tau_{\theta z}}{\partial \theta}+\frac{\partial \tau_{zz}}{\partial z}\right]-\rho g$
- $0=\left[\frac{1}{r}\frac{\partial(r\tau_{rz})}{\partial r}\right]-\rho g$
- $0=-\frac{\partial p}{\partial z}+\left[\frac{1}{r}\frac{\partial(r\tau_{rz})}{\partial r}+\frac{\partial \tau_{zz}}{\partial z}\right]-\rho g$
- $0=-\frac{\partial p}{\partial z}-\rho g$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$0=-\frac{\partial p}{\partial z}-\rho g$

7) Match the dimensionless number with the significance *2 points*

Dimensionless group	**significance**
I. Reynolds number	a. the ratio of convective to diffusive contributions
II. Peclet number	b. the ratio of inertial to viscous forces
III. Deborah number	c. the ratio of material time to characteristic time of deformation
IV. Weissenberg number	d. the ratio of material time to experimental time

- I-b,II-c,III-a,IV-d
- I-c,II-b,III-d,IV-a
- I-d,II-a,III-c,IV-b
- I-b,II-a,III-d,IV-c

No, the answer is incorrect.
Score: 0

Accepted Answers:
I-b,II-a,III-d,IV-c

8) *2 points*

For oscillatory shear, ω is the frequency, γ is the strain amplitude and λ is the material relaxation time. The Deborah number (De) and Weissenberg numbers (Wi) be

- $De = \omega\lambda, \;\; Wi = \omega\lambda\gamma$
- $De = \frac{\omega\lambda}{\gamma}, \;\; Wi = \omega\lambda\gamma$
- $De = \omega\lambda\gamma, \;\; Wi = \omega\lambda$
- $De = \omega\lambda\gamma, \;\; Wi = \frac{\omega\lambda}{\gamma}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$De = \omega\lambda, \;\; Wi = \omega\lambda\gamma$

9) State True/False. *2 points*

In rheometric flows, homogeneous deformation refers to the strain rate being uniform everywhere in the geometry.

- True
- False

No, the answer is incorrect.
Score: 0

Accepted Answers:
True

10) Pick the correct statement/s. While discussing normal stresses arising, in a simple shear flow inolving macromolecules *2 points*

- All macromolecules orient in the flow direction
- The average orientation of macromolecules is not random, but aligned in the flow direction
- Due to flow the average orientation of macromolecules becomes random
- The macromolecules orient as well as stretch in the flow direction

No, the answer is incorrect.
Score: 0

Accepted Answers:
The average orientation of macromolecules is not random, but aligned in the flow direction
The macromolecules orient as well as stretch in the flow direction

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