

FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI
SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY
DEPARTMENT OF POLYMER AND TEXTILE ENGINEERING

2019/2020 Harmattan Semester Examinations
Pte 411 (Polymer Rheology 1). Instructions: Attempt Any Five (5) Questions
Date - 16/02/2021. Time: 3 Hours

- 1a. Using appropriate rheograms, explain the following time-independent fluids:
i. Newtonian fluid (ii) Dilatant fluid (iii) Pseudoplastic fluid
ii. Bingham fluid (v) Casson fluid
- b. Rheopectic fluid and thixotropic fluid are time-dependent fluids. With two (2) distinct points, distinguish between the two fluids types.
- 2a. State the Ostwald-de Waele equation for non-Newtonian fluids and explain the terms therein.
- b. For a Newtonian fluid flowing through a tube of circular cross-section, show that the velocity profile, V is given as $V = V_0 [1 - (r/R)^2]$.
- 3a. Maxwell model is one of the mechanical models for analyzing linear viscoelastic response of polymers. Starting from the first principle, derive the model for Maxwell element.
- b. Stress relaxation is a viscoelastic behavior of polymers, using Maxwell model, show that applied stress on a polymeric material decreases with time.
- 4a. Use appropriate sketches of cone-and-plate viscometer to derive the equation that shows the relationship between the fluid viscosity and the torque.
- b. Differentiate between stress relaxation and creep deformation.
- c. What are the two broad classifications of rheometers.
- 5a. Derive the rheological equation of the element used in viscoelasticity experiment by arranging both the spring and dashpot in series and supported by the same stress.
- b. Calculate the viscosity of the fluid in a cone-and-plate viscometer whose cone diameter is 6 cm. If the speed of rotation of the cone is 3.0 radians per second, the distance from the cone axis at which the load is applied is 5 cm and a load of 1000 N is applied. Take the cone angle as 0.1 radian.
- c. Outline the factors affecting flow properties of polymer melts.
- 6a. Consider a cup-and-bob viscometer of bob length 20 cm, bob diameter 10 cm and cup diameter 14 cm. The torque exerted on the material is 10 N-cm and the speed of rotation is 10 radians per second. Calculate the viscosity of the fluid in the viscometer.
- b. With the aid of a well labeled diagram, describe the operations of a cup-and-bob viscometer.
- c. A capillary viscometer was used to measure the flow rate of a fluid. The length and diameter of the capillary die are 12 cm and 4 cm respectively. Calculate the volumetric flow rate given that the total pressure drop across the die is 36 Pascal and the apparent viscosity is 10 Pascal seconds.