



UNIVERSITY OF GHANA

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BSc. (ENG) MATERIALS SCIENCE AND ENGINEERING

END OF FIRST SEMESTER EXAMINATIONS: 2015/2016

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

MTEN 417: POLYMER PROCESSING & TECHNOLOGY II (2 CREDITS)

TIME ALLOWED: TWO (2) HOURS

Answer ALL Questions

Question 1

- a) List the five major equipment components of a single screw extruder.
- b) Calculate the length (in inches) of a single screw extruder with a screw diameter of 2.5 in. and a 24:1 length to diameter ratio (L/D).
- c) List four (4) specifications that will be required when purchasing a new screw for an extruder.
- d) Conventional plasticating extruder screws have three (3) geometrically different sections:
 - i. List the names of the three (3) geometrically different sections
 - ii. Briefly explain the functions of the three (3) geometrically different sections
- e) State one (1) function of the breaker plate in an extrusion machinery setup.

25 Marks

Question 2

- a) Provide answers to the following questions:
 - i. Draw the velocity profile for drag flow of a polymer melt in the metering section of an extruder.
 - ii. Draw the velocity profile for pressure flow of a polymer melt in the metering section of an extruder.

- iii. State the relationship (equation) between polymer throughput, drag flow, pressure flow and leakage flow.
- b) Where does the heat required to melt solid polymer in an extruder come from?
- c) With the help of a diagram, distinguish between dispersive and distributive mixing.
- d) A power law model (equation 1 below) is a simple model used to describe polymer melt viscosity as a function of shear rate.

$$\eta = m\dot{\gamma}^{n-1} \quad \text{equation 1}$$

Provide answers to the following questions:

- i. What does the variable “m” in equation one (1) represent
- ii. What does the variable “n” in equation one (1) represent
- iii. What will be the flow behaviour of a polymer that has “n” in the range of 0.8 – 1.
- e) Explain how solid bed width and melt film thickness affect the melting rate of a polymer in an extruder.

25 Marks

Question 3

- a) Define polydispersity index (PI).
- b) Polymers can be classified by their thermal behaviour as thermoplastics and thermosets. Briefly explain the difference between thermoplastic and thermoset polymeric materials.
- c) What type of mixing will you use for the following operations and why:
 - i. Colouring polymer with pigments?
 - ii. Adding reinforcing fibres to a polymer matrix?
- d) How are screens placed in an extruder breaker plate for filtration? Place 40, 120, 40, and 80-mesh screens in the proper order.
- e) Calculate the power required to heat polycarbonate (heat capacity of polycarbonate (PC) is 1.40 kJ/ kg°C) from 25 to 310 °C at a rate of 650-lb/h throughput. Leave your final answer in kilowatts. Take 1 lb = 0.454 kg.

25 Marks

Question 4

- a) What is the thickness convention that distinguishes between a film and a sheet?
- b) In wire coating operations, what is the purpose of preheating the wire before it enters the crosshead die?
- c) Provide answers to the following questions:
 - iii. Why is it difficult to print or coat the surfaces of polyolefins during processing?
 - iv. Describe two (2) surface treatment methods that can be used to change the surface characteristics of polyolefins to improve their surface adhesion properties.
- d) Blow moulding can be used to produce large hollow parts. Describe the large-part blow moulding process.
- e) What are the functions of the following sections of the mould used in the injection moulding process:
 - i. Sprue
 - ii. Runner

25 Marks