National Exams May 2015

04-Agric-A6, Physical Properties of Biological Materials and Food Products

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is a CLOSED BOOK EXAM.
   Approved calculator is permitted. One aid sheet allowed written on both sides.

3. FIVE (5) questions constitute a complete exam paper.
   The first five questions as they appear in the answer book will be marked.

4. Each question is of equal value. Breakdown is given for different parts of the question.

5. Some questions require answers in essay format. Clarity and organization of the answer are important.

Marking Scheme

Five questions out of nine

1. 20 marks total
2. (a) 8 marks, (b) 12 marks
3. 20 marks total
4. 20 marks total
5. (a) 8 marks, (b) 12 marks
6. 20 marks total
7. (a) 10 marks, (b) 10 marks
8. (a) 12 marks, (b) 8 marks
9. 20 marks total

Do any 5 questions from the following 9 questions

1. A shear sensitive fluid is to be transported from a supply tank to a filler as gently as reasonably possible. Consider the use of each of the following: Indicate which would be desirable for a fluid with the following characteristics (a) Bingham, (b) Pseudoplastic, and (c) Thixotropic. (20 marks)
   (i) A cone bottomed tank rather than a slightly slopped tank bottom.
   (ii) A auger in a centre line of the tank rather than free drainage.
   (iii) A swept wall tank rather than no wiping.
   (iv) Large diameter rather than standard diameter tubing.
   (v) Sweep rather than standard elbows.
   (vi) Centrifugal pump.
   (vii) Gravity flow of product.
   (viii) Rotary pump (lobe-type).
   (ix) Large diameter pump inlets rather than standard inlets.
   (x) Short piping between tank and filler.
   (xi) As few control valves as possible.
   (xii) As few elevations as possible.

2. (a) Consider a product with a structure like a rubber ball filled with liquid. When would one sense the liquid at high viscosity at a low or high rate of strain? Explain. (8 marks)
   (b) What is the relationship between concentration of a colloid and (i) yield stress, and (ii) power law coefficient (n)? Explain briefly. (12 marks)

3. Using batch scale laboratory tests, or batch equipment tests, how would you determine or estimate the following: (i) The maximum pressure developed at a given stage of processing involving temperatures which can induce pyrolysis. (ii) The cooking time for reaching a certain degree of gelation in preparing a starch base processing recipe. (20 marks)

4. Consider the problems of controlling temperature (T), and viscosity or texture in the processing and distribution. Identify the environmental, surface, and package structure and size attributes which may need control. Then outline an approach for analysis of the history of T or texture (or viscosity) in a package product system following a step change in ambient temperature (T_a). Sketch approximately these histories. (20 marks)

5. (a) Explain why food products often freeze in less time than is required to thaw? (8 marks)

(b) What shape container of the same radius or of the same characteristic dimension would heat faster: an infinite slab, an infinite cylinder or sphere? Why? (12 marks)

6. How you will measure the surface heat transfer coefficient of a mushroom at given ambient conditions (temperature, air flow/velocity, etc.)? (20 marks)

7. (a) Milk is atomized in a spray dryer and it is found that the cumulative droplet size distribution on a mass basis can be represented by a straight line from 0% (x) at 50 μm (D_p) to 100% at 250 μm. Calculate both the mass mean and mean volume-surface diameters of the droplets. (10 marks)

   (b) The screen analysis for a powder food is shown in the following table. The density of the particles is 0.0018 g/mm^3, shape factor (a) = 2 and sphericity (ϕ) = 0.7. For the material between 4 mesh and 200 mesh in particle size, calculate A_W in mm^2/g, and N_W in #/g. (10 marks)

Mesh size	D_{pi}, mm	Average D_{pi}, mm	Mass fraction, X_i
4	4.699	--	0.0000
8	2.362	3.5305	0.2397
14	1.168	1.7650	0.4386
28	0.589	0.8785	0.1768
48	0.295	0.4420	0.0859
100	0.147	0.2210	0.0360
Pan	--	--	0.0230

$\sum X_i/D_{pi} = 0.8749$; $\sum X_i/D_{pi}^3 = 4.676$; $\sum X_i D_{pi} = 1.8216$

8. (a) Provide one method each of Optical properties (three colour parameters, and % transmittance at a particular wave length) of agricultural materials. (12 marks)

   (b) How you will measure dielectrical properties of agricultural materials at a particular wave length? (8 marks)

9. How you will analyse stress relaxation data for a food material using successive residual method? Consider Maxwell model with 3 terms. (20 marks)