ORDRE DES INGÉNIEURS DU QUÉBEC

MAY 2012 SESSION

Open-book examination
Calculators : only authorized models
Duration : 3 hours

04-AGRIC-B9 Food Process Engineering (Part 2)

ATTEMPT ALL QUESTIONS. CITE ALL ASSUMPTIONS MADE AS NEEDED. ALL QUESTIONS ARE OF EQUAL VALUE

1) A commercial bakery is mixing the dry ingredients for the production of a pound cake mix. They combine 100 kg of flour at 11% moisture content, with 100 kg of sugar at 0.5% moisture content and 4.9 kg of dried skim milk at 2.5% moisture content. Calculate the moisture content of the blended ingredients (on both wet and dry basis).

2) Determine the depth of penetration of microwaves at 915 MHz and radio frequencies at 27 MHz in liquid whole egg at room temperature.

Table 6
Dielectric properties of liquid and pre-cooked egg whites and whole eggs (adapted from Wang et al., 2009).

Egg product	State	Temperature (°C)	Dielectric constant		Dielectric loss factor	
			Frequency		Frequency	
			27.12 MHz	915 MHz	27.12 MHz	915 MHz
Egg white	Liquid	20	84.6	64.0	427.0	18.7
		80	98.3	50.5	866.5	33.3
		120	135.1	53.2	1665.8	56.9
	Pre-cooked	20	89.3	64.5	411.8	18.9
		80	99.5	53.0	937.1	34.6
		120	124.4	50.1	1480.5	52.2
Whole egg	Liquid	20	76.3	55.5	335.9	15.8
		80	87.5	48.9	801.8	30.5
		120	106.1	44.7	1132.7	42.3
	Pre-cooked	20	79.6	56.5	336.8	16.3
		80	89.0	48.5	745.8	29.0
		120	104.8	44.3	1020.0	39.5

3) Determine the membrane area required to remove 125 kg h^{-1} of water from a 5% by weight protein solution (average molecular weight of protein = 22,000, solution density = 1050 kg m^{-3}) using an ultrafiltration membrane operated at 5°C and with a mean transmembrane pressure of 500 kPa. The membrane is 90 μm thick and the effective diffusivity of water through the membrane is 8×10^{-8} m^2 s^{-1}.

4) The following data was obtained for orange crystals, presenting the equilibrium data of water vapour and the solid food material. Determine the monolayer (or monomolecular) moisture content for this food.

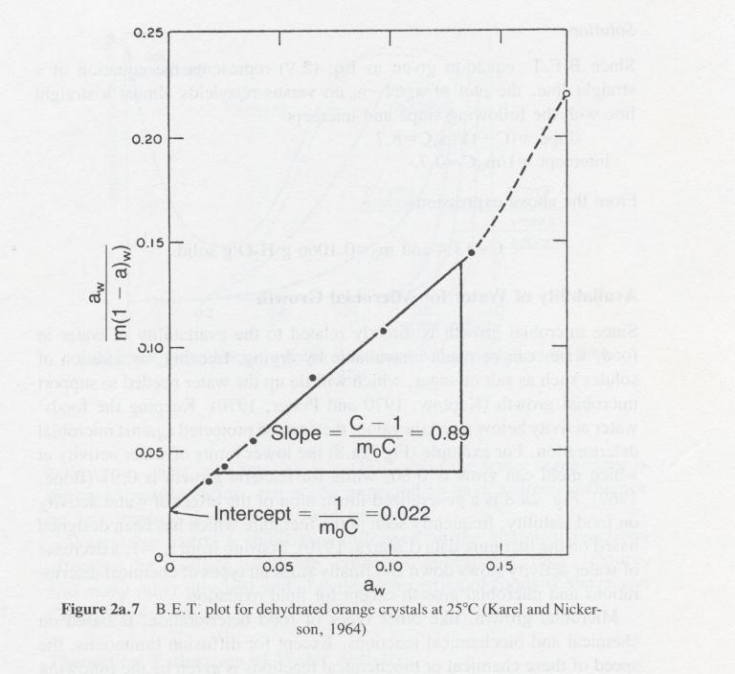

Figure 2a.7 B.E.T. plot for dehydrated orange crystals at 25°C (Karel and Nickerson, 1964)

5) With the objective of achieving food quality and food safety, please describe the differences, advantages and disadvantages between HACCP (Hazard Analysis and Critical Control Points), BMP (best management practices) and the ISO 22000 (International Standardization Organization) certification in terms of a food production plant.

6) The following data were obtained by drying a small sample of food in an air stream at constant humidity and temperature and recording the mass of the sample at intervals of 5 min. The sample was then dried to a constant mass of 70 g. Plot a curve of drying rate against moisture content and comment on the evolution of the rate of drying with time through the stages.

Time (min)	Mass (g)
0	100.0
5	97.20
10	94.40
15	91.60
20	88.80
25	86.00
30	83.20
35	80.64
40	78.70
45	77.26
50	76.20