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University Examinations 2013/2014

SECOND YEAR, SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN FOOD SCIENCE AND TECHNOLOGY

AFS 2207: FOOD ENGINEERING 1

DATE: DECEMBER 2013 **TIME: 2 HOURS**

INSTRUCTIONS: *Answer questions **one** and any other **two** questions.*

QUESTION ONE (30 MARKS)

a) State the first law of thermodynamics. (1 Mark)
b) State Newton's second law of motion and derive the SI units of weight. (3 Marks)
c) Differentiate between solid density and bulky density. (1 Mark)
d) Maize grains were dried to 10% moisture content. If the weight of maize was 100kg. Determine the quantity of solids and express the moisture content in dry basis. (3 Marks)
e) A student was to determine specific heat capacity of two food samples A and B. sample A had 20% and B 80% moisture content. How would the specific heat capacity of two foods compare. (2 Marks)
f) 1000kg of a waste stream containing 10% weight of suspended solids is separated in a vacuum filter to produce clear water and wet solids containing 20% moisture. How much of each stream is produced. (3 Marks)
g) Milk (mean heat capacity 3.8kj/kg/K) flows in a pipe at a rate of 0.2 kg/s and heat is supplied through pipe wall. Calculate the rate of heat transfer to the milk if it enters at $20°C$ and leaves at $80°C$. (3 Marks)
h) A pipe with inside diameter of 2cm was used to pump juice in a tank. The tank is 1.5M diameter and 3M higher. The density of juice is 1000kg/M^3 and viscosity is 1500 x 10^{-6} Pa.S.
   i. What is the minimum time to fill the tank with this juice under laminar conditions in the pipe? (3 Marks)
   ii. What is the minimum time to fill the tank under turbulent condition? (3 Marks)
i) Discuss the principle of ultrasound in food preservation. (2 Marks)
j) Discuss two types of evaporators used in food industry. (6 Marks)

QUESTION TWO (20 MARKS)

a) A wall of thermal processing equipment is built of insulating brick 10cm thick and thermal conductivity $0.22Jm^{-1}s^{-1}{\circ}C^{-1}$. Steel is used as reinforcement penetrating the brick in parallel arrangement. The total area of the brick wall is $18cm^2$ while that of steel reinforcement is $2m^3$. (Total area of the wall $20m^2$). If the thermal conductivity of the steel is $45\ JM^{-1}s^{-1}{\circ}C^{-1}$.

i. Calculate the relative proportions of the total heat transferred through the wall by the brick and the steel (5 Marks)

ii. Calculate the total heat lost through the wall if the inner side of the wall is at 215^{o}c and the outer side is at $10°C$. (5 Marks)

iii. Relate the heat loss through the brick and steel with thermal property of the material. (2 Marks)

b) Non-thermal food processing technologies are gaining popularity. Name four examples of non-thermal food processing technologies highlighting their principle of action. (8 Marks)

QUESTION THREE (20 MARKS)

a) Differentiate between pasteurization and sterilization. (4 Marks)

b) Differentiate between D-value and Z-value. (4 Marks)

c) A suspension of bacteria spores containing $1.6x10^5$ spores per ml is heated at $110°C$. The number of survivors is determined in samples taken every 10 minutes. The results are drawn below. Assuming first order kinetics. Calculate decimal reduction time. (6 Marks)

Heating time	N(survivor per time)
0	160,000
10	25,000
20	8,000
30	1600
40	200

d) Orange juice is aseptically packed in a multi-layer carton. During packing the juice contained a minimum of 50 mg vitamin C per 100g. The label claims a vitamin c content of 40mg per 100g. What must be the maximal storage temperature, if the product has to comply with the claim on the label after 180 days of storage?
Assume that the loss of vitamin c follows first-order kinetic with a rate constant $K=0.0041\ day^{-1}$ and energy of activation of E-700 000 kg at $27°C$. (6 Marks)

QUESTION FOUR (20 MARKS)

a) Explain the causes of surface hardening of dried food in your explanation suggest ways to ameliorate the problem. (6 Marks)

b) The initial moisture contents of a product is 77% (wet basis) and the critical moisture content is 30% (wet basis). If the constant drying rate is 0.1 kg $H_20/m^2/s$). Calculate the time required for the product to begin the falling rate drying period. The product is a cube of 5cm and initial product density is $950kg/M^{3.}$ (8 Marks)

c) Discuss fluidized bed drier and spray drier, highlighting the principle and applications of each in food industry. (6 marks)