Prince of Songkla University
Faculty of Engineering

Exam: Final Exam, Semester II
Date: March 1, 2005
Subject: 230-591 - Special Topic
 (Food Unit Operations)

Academic Year: 2004 – 2005
Time: 13:30 – 16:30
Room: R 200

ทุจริตในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

Instructions: There are a total of 2 parts. After you have completed the CLOSED BOOK SECTION, you may obtain the OPEN BOOK SECTION from the instructor. Place your name and the student ID number on every page. Students are allowed to use <u>only</u> a pen or pencil. Students may use <u>only</u> class notes and homework materials in the Closed Book Section of the exam. No exams are allowed to leave the room. No exams are allowed to leave the room.

Points Distribution (For Grader Only)		
Part	Points Value	Score
I	15	
II	13	
III	27	
IV	15	
V	30	
VI	40	
Total	140	

Exam prepared by
Ram Yamsaengsung
February 21, 2005

PLEASE CHECK TO MAKE SURE THAT
YOU HAVE ALL 4 PAGES OF THE CLOSED BOOK SECTION BEFORE
BEGINNING
(not including the cover sheet).
GOOD LUCK!

Prince of Songkla University
Faculty of Engineering

Exam: Final Exam, Semester II
Date: March 1, 2005
Subject: 230-591 - Special Topic
  (Food Unit Operations)

Academic Year: 2004 – 2005
Time: 13:30 – 16:30
Room: R 200

ทุจริตในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

CLOSED BOOK SECTION (70 points)

Part I. True and Faults (T/F) (15 points), If the statement is false, make it true.

___ 1. The friction loss coefficients (k_f) values decrease with decreasing pipe diameter.

___ 2. Most microorganisms can grow best at intermediate pH and high a_w.

___ 3. Sterilized products do not require refrigeration.

___ 4. Products in glass containers require slow heating and cooling for an effective thermal treatment.

___ 5. For laminar flow to occur in Power-Law and Bingham Plastic fluids, the Reynolds ($N_{Re,PL}$ or $N_{Re,B}$) number must be less than the Critical Reynolds number.

___ 6. The metabolic activity of microorganisms can increase the pH of foods.

___ 7. The thermal resistance constant can be obtained by plotting a log-log plot between the decimal reduction time and temperature.

___ 8. During thermal processing, the population of the microorganisms is reduced in a linear manner.

___ 9. For turbulent flow, the kinetic energy correction factor (α) is always 2.0.

___ 10. The decimal reduction time is the time required to cause a 90% reduction in the thermal resistance constant.

___ 11. The negative sign in the heat conduction equation indicates that heat flows from low temperature region to high temperature region.

___ 12. Convective heat flux is proportional to the conductivity of the material and inversely proportional to the thickness of the material

___ 13. Under ideal conditions, some Newtonian fluid can become turbulent at Reynolds number of 1,350.

___ 14. It is easier for material with high yield stress to achieve turbulence.

___ 15. Rapid freezing increases the number of nuclei formed.

1

Part II. Fill in the blanks (13 points)

1. The thermal process that produces products that require refrigeration is called _____.

2. _____ is the process of using heat from the processed product to raise the temperature of the incoming "raw" product.

3. _____, such as benzoic and sorbic acids, can be added to foods to help prevent microbial growths.

4. The _____ is generally 12 times that of the decimal reduction time.

5. There are two major types of heat exchangers. The _____ type includes the steam infusion and surface injection, while the _____ type includes the plate, tubular, shell-in-tube, and scraped surface.

6. _____ convection is due to the density difference caused by temperature gradients or turbulent flow, while _____ convection involves the use of some mechanical means, such as pumps or fans, to induce the movement of the fluid.

7. The two types of flow direction that can occur in a double-pipe tubular heat exchanger are _____ and _____.

8. The _____ heat exchanger is useful in removing fouling from the tube wall.

9. _____ is generally used to heat mushrooms in canned containers.

10. The decimal reduction time _____ (increases/decreases) with increasing process temperature.

Part III. Shorts Answers (27 points)

1. Write down the radiative heat flux from a surface to the surrounding and give the units for the Stephan-Boltzman constant. **(2 points)**

2. What are the two major types of friction losses that occur in the flow of fluid through a pipe? **(2 points)**

3. What is the Biot number a ratio of? What does a Biot number > 40 mean?
(3 points)

4. Name 3 examples of direct contact freezing system. **(3 points)**

5. Name 4 different units that can be used to cook chicken. **(4 points)**

6. What are the advantages of vacuum frying? **(4 points)**

7. Explain the heat and mass transfer processes that take place during the frying of battered (breaded like KFC's) fried chicken. Mention the role of the crispy batter (flour). **(4 points)**

8. Name the 4 products that were cooked in this class by your classmate and A. Ram. **(4 points)**

Part IV. Short Calculations (15 points)

1. For the pasteurization of orange juice, a regenerative heating/cooling section is used. After the "starter" raw juice has been heated to 73°C, it is passed through a holding loop and into a regeneration section. The juice then heats up the incoming raw juice from 28°C to 60°C. While the "starter" juice temperature decreases to 43°C. Compute the % regeneration of the system. **(4 points)**

2. For problem 1, what is the flow rate of the chilled water required to reduce the temperature of pasteurized juice from 43°C to 5°C? The specific heat of orange juice is 3.97 kJ/kg°C and the specific heat of the chilled water is 4.18 kJ/kg°C, and the mass flow rate of the orange juice is 180 kg/hr. Chilled water enters the heat exchanger counter-currently at 2°C and leaves at 10°C. **(4 points)**

3. What does LMTD stand for? For a countercurrent flow regime, if milk enters the heat exchanger at 50°C and leaves at 5°C, while chilled water enters at 0°C and leaves at 15°C, what is the LMTD of the system? **(4 points)**

4. If the decimal reduction time, D, is 3.5 minutes, how long does it take to reduce the number of microorganisms from 190,000,000 to 5. **(3 points)**

4

Prince of Songkla University
Faculty of Engineering

Exam: Final Exam, Semester II   **Academic Year: 2004 – 2005**
Date: March 1, 2005   **Time: 13:30 – 16:30**
Subject: 230-591 - Special Topic   **Room: R 200**
 (Food Unit Operations)

ทุจริตในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

OPEN BOOK SECTION (70 points)

Part V. Calculations (30 points)

1. If the maximum velocity of a power law fluid flowing through a pipeline system is 1.8 times that of the average velocity, what is the flow behavior index of the material? **(2 points)**

2. The results of a thermal resistance experiment gave a D value of 4.5 minutes at 110°C. If there were 3.5×10^4 survivors after 13.5 minutes of processing, determine the microbial population, N, at 5, 15, and 20 minutes. **(8 points)**

3. If raising the temperature in problem 3 by 9.5°C caused a 90% reduction in the decimal reduction time, how long would it take to **safely** process a can of mushroom at 129°C? If a can of mushroom originally contained 5.5×10^{12} microbes/g of product, how many microorganisms would be left after 90 seconds of processing at this temperature? What is the probability of spoilage? A can of mushroom contains 150 g of product. **(12 points)**

4. If the thermal death time is F^8_{110}, what is the spoilage probability of a 60-seconds process at 126°C, when $D_{110} = 3$ minutes and the initial population is 10^8 per container. **(4 points)**

5. What is the freezing point depression if 250 g of sucrose is added to 1 kg of water? Sucrose is $C_{12}H_{22}O_{11}$. **(4 points)**

Part VI. Long Answers (40 points)

1. You and your business partners just bought an orchard in Krabi. The orchard is able to provide 1,000 kg of pineapple, 500 kg of guava, 1,500 kg of rambutan, and 500 kg of bananas per month. Assuming you have the capital (money for investment) to construct a food processing facility, describe at least 5 different products that you would produce and the major equipment that you will need. **(15 points)**

2. You just inherited (received) 500,000 baht and Ram's Bakery/ House from your Aunt. The bakery is located on Punyakun Road near the PSU 109 Entrance. Besides from cookies and cakes, the bakery also sells snacks and drinks. The bakery has been losing profit since the opening of Lotus. Customers have been complaining that your products are too expensive compared to Farmhouse and Lotus, but if you lower the price too much, you will lose money. One solution is to develop a new product. Discuss your new snack product that will be able to compete with Lotus. List the major ingredients, how to make it, and how to package it, the price per unit, the units per package, etc. Finally, discuss additional **strategies** that could be used to increase profit. **(25 points)** (i.e. change the name of the bakery might also help)