



2<sup>nd</sup> SEM. 2005/2006

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**UNIVERSITY OF SWAZILAND**

**FINAL EXAMINATION PAPER**

**PROGRAMME : BACHELOR OF SCIENCE IN HOME  
ECONOMICS [FOOD SCIENCE AND  
TECHNOLOGY OPTION] YEAR IV**

**COURSE CODE : FST 411**

**TITLE OF PAPER : PRINCIPLES OF FOOD ENGINEERING**

**TIME ALLOWED : TWO (2) HOURS**

**INSTRUCTIONS : ANSWER QUESTION ONE (1)  
AND ANY OTHER (3) QUESTIONS**

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GRANTED BY THE CHIEF INVIGILATOR**

**QUESTION 1 [COMPULSORY]**

- a. Explain the following terms:
- Specific heat capacity
  - Specific latent heat of fusion
  - Specific latent heat of vaporization
  - Specific enthalpy
- [15 marks]
- b. A copper pipe 15m long is installed at 15°C and conveys water at 85°C. What will be the change in length and final length of the pipe given that the coefficient of linear expansion of copper is  $17 \times 10^{-6} \text{ mK}^{-1}$
- [10 marks]  
[Total = 25 marks]

**QUESTION 2**

- a. Describe four factors in choosing a heat exchanger.
- [15 marks]
- b. Raw milk at 7°C is pasteurized at 72°C in a plate heat exchanger at 5000 l h<sup>-1</sup>. Given that the specific heat capacity of milk is  $3.9 \text{ kJ kg}^{-1} \text{ K}^{-1}$  and the density of milk is  $1030 \text{ kg m}^{-3}$
- Calculate the volumetric flow of milk ( $\text{m}^3 \text{ s}^{-1}$ )
  - Calculate the rate of heat transfer required to raise the temperature of milk from 7°C to 72°C.
- [10 marks]  
[Total marks = 25]

**QUESTION 3**

- a. A single-effect vertical tube evaporator is used to concentrate syrup from 10% to 40% solids at a rate of  $100 \text{ kg h}^{-1}$ . The feed enters at 15°C and is evaporated under a reduced pressure of 47.4 kPa (at 80°C). Steam is supplied at 169 kPa (115°C). Assuming that the boiling point remains constant and that there are no heat losses, calculate the quantity of steam used per hour and the number of tubes required. The specific heat capacity of syrup is  $3.960 \text{ kJ kg}^{-1} \text{ K}^{-1}$ , the specific heat capacity of water is  $4.186 \text{ kJ kg}^{-1} \text{ K}^{-1}$ , the latent heat of vaporization of syrup is  $2309 \text{ kJ kg}^{-1}$ , the overall heat transfer coefficient is  $2600 \text{ W m}^{-2} \text{ K}^{-1}$ , the latent heat of steam is  $2217 \text{ kJ kg}^{-1}$  at 115°C and the area of one tube is  $0.122 \text{ m}^2$
- [15 marks]
- b. Describe factors that will influence the rate of heat transfer in an evaporator.
- [10 marks]  
[Total marks = 25]

**QUESTION 4**

- a. Two fluids, milk and sunflower oil are flowing along pipes of the same diameter (5cm) at 20°C and at the same flow velocity of  $3\text{ms}^{-1}$ . Determine whether the flow is streamline or turbulence in each fluid, given that the viscosity of milk is  $2.10 \times 10^{-3} \text{Nsm}^{-2}$  and density is  $1030\text{kg m}^{-3}$ , and the viscosity of rape seed oil is  $118 \times 10^{-3}\text{Nsm}^{-2}$  and density is  $900\text{kg m}^{-3}$

[10 marks]

- b. Milk containing 3.7% fat and 12.8% total solids is to be evaporated to produce a product containing 7.9% fat. What is the yield of product from 100kg of milk and what is the total solids concentration in the final product, assuming that there are no loses during the process.

[15 marks]

**[Total = 25 marks]****QUESTION 5**

- a. Describe the two types of steam boilers. What are the advantages of using steam?

[10 marks]

- b. A boiler burns coal of calorific value of  $31400 \text{kJ kg}^{-1}$  and consumes 1585kg of coal per hour. Steam with a dryness fraction of 0.95 is produced at a pressure of 11 bar, using feed water at a temperature of 27°C. If 14500 kg of steam are generated an hour, calculate the thermal efficiency of the boiler at 11 bar given that sensible heat ( $h_f$ ) =  $781 \text{kJ kg}^{-1}$ , latent heat of steam ( $h_{fg}$ ) =  $2000 \text{kJ kg}^{-1}$  and specific heat capacity of water is  $4.18 \text{kJ kg}^{-1}\text{K}^{-1}$

[15 marks]

**[Total = 25 marks]**