"Investing in Africa's future"

COLLEGE OF HEALTH, AGRICULTURE AND NATURAL SCIENCES

AAE401: AGRICULTURAL PROCESSING AND TECHNOLOGY

END OF SECOND SEMESTER FINAL EXAMINATIONS

MAY/JUNE 2020

LECTURER: MR. W. ZENDERA

DURATION: 48 HRS

INSTRUCTIONS

1) Choose and Answer **ONE** question Only
2) ALL questions carry 100 marks
3) Clearly indicate all your calculations

Question 1

a) Mwinilunga District is located in North Western Province of Zambia. The District has the highest potential for pineapple production in the country together with other areas like Nyimba in Eastern Province and Kawambwa in Luapula Province. North Western Province and western province is known to be the only producer of pineapples in the country. According to statistics obtained from the Mwinilunga District Cooperative Union, there are about 600 farmers involved in growing of pineapples in Mwinilunga District with a total hectarage of 453, producing 3, 171 tonnes in 2004 while Solwezi district has 120 farmers with a total hectarage of 75ha. The estimated production for Solwezi is estimated at 322 metric tonnes for 2004/2005 season. A lot of pineapples produced in the region go to waste since the collapse of the pineapple processing plant in the 1990s. In 1991/92 season, prior to the collapse of the pineapple factory the total area cultivated were 1,421 hectares, with production of 11, 368 tonnes. Currently most of the pineapple fields have been left unattended to by most farmers because of lack of markets.

i. You have just been appointed as the leading specialists for Mwinilunga district explain how you can assist the farmers to create a market for their pine apples. **[6 marks]**

ii. Name two products that can be produced from pine apples and their uses. **[4 marks]**

iii. With the aid of a process flow diagram explain in detail how you would process one of the products you mentioned in (ii). **[30 marks]**

iv. Describe any two possible thermal processing techniques that you can use in processing your product. **[10 marks]**

v. Explain some of the possible effects of the thermal processing on the quality of the product. **[10 marks]**

vi. Pine apples are estimated to contain about 30 % air by volume within their structure, when packed raw this may contaminate the product. Explain two processes that can be used to remove the excess air. **[10 marks]**

b) To make strawberry jam, strawberries containing 15% solids and 85% water are crushed. The crushed strawberries and sugar are mixed in a 4:5 ratio by mass and the mixture is heated to evaporate the water. The residue (jam) contains 1/3 water by mass.

i. Draw a schematic diagram to represent this process **[8 marks]**

In order to make 100 g of Jam calculate:

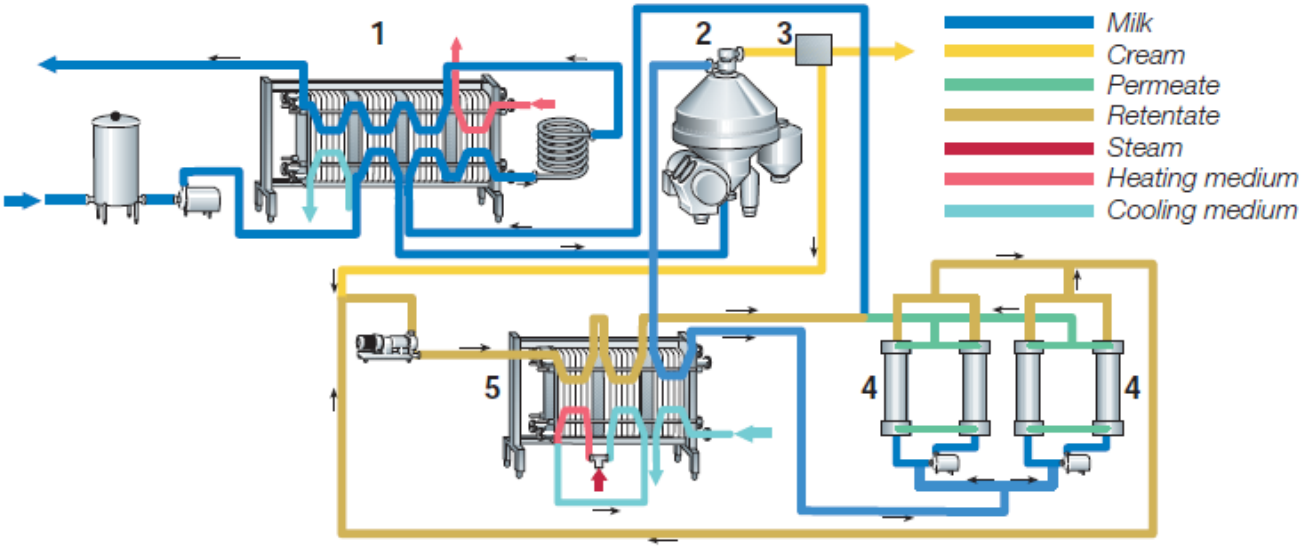
ii. The amount of strawberry needed. **[6 marks]**

iii. The mass of sugar added **[8 marks]**

iv. The mass of water evaporated **[8 marks]**

Question 2

Figure 1 shows part of a cheese milk treatment including a double-loop membrane filter and sterilization plant.



KEY:

1 Pasteurizer
2 Centrifugal separator
3 Automatic standardization system
4 Double-loop membrane filtration plant
5 Sterilization plant

Figure 1: Cheese milk production process

a) Describe a heat pretreatment process which is sometimes done to the milk before pasteurization. **[10 marks]**

b) Describe the pasteurization process in (1) and explain why it is done. **[10 marks]**

c) Describe the type of membrane filtration process that takes place in the double loop membrane filter and state the retentate (s) and permeate (s). **[10 marks]**

d) Identify and explain the stages in figure 1 where regenerative heating and cooling is being applied. What are the advantages of this process? **[10 marks]**

e) If 20 000 l/h cheese milk is to be heated from 4 °C to 34 °C by 30 000 l/h of a heating medium (water) at 50 °C. Density and specific heat (cp) for milk are about 1 020 kg/m^3 and 3.95 kJ/kg, K and for water 990 (at 50°C) and 4,18 kJ/kg, K calculate the final temperate of the heating medium. **[10 marks]**

f) Calculate the logarithmic mean temperature difference. **[10 marks]**

g) If the heat transfer coefficient is assumed to be 5 000 W/m^2 calculate the required heat transfer surface area assuming the plates are less fouled. **[10 marks]**

h) Explain the principle of operation of a centrifugal separator in food processing. **[10 marks]**

i) In the centrifugal separator in figure 2 skim milk and cream are being separated

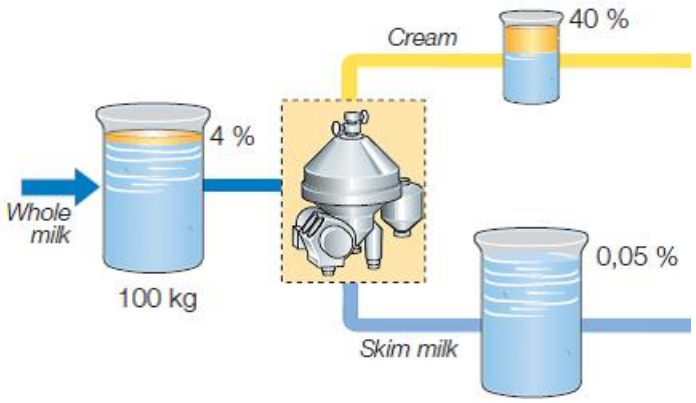


Figure 2: Centrifugal separator

If 100 kg/h of whole milk containing 4 % fat is to be separated into skim milk with 0.05 % fat and cream with 40 % fat what are the flow rates of the 2 outputs streams from a continuous centrifuge which accomplishes their process. **[20 marks]**

Question 3

a) A crop is dried in a dryer (figure 3) from an inlet moisture content of 0.3 kg moisture per kg product to an outlet moisture content of 0.15 kg moisture per kg product. Air at dry bulb temperature = 20 °C and RH = 40 % is heated to the dryer inlet temperature of 110 °C. The dry bulb temperature of the exhaust air from the dryer should be at least 10°C above the dew point to prevent condensation in the pipework.

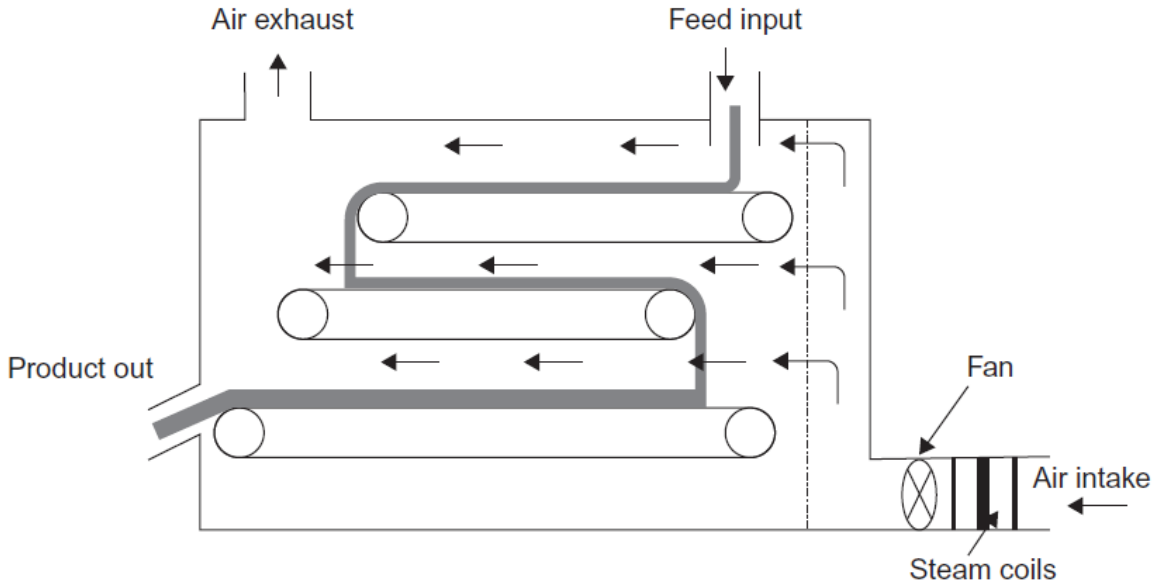


Figure 3: Dryer Y

i. Name the type of dryer in figure 3. **[4 marks]**

ii. Name the type of airflow in relation to the feed in figure 3. **[3 marks]**

iii. Give three characteristics of air that are necessary for successful drying of the crop. **[3 marks]**

iv. Name the type of dryer X shown in figure 4. **[3 marks]**

v. State the advantages of Dryer Y over dryer X **[7 marks]**

vi. Calculate the exhaust air temperature **[10 marks]**

vii. Calculate the RH that meet this requirement, and **[10 marks]**

viii. Calculate the mass of air required (kg/h per kg of dry solids). **[10 marks]**

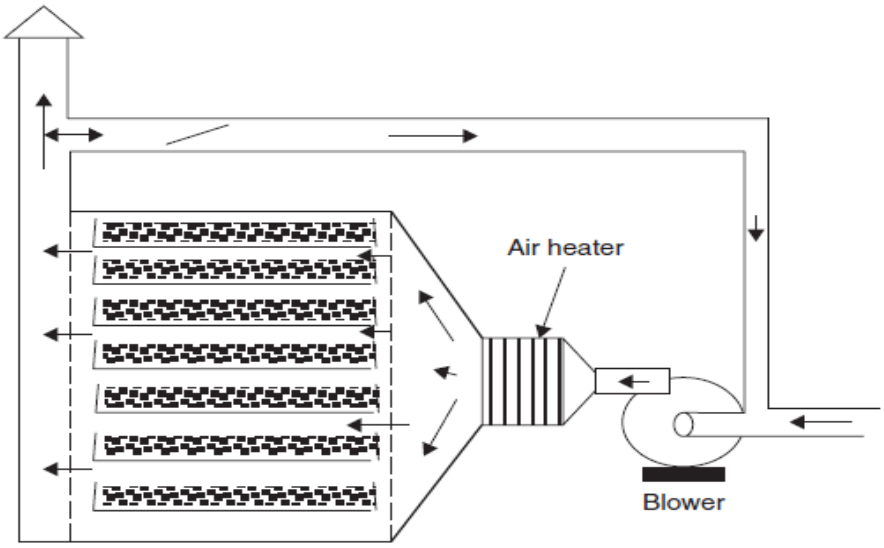


Figure 4: Dryer X

A dryer reduces the moisture content of 100 kg of a potato product from 80 % to 10 % moisture. 250 kg of steam at 70 kPa is used to heat 52,800 kg of air to 80 °C, and the air is cooled to 71°C in passing through the dryer. Calculate the efficiency of the dryer. The specific heat of potato is 3.43 kJ kg-1 °C-1. Assume potato enters at 24°C, which is also the ambient air temperature, and leaves at the same temperature as the exit air. Calculate:

i. The final mass of the dried potato, **[5 marks]**

ii. The mass of the water removed, **[5 marks]**

iii. The amount of heat required to raise the potato product from 24 °C to 71 °C, **[10 marks]**

iv. The amount of heat required to evaporate the vapour (M_vH_v), **[10 marks]**

v. Heat given up by the air (take specific heat of air to be 1 J/ kg/ °C) and **[10 marks]**

vi. The efficiency based on the latent heat of vaporization. **[10 marks]**

END OF EXAMINATION PAPER