Manufacturing of Dried Dairy Products

(OFO-code: 681301)

EXTERNAL SUMMATIVE ASSESSMENT: THEORY

Learner name & surname: _____

Assessor name & surname: _____

Date: _____

DECLARATION OF COMPETENCE	
To be completed by the External Assessor (tick the applicable block)	
Learner competent (C)	
Learner not yet competent (NYC)	

Instructions to the Learner:

1. Answer all of the following questions without referring to any notes.
2. No group work is allowed, i.e. complete the questionnaire on your own individual effort.
3. After completion, hand the questionnaire to the External Assessor for evaluation.
4. You need to obtain a minimum of 70% for this assessment in order to be found competent in the theory component.

1. (a) Complete the following sentences on the principles of evaporation: (7)

Evaporation is the process during which water is _____ from milk or dairy solutions. In order for this to happen, _____ should be applied to change the water from a _____ phase to a _____ phase. This means the milk is _____ to a solid content of approximately _____, which will also increase the _____ of the milk.

(b) Why is evaporation performed under very low pressure? (2)

_____

_____

_____

2. (a) What important treatment is given to milk prior to evaporation? Also give the parameters of this treatment. (2)

_____

(b) What is the purpose of this treatment? Name 3 things. (3)

_____

_____

_____

_____

3. Name 2 factors that influence the evaporation efficiency. (2)

_____

_____

_____

_____

4. How does evaporation take place inside the falling film evaporator? (5)

_____

_____

_____

_____

_____

_____

_____

_____

5. Name any 2 raw materials commonly used in evaporated liquid dairy products, including the function of each. (4)

_____

_____

_____

_____

6. Why is controlled crystallisation of lactose performed specifically for dairy powder manufacturing? (1)

_____

_____

7. How much time is allowed for crystallisation? (1)

_____

8. To what temperature is the product cooled before inoculation? (1)

_____

9. To what temperature is the product cooled after crystallisation? (1)

_____

10. Give 1 example of seeding material used for controlled lactose crystallisation. (1)

_____

11. Stirring during crystallisation is very important. Give 2 reasons why. (2)

_____

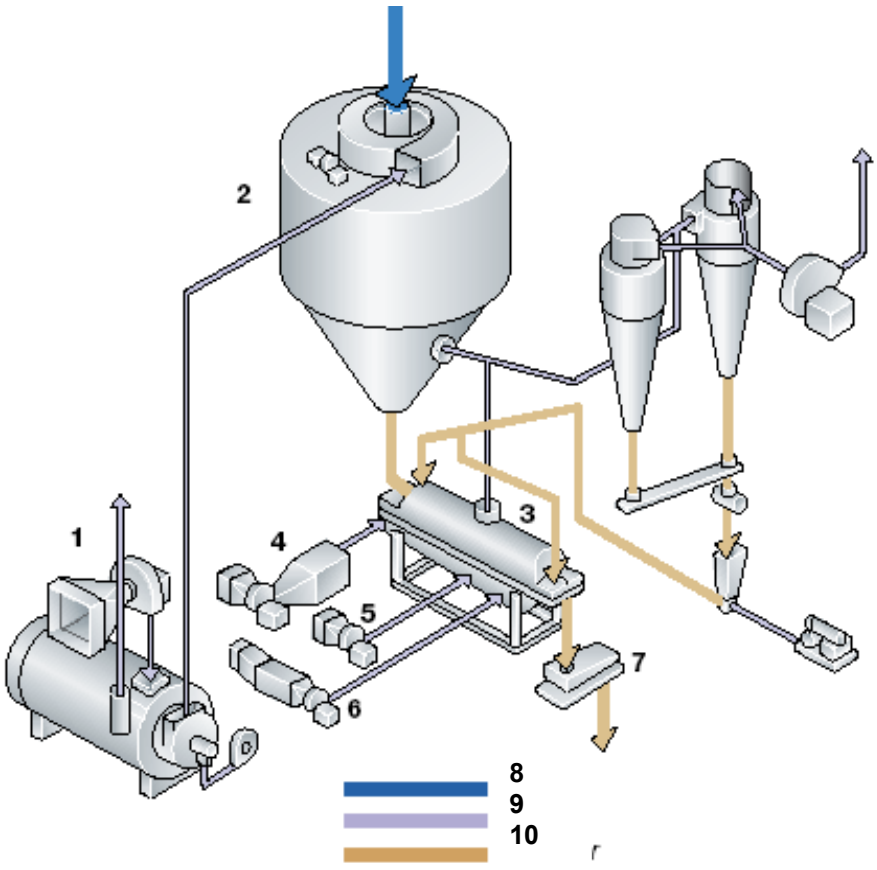
_____

_____

_____

12. (a) What type of spray dryer is shown in the figure below? (1)

_____



(b) Name the functions and parts of the spray dryer in the above figure. (10)

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

(c) Describe the drying process that takes place in this spray dryer. (10)

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

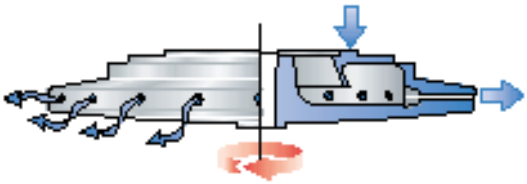
_____

13. Give 2 reasons why the concentrate is heated before drying. (2)

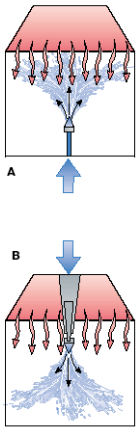
14. What is the purpose of atomising? (2)

15. Name the following 2 atomisers: (2)

15.1



15.2



15.1 _____ 15.2 _____

16. What is the purpose of the air inlet filters? (1)

17. (a) What is the purpose of the cyclone? (1)

(b) How does the cyclone work? (7)

18. (a) What is the function of a fluid bed? (2)

(b) How does the fluid bed work? (5)

19. What is the purpose of the pneumatic transport system? (1)

20. What is the purpose of a bag filter? (1)

21. Why is milk powder particles subjected to an agglomeration process? (3)

22. Describe the principle of instantising through agglomeration. (5)

23. How is milk powder agglomerated? Name 2 methods. (2)

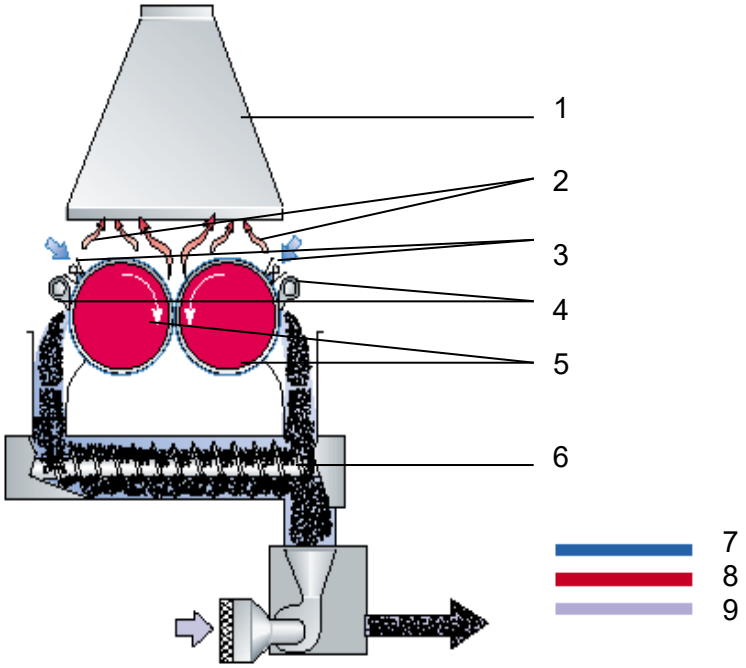
24. What does lecithinising of milk powder particles mean (principle) and why is it done? (5)

25. Complete the following sentence for the principles of roller drying: (5)

During roller drying, the milk concentrate is distributed on slowly _____ hollow drums that are heated internally by pressurised _____ to 120-170°C. A _____ of milk is spread uniformly over the outer surface. The water in the milk _____ and is drawn off by a flow of air when it comes into contact with the hot drum surface. Before the drum has completed one revolution, the dried milk is _____ by a blade that contacts the drum surface uniformly along its length.

26. (a) What type of roller dryer is given in the figure below? (1)

_____



(b) Give the parts and functions of the roller dryer in the figure below by naming the numbers (1-9). (9)

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

27. What is the function of pre-heating the milk prior to roller drying for bakery use? (2)

_____

_____

_____

_____

28. What is the function of the airflow over the drums during roller drying? (1)

_____

_____

29. What are the functions of the screw conveyor? (2)

_____

_____

_____

_____

30. (a) Why is the speed at which the drums turn so important? (2)

_____

_____

_____

(b) Why must both drums turn at the same speed? (1)

_____

(c) Why must the drums be of uniform thickness? (1)

_____

_____

31. Condensate must be removed on a continuous basis during roller drying. Why? (2)

_____

_____

_____

_____

_____

TOTAL: (118)

Manufacturing of Dried Dairy Products

(OFO-code: 681301)

MODEL ANSWERS FOR EXTERNAL SUMMATIVE THEORY ASSESSMENT

Instructions to the External Assessor:

1. Evaluate each learner's answers at the hand of the model answers provided below.
2. Learners must answer all questions, without referring to any notes. No group work is allowed, i.e. each learner's questionnaire must be completed on own individual effort.
3. The learner must achieve a minimum of 70% for this assessment in order to be found competent in the theory component.
4. After evaluation, complete the Declaration of Competence on the first page of the learner's knowledge questionnaire, as well as the Summative Declaration in **Section 8** of the Assessment Guide.

1. Evaporation is the process during which water is boiled off from milk or dairy solutions. In order for this to happen, heat should be applied to change the water from a liquid phase to a gas phase. This means the milk is concentrated to a solid content of approximately 50%, which will also increase the viscosity of the milk. (7)

(b) To minimise the negative impact of heat, evaporation takes place under very low pressure (vacuum), therefore also at **lower temperatures (sometimes as low as 40°C)**, which will **reduce negative changes in the product due to heat application**. (2)

2. (a) **Pre-heating** (1) of **116°C for 30 seconds** (1) (2)

(b) All 3 of the following: (3)

- To **destroy micro-organisms**.
- To **destroy enzymes** that can create quality problems.
- To **stabilise** the **protein** complex.

3. Any 2 of the following: (2)
   - The **more stages** (up to 7) the **less energy** is needed because vapour of the previous stage is used as heat source for the next stage.
   - The use of a thermo-compressor **lowers the steam consumption**.
   - To minimise loss of milk solids in the vapour, it is important to have a **high vapour velocity** with **tangential movement** in the separator to ensure a centrifugal movement of milk.

4. After inlet into the tubes, the slightly overheated product **expands** (1) as soon as it leaves the mouth piece, and as a result, a quantity of **water** immediately **evaporates** (1).

   The **steam** that forms in this way, **presses the product against the sides** of the tubes causing the product to **flow downward** in the form of a **thin film** against the tube sides (1). The **water** in the product is **extracted very quickly** and **effectively** in this way (1).

   The **steam** necessary to **heat** the product (to supply the latent heat for evaporation) is circulated through the **jackets** of the calandria (1).

   (5)

5. Any 2 of the following: (4)

Raw material	Function
Water	Provides desired moisture content and helps to dissolve dry ingredients.
Skim milk powder / whey powder	Provides solids-non-fat, nutritional value and texture to the product.
Fat	Provides rich flavour, texture and body, as well as energy.
Emulsifier	Stabilises fat-in-water or water-in-fat dispersions.
Flavouriing and colouring	Provides variety through different flavours and colours. Appeal to children's market.
Stabiliser	Provides body and texture. Prevents excessive settling out of cocoa particles in chocolate flavoured sterilized milk.
Preservatives	Retard unwanted microbial growth.

6. In order to prevent <u>powder caking and browning</u> during storage due to low α lactose presence. (1)

7. One hour. (1)

8. 30°C (1)

9. 15 – 18°C (1)

10. **α-lactose hydrate** in powdered form. (1)

11. Any 2 of the following: (2)
- To **transfer super-saturated solution** to the **surface of the crystals** and at the same time to **replace saturated solution**.
- To **prevents** the **viscosity** of the suspension from **increasing too much**.
- To **prevent** the **lactose** crystals from **settling out**.

12. (a) Two-stage spray dryer. (1)

(b)
1. Indirect air heater
2. Drying chamber
3. Vibrating fluid bed
4. Heater for fluid bed air
5. Ambient cooling air for fluid bed
6. De-humidified cooling air for fluid bed
7. Sieve
8. Milk concentrate
9. Air
10. Powder (10)

(c) The milk concentrate is fed to the drying chamber by a high-pressure pump, and then continues to the atomiser (1). The very small milk droplets are sprayed into the mixing chamber, where they are mixed with hot air (1). The air is drawn in by a fan through a filter and supplied to a heater, where it is heated to 150 – 250°C (1). In the drying chamber the atomised milk is mixed thoroughly with the hot air and the water in the milk is evaporated (1). Most of the drying takes place as the droplets are decelerated by air friction following release from the atomiser at high velocity. The free water evaporates instantaneously (1). The water in the capillaries and pores must first diffuse to the surfaces of the particles before it can be evaporated (1). This takes place as the powder slowly settles in the spray tower (1). The powder particles are only heated to 60 – 70°C because the heat content of the air is continuously decreased by the evaporation of water (1).

The last traces of moisture are the most difficult to remove, unless high outlet drying temperatures are used to provide a sufficient driving force. An after-drying stage is incorporated after the spray dryer in a two-stage process, namely the vibrating fluid bed (1).

The moisture content of the powder leaving the chamber is 2 – 3% higher than the final moisture content. The function of the fluid bed dryer is to remove excess moisture and finally to cool the powder down (1).

(10)

13. Any 2 of the following reasons: (2)
- Energy is saved because it is cheaper to heat milk in a milk/water heat exchanger than by drying air.
- The heat treatment decreases the microbiological load of the concentrate.
- Heat lowers the viscosity of the concentrate and as a result, smaller drops are formed by the atomiser.
- A pressure atomiser needs a higher supply temperature than the supply temperature from the evaporator.

14. The purpose of atomising is the following:
- To disperse the milk into small drops with a diameter of 0.1 – 0.01 mm, causing the surface-to-mass ratio to increase. This facilitates evaporation.
- To remove air from the concentrate (air retards heat transfer).

(2)

15.1 Rotating disc atomiser (1)

15.2 Stationary nozzle atomiser (1)

16. Air must be filtered effectively **to prevent contamination of the powder with impurities**. (1)

17. (a) To reclaim the powder from the drying air. (1)

(b) The working principles of the cyclone are based on a vortex movement (1) where the centrifugal force performed on each particle causes the particles to move to the outside, away from the center axle of the cyclone (1). The movement of the powder to beneath is the result of two opposing forces, namely centrifugal force, and drag forces (1). Centrifugal force stimulates movement away from the center and drag forces stimulate movement towards the center (1). Because centrifugal force is dominant, a separation occurs (1).

Powder and air enters the cyclone tangential. Powder and air move downward together in a spiral movement, where powder is swung out against the side of the cyclone and leaves the cyclone through a valve at the bottom (1). Clean air spirals upwards against the imaginary axis of the cyclone and leaves the cyclone at the top (1).

(7)

18. (a) The function of the fluid bed dryer is to **remove excess moisture** and finally to **cool the powder down**. Also **functional in instantising** of milk powder. (Any 2 facts). (2)

(b) The fluid bed is connected to the bottom of the drying chamber and consists of a vibrating casing with a perforated bottom. When a layer of powder is distributed on the perforated bottom, the vibrations convey the powder at uniform speed along the length of the casing. (1)

The vibrations convey the powder through the drying sections, where air at a gradually decreasing temperature is admitted through the powder bed. (1)

The powder from the drying chamber is admitted to the first section, with a moisture content of 2 – 3% above the final moisture content of the powder. Because of the higher humidity in the chamber of the dryer, more agglomeration of powder particles is possible. (1)

Water is evaporated from the agglomerates during its passage through the drying sections. It will have attained the required dryness when it has passed through the fluid-bed. (1)

Any larger particles at the outlet of the dry bed are screened. The drying air from the fluid bed, together with the air from the spray tower, is then blown to the cyclone for recovery of milk particles. (1)

(5)

19. To transport the powder from the drying chamber to the cyclones and subsequent packaging system. (1)

20. To aid in further cleaning of the air that is extracted from the cyclone. (1)

21. Milk powder that will dissolve quickly in water must be instantised, i.e. the milk particles must be **treated** (1) so that they form **larger, porous agglomerates** (1) with a diameter of 0,2 to 0,3 mm that will **easily reconstitute** (1). (3)

22. The milk **particles are first dried so that most of the water in the capillaries and pores is replaced by air** (1). The particles must then be **humidified so that the surfaces of the particles swell quickly** (1), **closing the capillaries** (1). The surfaces of the particles will then **become sticky** (1) and the particles will **adhere to form agglomerates** (1). (5)

23. **Re-circulation of dry milk particles** (fines separated by the cyclones) **back to the mixing chamber** containing drying air and atomised milk particles. (1)
Use of a **fluid bed**, as described in question 18 (b). (1)

24. Why is it done? Due to a **growing need for high fat and full fat milk powder that can be reconstituted in cold water** (1), it has become necessary to **add a surface-active agent (or surfactant) to facilitate reconstitution of the powder** (1).
What does it mean? (principle): A surfactant has a **hydrophobic (water repelling) and a hydrophyllic (water attracting) part** (1). The **hydrophobic part of the lecithin molecule dissolves in the milk fat and its hydrophyllic part dissolves in the water** (1). In this way **fat and water can be kept in contact** with one another (1).

(5)

25. During roller drying, the milk concentrate is distributed on slowly rotating hollow drums that are heated internally by pressurised steam to 120-170°C. A thin layer of milk is spread uniformly over the outer surface. The water in the milk evaporates and is drawn off by a flow of air when it comes into contact with the hot drum surface. Before the drum has completed one revolution, the dried milk is scraped off by a blade that contacts the drum surface uniformly along its length. (5)

26. (a) Spray-fed roller dryer (1)

(b) See the figure given in the knowledge questionnaire.
1. Hood for withdrawal of water vapour
2. Evaporated water
3. Spray nozzles
4. Scraping knives (blades)
5. Rotating hollow drums, internally heated with steam
6. Screw conveyor
7. Milk
8. Heating medium (steam)
9. Air for pneumatic transportation and cooling

(9)

27. **Whey-proteins suppress the leavening action in bakery products** (1), therefore **heat treatment prior to drying is ideal to denature the whey-proteins** (1) that will interfere with leavening. (2)

28. To carry away moisture. (1)

29. To **ground the dried film into flakes** (1) and to tr**ansfer it to the grinder or hammer mill** (1). (2)

30. a) The speed of the drums is important as its **affects the thickness of the dried film** (1) and the **time that the product spends on the drum** (1). (2)

(b) To **ensure uniform drying at both sides**. (1)

(c) To provide uniform heat transfer. (1)

31. It is essential to remove the condensate as rapidly as it accumulates in the bottom of the drum since **flooding of the inside of the drum with condensate reduces the rate of heat transfer** (1) and **subsequent efficiency of drying** (1). (2)

TOTAL: (118)