higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T340**(E)**(M26)T

NATIONAL CERTIFICATE

CHEMICAL TECHNOLOGY N6

(15040106)

26 March 2018 (X-Paper)
09:00–12:00

Calculators may be used.

This question paper consists of 7 pages and 1 formula sheet.

Copyright reserved

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
CHEMICAL TECHNOLOGY N6
TIME: 3 HOURS
MARKS: 200

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Sketches must be large, neat and fully labelled.
5. Write neatly and legibly.

Copyright reserved

QUESTION 1

1.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 In a batch process, the rate of drying should be greatest at the end of the operation when water covers the entire surface of the solids.

1.1.2 Free moisture content represents the amount of water that can be removed from dry solids under any given condition of air humidity and temperature.

1.1.3 When part of the solid surface is no longer wetted by the liquid, the water area available for direct heat and mass transfer is regarded as the falling rate period.

1.1.4 Freeze-drying is the sublimation of water vapour from ice under high vacuum at a temperature above 0 °C.

1.1.5 A drying operation involves the simultaneous transfer of mass and heat, and the rate of water removal is determined by the rate at which mass and heat may be transferred.

(5 × 2) (10)

1.2 Define the following:

1.2.1 Drying

1.2.2 Dry weight basis

(2 × 1) (2)

1.3 Discuss the principle of drying under the following headings:

1.3.1 Water on the surface

1.3.2 Water not on the surface

(2 × 4) (8)

1.4 Name TWO materials that can be dried by EACH of the following dryers:

1.4.1 Tray dryer

1.4.2 Rotary dryer

1.4.3 Spray dryer

(3 × 2) (6)

Copyright reserved

1.5 Discuss the tray dryer under the following headings:

1.5.1 Advantages (2)

1.5.2 Disadvantages (4)

1.5.3 Draw and label a diagram of a tray dryer. (10)

1.6 State FOUR factors that influence the efficiency of the spray dryer. (4)

1.7 Differentiate between a *direct dryer* and an *indirect dryer*. (4)

[50]

QUESTION 2

2.1 Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–J) next to the question number (2.1.1–2.1.5) in the ANSWER BOOK.

	COLUMN A		COLUMN B
2.1.1	The latent heat that is evolved when solid forms form a solution	A	purity product
2.1.2	The results of mother liquor into the crystal face, which gives a milky surface and an impure product	B	rate of nucleation
2.1.3	The number of new particles formed per unit time per unit volume of the magma or solids-free mother liquor	C	super saturation
2.1.4	The two-phase mixture of the mother liquor and crystals of all sizes which occupies the crystalliser and is withdrawn as product.	D	magma
2.1.5	A sound well-formed crystal is nearly pure, but it retains mother liquor when removed from the final magma	E	heat of crystallisation
		F	needle breeding
		G	veiled growth
		H	initial breeding
		I	homogenous nucleation
		J	Ostwald ripening

(5 × 2) (10)

2.2 Define the following:

2.2.1 Crystallisation

2.2.2 Evaporation

(2 × 2) (4)

2.3 Write brief notes on the following:

2.3.1 Equilibrium and yields (6)

2.3.2 Homogeneous nucleation (5)

2.3.3 Ostwald ripening (5)

2.4 Give TWO methods obtained in laboratory experiments where crystals are usually produced from a solution. (2)

2.5 Give TWO factors that allow the purification of the product to be effective. (2)

2.6 Name THREE processes used to remove magma from the mother liquor during the purification of the product. (3)

2.7 Name THREE groups of nucleation. (3)

2.8 Give THREE advantages of crystallisation in the industry. (3)

2.9 Discuss THREE ways in which supersaturation can be generated. (3 × 2) (6)

2.10 Give ONE way in which initial breeding can be prevented. (1)

[50]

QUESTION 3

3.1 Give a suitable name or term for each of the following descriptions. Write only the name or the term next to the question number (3.1.1-3.1.5) in the ANSWER BOOK.

3.1.1 The total kilograms of water vaporised in an evaporator per kilogram of original steam supplied

3.1.2 The equilibrium vapour pressure which is exerted by the component in a liquid solution equals the mole fraction of that component in the solution times the equilibrium vapour pressure the component would exert if it were pure and at the same temperature as the solution

3.1.3 The difference in temperature of the liquid at the heat source and the liquid at the top of the evaporating surface

Copyright reserved

3.1.4 It occurs in all types of evaporators, and it is important when the solution to be evaporated contains dissolved materials that have an inverted solubility

3.1.5 The carrying over of liquid droplets into a vapour space of an evaporator – a carrying over that occurs because the vapour velocity is high enough to overcome the tendency for the liquid drops to settle.

(5 × 2) (10)

3.2 Write brief notes on how the *capacity* varies according to the temperature of the feed:

3.2.1 When feed to the evaporator is at the boiling point

3.2.2 When feed is cold

3.2.3 When feed has a temperature above the boiling point in the vapour space

(3 × 2) (6)

3.3 Give THREE factors that influence the economy of an evaporator system. (3)

3.4 Write brief notes on the boiling point due to material in the solution. (7)

3.5 Discuss the *agitated-film evaporator* under the following headings:

3.5.1 Operation (6)

3.5.2 Advantages (3)

3.5.3 Disadvantages (3)

3.5.4 Uses (2)

3.6 In making calculations dealing with evaporations, it is generally acceptable to make certain assumptions in order to simplify the work.

Explain the assumptions in an evaporator's calculations. (10)
[50]

QUESTION 4

4.1 Complete the following sentences by writing down only the missing word or words next to the question number (4.1.1–4.1.10) in the ANSWER BOOK.

The concept of the film states that when a fluid is (4.1.1 …) a (4.1.2 …), a thin film of the fluid is (4.1.3 …) as existing between a (4.1.4 …) and a (4.1.5 …).

The instantaneous (4.1.6 …) through a (4.1.7 …) by conduction is (4.1.8 …) to the (4.1.9 …) and to the (4.1.10 …) of the body through which heat flows.

(10 × 1) (10)

4.2 Define the following:

4.2.1 Convection (3)

4.2.2 Saturation air (4)

4.2.3 Absorptivity (3)

4.2.4 Wet-bulb temperature (5)

4.2.5 Dew-point temperature (4)

4.3 Write notes on the following:

4.3.1 Condensing vapour (6)

4.3.2 Forced convection of gases (5)

4.4 Discuss the general rule regarding the standard method for operating heat exchangers under the following headings:

4.4.1 Start up (4)

4.4.2 Shut down (4)

4.4.3 Steam condensate (2)

[50]

TOTAL: 200

Copyright reserved

CHEMICAL TECHNOLOGY N6

FORMULA SHEET

$$Q = UA\Delta t$$

$$qs = mCp\Delta t$$

$$Q = q_S + q_V$$

$$qv = m^1 h_{fg}$$

$$Q(TOTAL) = \left(KA\Delta\frac{t}{x}\right) + (KA\Delta\frac{t}{x})^2 + (KA\Delta\frac{t}{x})^3$$

$$\frac{1}{UA} = \frac{1}{h^1 A^1 f} + \frac{1}{h^{11} A^{11} f} + \frac{x_w}{K.A_w}$$

$$\Delta t_{lm} = \frac{\Delta t_2 - \Delta t_1}{ln\frac{\Delta t_2}{\Delta t_1}}$$

$$H_a = \frac{18Pa}{29(P - pa)}$$

$$H_S = \frac{19Ps}{29(P - ps)}$$

$$H_P = H_R\left(\frac{P - ps}{P - pa}\right)$$

$$H_R = \frac{Pa}{Ps} \bullet 100$$

Copyright reserved