higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

CHEMICAL TECHNOLOGY N6

(15040106)

29 November 2019 (X-Paper)
09:00–12:00

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

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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. Round off each final answer to THREE decimals.
5. Write neatly and legibly.

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QUESTION 1

Give ONE term for each of the following descriptions. Write only the term next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1 1.1.1 Two-phase mixture of mother liquor and crystals of all sizes which occupies the crystalliser and is withdrawn as product

1.1.2 Process where the third component may act physically by forming with the original solvent or a mixed solvent in which the solubility of the solvent is sharply reduced

1.1.3 Action of reducing ore to minute particles or fragments

1.1.4 Mass of bubbles forming on the surface of a liquid

1.1.5 Fraction of the incident radiation absorbed by a material

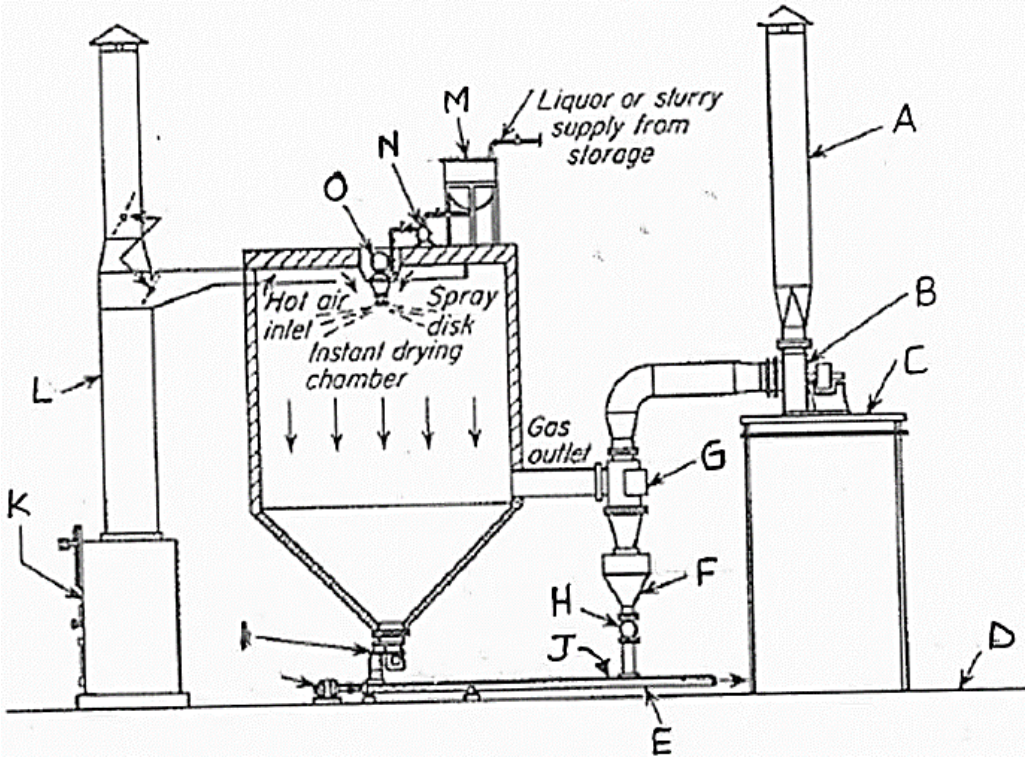
(5 × 2) (10)

1.2 Write brief notes on the principle of drying. (10)

1.3 Complete the following paragraph by writing the missing word or words next to the question number (1.3.1–1.3.10) in the ANSWER BOOK.

During flash drying (1.3.1) … are/is transported for a few seconds in hot gases during which drying occurs. The rate of (1.3.2) … and drying is rapid. Drying occurs for a short time at a (1.3.3) … Wet feed enters the (1.3.4) … mixer and is then blended with (1.3.5) … to make it free-flowing. It then goes to the (1.3.6) … where hot gases enter. Pulverised solids are carried to a (1.3.7) … by a hot gas steam where drying occurs. The (1.3.8) … separates vapour and solids and the gas leaves through a vent. Solids pass through a (1.3.9) … to a solid divider which sorts the solids for (1.3.10) … (10 × 1) (10)

1.4 Study the diagram of a spray dryer below and answer the questions.



1.4.1 Label the diagram by writing only the answer next to the letter (A–O) in the ANSWER BOOK. (15 × 1) (15)

1.4.2 Give FIVE advantages of a spray dryer. (5)

[50]

QUESTION 2

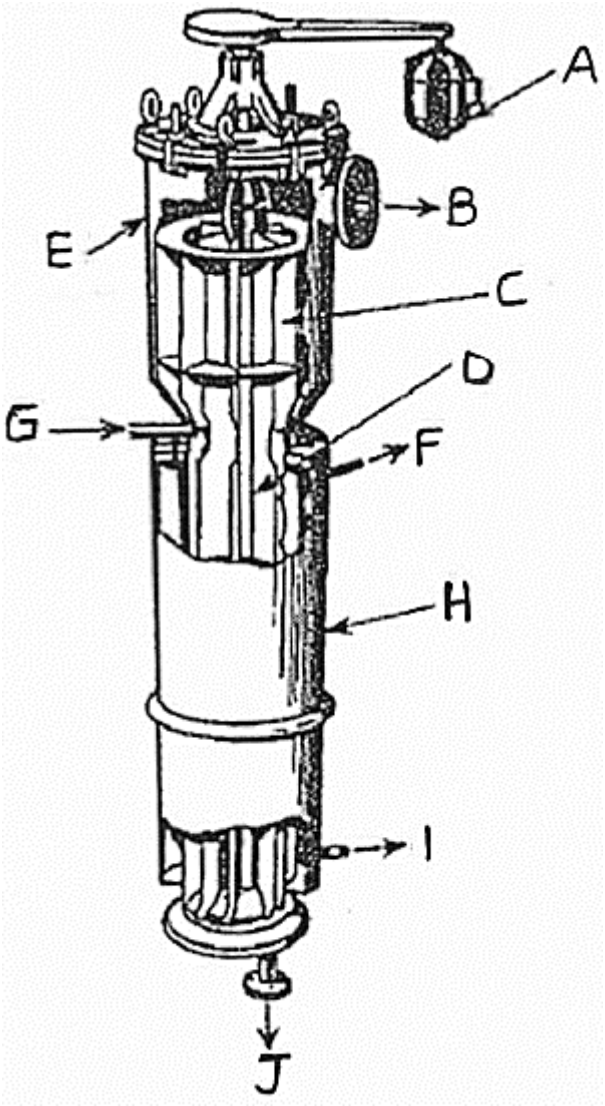
2.1 Write brief notes on each of the following:

2.1.1 Contact nucleation (5)

2.1.2 Ostwald ripening (5)

2.2 State FOUR principles of crystallisation. (4)

2.3 Study the diagram below and answer the questions.



2.3.1 Name the evaporator. (2)

2.3.2 Label the diagram by writing only the answer next to the letter (A–J) in the ANSWER BOOK. (10 × 1) (10)

2.3.3 Explain the operation of an evaporator. (10)

2.3.4 Give THREE disadvantages of an evaporator. (3)

2.3.5 List FOUR applications of an evaporator. (4)

2.4 Differentiate between *capacity* and *economy*. (2 + 2) (4)

2.5 Illustrate each of the following with the aid of a diagram:

2.5.1 Good growth

2.5.2 Spikewise growth

2.5.3 Veiled growth

(3 × 1) (3)
[50]

QUESTION 3

3.1 Write notes on the operation of a natural-circulation tower. (7)

3.2 Primary nucleation involves the birth of very small bodies of a new phase within a super-saturated homogenous existing phase and a consequence of rapid local fluctuation on a molecular scale.

How does this type of nucleation occur? (4)

3.3 Explain each of the following:

3.3.1 Boiling point rise due to material in a solution (4)

3.3.2 Boiling point rise due to hydrostatic head (4)

3.3.3 Raoult's law (6)

3.4 A solution is to be concentrated from 25% to 70% solids in a vertical tube evaporator. The boiling point elevation of the solution is negligible and the specific heat capacity of the feed is 4,75 kJ/kg.K.

Saturated steam is available at 65 kPa (abs) and the pressure of the condenser is 112,54 mmHg (abs). The feed enters the evaporator at 16 °C. The overall coefficient is 1 800 W/m^{2}K. The atmospheric pressure is 101,3 kPa. The evaporator must evaporate 30 000 kg/h.

FORMULAE:

1. $m' = m - \frac{\text{conc. of the feed}}{\text{conc. of the product}} \times m$

2. $q_s = mC\Delta t$

3. $q_v = m' h_{fg}$

4. $Q = UA\Delta t$

Calculate:

3.4.1 The temperature of the boiling water (3)

3.4.2 The heat of vaporisation at 112,54 mmHg (4)

3.4.3 The volumetric flow rate of the feed (m) (4)

3.4.4 The surface area of the evaporator (A) (10)

3.4.5 The steam consumption (m_s) in kJ/h (4)

[50]

QUESTION 4

4.1 Write brief notes on each of the following:

4.1.1 Steady flow of heat (4)

4.1.2 Resistance to flow (4)

4.1.3 Percentage relative humidity (8)

4.1.4 Saturation volume (4)

4.2 Name TWO methods of cleaning a heat exchanger. (2)

4.3 Draw a diagram of each of the following cooling towers:

4.3.1 Atmospheric

4.3.2 Forced draft

(4 × 2) (8)

4.4 A sphere with a diameter of 25 cm is placed in a completely closed box. The temperature of the sphere is maintained at 800 °C and the inside surface of the box is kept at 350 °C. Assume that the sphere and the inside surface area of the box are black bodies.

Calculate the radiation of heat loss from the sphere to the box in J/h.

FORMULA: Area of the sphere = $4\pi r^2$ and $Q = 0{,}173\ A\ [\ (\frac{T_2}{100})^4 - (\frac{T_1}{100})^4]$ (5)

4.5 Write brief notes on the standard method of operating a heat exchanger under each of the following headings:

4.5.1 Start up (5)

4.5.2 Shut down (5)

4.5.3 Steam condensate (5)

[50]

TOTAL: 200

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FORMULA SHEET

1. $Q = UA\Delta t$

2. $qs = mCp\Delta t$

3. $Q = q_S + q_V$

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

5. $Q_{\text{total}} = (kA^{\Delta}\frac{t}{x}) + (kA^{\Delta}\frac{t}{x})^2 + (kA^{\Delta}\frac{t}{x})^3$

6. $\frac{1}{UA} = \frac{1}{h^1 A^1{}_f} + \frac{1}{h^{11} A^{11}{}_f} + \frac{x_w}{kA_w}$

7. $\Delta t_{\ell m} = \frac{\Delta t_2 - \Delta t_1}{In\frac{\Delta t_2}{\Delta t_1}}$

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

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

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

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

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