higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

CHEMICAL TECHNOLOGY N6

21 April 2021

This marking guideline consists of 7 pages.

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SECTION A

QUESTION 1

1.1	1.1.1	C		
	1.1.2	C		
	1.1.3	B		
	1.1.4	D		
	1.1.5	B		
	1.1.6	B		
	1.1.7	C		
	1.1.8	A		
	1.1.9	C		
	1.1.10	D		
			(10 × 2)	(20)
1.2	1.2.1	True		
	1.2.2	False		
	1.2.3	True		
	1.2.4	True		
	1.2.5	False		
	1.2.6	True		
	1.2.7	True		
	1.2.8	False		
	1.2.9	True		
	1.2.10	False		
			(10 × 1)	(10)
1.3	1.3.1	Rate of nucleation		
	1.3.2	Forced-circulation evaporator		
	1.3.3	Entrainment		
	1.3.4	Economy		
	1.3.5	Multiple-effect evaporator		
	1.3.6	Fourier's law		
	1.3.7	Radiation		
	1.3.8	Flash evaporation		
	1.3.9	Black body		
	1.3.10	Screw-conveyor dryer		
			(10 × 1)	(10)
				[40]

TOTAL SECTION A: 40

SECTION B

QUESTION 2

2.1 Wet solids are transported in hot gases for a few seconds.✓ Drying occurs for a short time during transportation.✓ Wet feed enters the paddle-conveyor mixer.✓ It is then blended with dry material to make it free flowing.✓ Mixed material enters the hammer mill swept with hot flue gas from the furnace.✓ Pulverised solids are carried to a long duct by a hot gas stream where drying occurs.✓ The cyclone separates vapour and solids.✓ The gas leaves through a vent fan.✓ Solids pass through a star feeder to a solid divider.✓ The divider sorts solids for refeeding.✓ (10)

2.2 2.2.1 The liquid enters at the top of the evaporator.✓ It then flows downwards inside the heated tubes as a film.✓ Vapour evolved from the liquid is usually carried downward with the liquid✓ and leaves from the bottom of the unit.✓ In appearance these evaporators resemble long vertical tubular exchanges✓ with a liquid-vapour separator at the bottom and a distributor at the top.✓ (6)

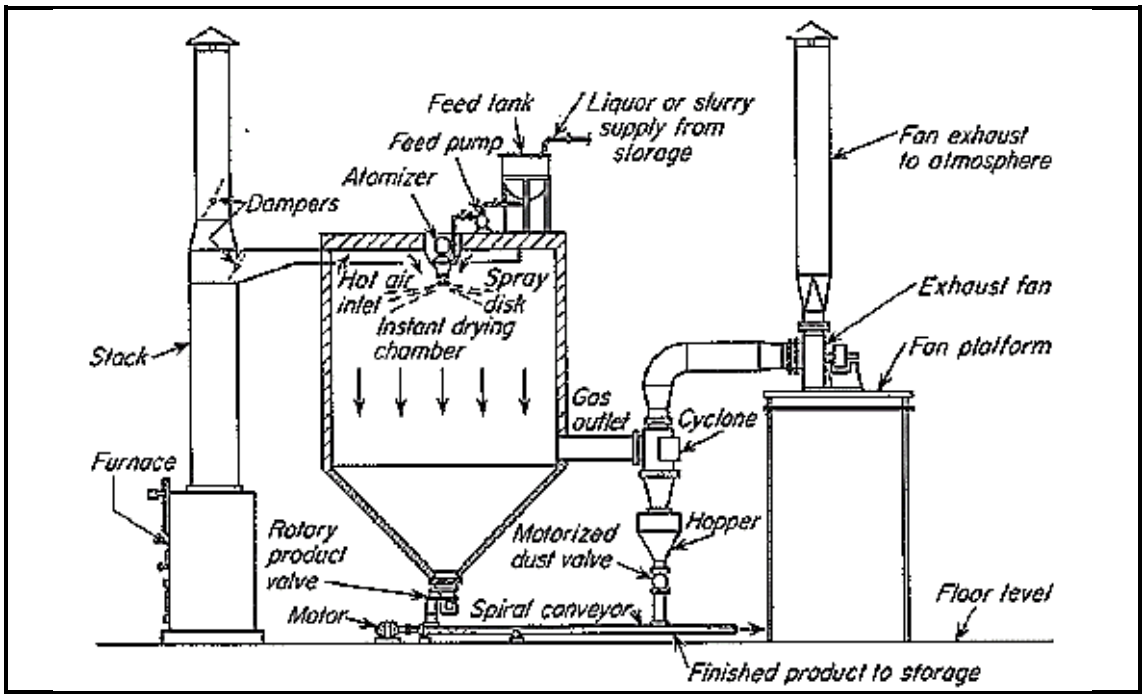
2.2.2
- Allows minimum time of exposure to heated surface
- Well adapted to concentrated viscous liquid
- Handles sensitive products (3)

2.2.3
- Concentrated viscous liquid
- Heat-sensitive material (2)

2.3
- Sanitary applications
- Pharmaceutical applications
- Industrial applications (3)

2.4
- Evaporator
- Capacity (2)

2.5



(25)

2.6
- The nature of the product dictates the type of the dryer to be used.✓
- Coarse granular inorganic solids: agitated dryer by direct contact with hot gases✓
- Fragile crystals of heat-sensitive organic materials: unagitated equipment by indirect heating✓
- Batch equipment is used when production rates are low✓ and the hold-up time in a unit is long.✓
- Large tonnages, rapid drying rate: continuous dryer✓
- Rigid or granular solids: tray and screw-conveyor dryer✓
- Material that cannot be agitated: rotary, screw-conveyor or tower dryer✓
- Material that can be agitated: flash dryer✓ (9)

[60]

QUESTION 3

3.1 3.1.1 The sublimation of water vapour✓ from ice under high vacuum✓ at temperatures below 0 °C✓ (3)

3.1.2 The formation of a solid✓ within a homogeneous phase✓ (2)

3.1.3 The number of kilograms of water✓ vapour carried by 1 kilogram✓ of dry air✓ (3)

3.1.4 Fraction of incident radiation✓ absorbed by a material✓ (2)

3.1.5 Heat transferred from one point to another✓ under steady conditions of temperature difference,✓ length of heat flow path and cross-sectional area✓ (3)

3.1.6 The amount of radiation energy✓ emitted is directly proportional✓ to the fourth power✓ of the absolute temperature of the heat source body.✓ (4)

3.2 $X_{furnace} = 0,12\ m$

$K_{furnace} = 3,89\ W/m.K$

$X_{ceramic} = \frac{40}{1\ 000} = 0,04\ m$✓

$K_{ceramic} = 0,46\ W/m.K$

$\Delta T = 1\ 356 - 1\ 250$✓ $= 106\ K$✓

$A = 0,35 \times 1,5 = 0,525\ m^2$✓✓

$\frac{K_{furnace}\ A}{X_{furnace}} = \frac{3,89✓ \times 0,525✓}{0,12✓} = 17,0188$✓

$\frac{K_{ceramic}\ A}{X_{ceramic}} = \frac{0,46✓ \times 0,525✓}{0,04✓} = 6,0375$✓✓

$Q = \Delta T \left(\frac{K_{furnace}\ A}{X_{furnace}} + \frac{K_{ceramic}\ A}{X_{ceramic}}\right)$

$= 106✓(17,0188✓ + 6,0375✓)$

$= 2\ 443,19\ J$✓✓ (19)

3.3 Economy is the kilogram of vapour✓ per kilogram of steam fed to the unit,✓ while capacity is the number of kilogram of water✓ vaporised per hour.✓ (2 + 2) (4)

3.4 Pure liquid or solvent exerts a certain vapour pressure at any given temperature.✓ If another substance is dissolved in pure substance,✓ the vapour pressure of the solvent over the mixture✓ will be less than that of the pure solvent at the same temperature.✓ The vapour pressure of the solvent is less than that of the pure solvent.✓ A solution boils when its vapour pressure equals the pressure of its surroundings.✓ A solution of nonvolatile material in water must be heated✓ above the boiling point of pure water before boiling can occur.✓ The boiling point rise due to material is the actual temperature of the mixture✓ minus the temperature of the pure solvent if it exerts the same vapour pressure as the mixture.✓ (10)

[50]

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QUESTION 4

4.1 4.1.1
- Number of effects
- Enthalpy of vaporisation of the steam
- Temperature of the feed

4.1.2
- Cost
- Relatively high pressure drop
- Design consideration

(2 × 3) (6)

4.2 4.2.1 It is the result of the occlusion✓ of the mother liquor into the crystal face✓ giving a milky surface and impure product.✓ It is caused by too rapid growth✓ that traps mother liquor into the crystal face.✓ (5)

4.2.2 It is the difference between the temperature of the condensing steam✓ in the steam chest ✓and the temperature of the boiling solution✓ at the liquid-vapour interface in the evaporator body.✓ (4)

4.2.3 Molecules of matter are in constantly in motion.✓ Heat is conducted through matter✓ by means of vibration.✓ Hot molecules vibrate more rapidly.✓ (4)

4.2.4 When a cool gas is exposed to a warmer surface,✓ the temperature of the gas close to the surface increases.✓ This warm gas has a smaller density✓ than the surrounding gases.✓ As a result, the warmer gas flows upward from the hot surface✓ setting a natural flow of the surrounding gases past the hot surface.✓ (6)

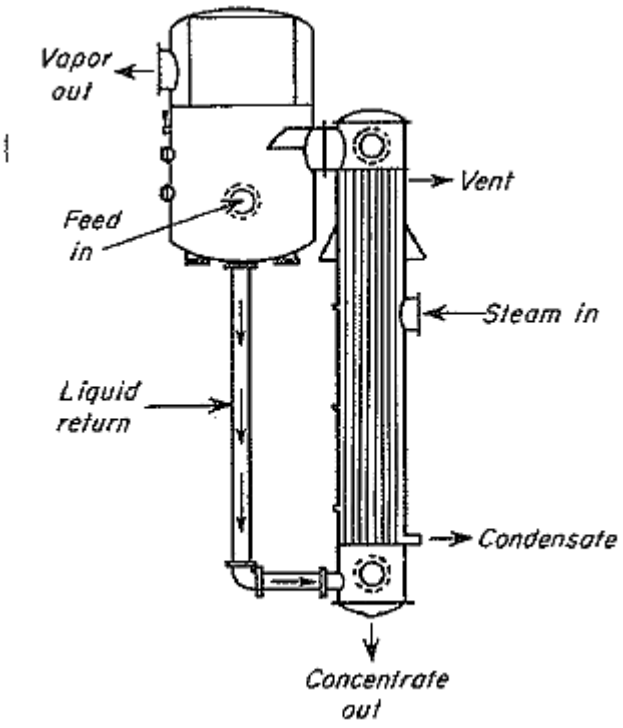
4.2.5 It is the number of kilograms of water✓ per kilogram of dry solids✓ when the drying limit has been attained✓ by using air at any given temperature and humidity.✓ (4)

4.3 The atmospheric towers depend on prevailing winds for air movement.✓ More positive air movement is ensured by depending on the displacement✓ of the warm air inside the tower by the cooler outside air.✓ Fairly tall chimneys are required✓ to operate at wet-bulb temperature.✓ It is used where the humidity is low.✓ (6)

4.4 4.4.1 Spikewise growth ($\Delta t > 8$ °C)
4.4.2 Good growth ($\Delta t < 4$ °C)
4.4.3 Veiled growth (4 °C < Δt < 8 °C)

(3 × 2) (6)

4.5



(2 × 1 diagram + 7 × 1 labels) (9)

[50]

TOTAL SECTION B: 160
GRAND TOTAL: 200

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