higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

CHEMICAL TECHNOLOGY N6

18 November 2020

This marking guideline consists of 8 pages.

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QUESTION 1

1.1	1.1.1	A		
	1.1.2	D		
	1.1.3	A		
	1.1.4	B		
	1.1.5	D		
	1.1.6	C		
	1.1.7	C		
	1.1.8	B		
	1.1.9	B		
	1.1.10	A		
			(10 × 2)	(20)

1.2	1.2.1	False		
	1.2.2	False		
	1.2.3	False		
	1.2.4	True		
	1.2.5	False		
	1.2.6	True		
	1.2.7	False		
	1.2.8	True		
	1.2.9	True		
	1.2.10	True		
			(10 × 1)	(10)

1.3	1.3.1	B		
	1.3.2	A		
	1.3.3	G		
	1.3.4	I		
	1.3.5	C		
	1.3.6	K		
	1.3.7	F		
	1.3.8	E		
	1.3.9	H		
	1.3.10	D		
			(10 × 1)	(10)

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1.4 1.4.1 Tubular exchange
1.4.2 Indirect heating
1.4.3 Latent heat
1.4.4 Adiabatic equilibrium
1.4.5 Condensing steam
1.4.6 Downwards
1.4.7 Critical temperature difference
1.4.8 Dehumidification
1.4.9 Heat and mass transfer/Mass and heat transfer
1.4.10 Calandria

(10 × 1) (10)
[50]

TOTAL SECTION A: 50

SECTION B

QUESTION 2

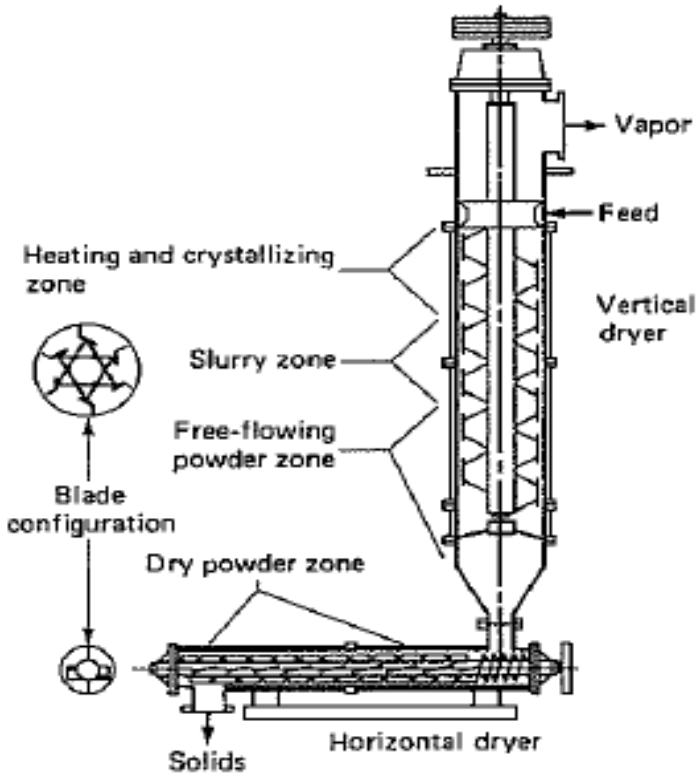
2.1 2.1.1 Chamber is cylinder with short conical bottom.✓ Liquid feed is pumped into spray disc atomiser in roof of chamber✓ which atomises liquid into tiny drops thrown rapidly into stream of hot gas entering near top of chamber.✓ Exhaust fan draws cooled gas through horizontal discharge✓ line set in side of chamber at bottom of cylindrical section. Gas passes through cyclone separator✓ where any entrained particles of solids are removed.✓ Much of dry solids settle outside✓ gas into bottom of drying chamber.✓ Dry solids are removed by rotary valve✓ and screw conveyor and combined with any solid collected in cyclone. ✓ (10)

2.1.2
- Short drying time
- Drying of highly heat-sensitive material
- Production of solid or hollow spherical particles
- Yield from solution, slurry or thin paste of dry product in single step
- Many combines the functions of an evaporator
- crystalliser dryer, size reduction unit and classifier (6)

2.1.3
- Highly heat-sensitive materials
- Food
- Synthetic detergent (3)

2.2
- Amount of material to be dried
- Type of material used
- Type of final product required
- Facilities available
- Economics of the process (5)

2.3



(10)

2.4
- Long-tube vertical evaporator
- Agitated film evaporator (2)

2.5 35 mmHg = x
760 mmHg = 101,3 KPa

$$P_a = \frac{35 \times 101.3}{760} \checkmark$$

$$P_a = 4.665 \text{ KPa} \checkmark$$

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

$$= \frac{18 \times 4.665 \checkmark}{29\ (101.3 - 4.665) \checkmark}$$

$H_a = 0.029$ Kg✓ water per Kg dry air or 0.030 Kg water per dry air

$$\text{Mass of dry air} = \frac{M_T}{1 + H_a}$$

$$= \frac{0.05 \checkmark}{1 + 0.029 \checkmark}$$

Mass of dry air $= 0.049$ Kg ✓

$$C_s = 1 + 1.88\ H_a \checkmark$$
$$= 1 + 1.88\ (0.049) \checkmark$$

$$= 1.092 \frac{KJ}{Kg}.K \checkmark$$

$$Q = mC_s\Delta t$$
$$= 1.092 \times 0.049\ (52 - 46) \checkmark\checkmark$$
$$= 0.321\ KJ \checkmark$$

(14)
[50]

QUESTION 3

3.1 3.1.1 Growth-related spurious nucleation✓ occurs at large super saturations or accompanies poor magma circulation✓ characterised by abnormal needle-like and whisker-like growth✓ from end of crystals which under these conditions may grow much further than sides.✓ Spikes are imperfect crystals which break off to give crystals of poor quality.✓ (5)

3.1.2 Sound, well-formed crystal is nearly pure✓ but retains mother liquor when removed from final magma.✓ Much of retained mother liquor✓ is separated from crystals by filtration or centrifuging✓ Mother liquor is also separated✓ from the crystals by washing with fresh solvent.✓ Effectiveness of purification steps✓ depends on the size and uniformity of crystals.✓ (8)

3.1.3 Small crystal can be in equilibrium✓ with super saturation solution.✓ Such equilibrium is unstable✓ because if large crystal is also present in solution✓ smaller crystal will dissolve and larger one✓ will grow until small crystals disappear.✓ (6)

3.2 Equilibrium moisture content is the kilograms of water per kilogram of dry solids✓ when the drying limit has been attained by the use of air✓ at any given temperature and humidity.✓

Critical free moisture content is the amount of water✓ that can be removed from wet solid✓ under any given condition of air humidity and temperature.✓ (6)

3.3 3.3.1
- Fluid shear nucleation
- Contact nucleation (2)

3.3.2
- Upward flow/Climbing film
- Downward flow/Falling film
- Forced circulation (Any 2 × 1) (2)

3.3.3
- Natural draught cooling tower
- Mechanical draught cooling tower
- Hybrid or wet/dry cooling tower (Any 2 × 1) (2)

3.4 3.4.1 100 times the ratio of actual humidity of air✓ to humidity if air✓ was saturated ✓at same temperature and total pressure✓ (4)

3.4.2 Equilibrium vapour pressure✓ exerted by component in liquid solution✓ equals mole fraction of that component in solution✓ times equilibrium vapour pressure component would exert if pure✓ and at same temperature as solution✓ (5)

3.4.3 It is the amount of water that can be determined ✓very easily by obtaining the difference ✓between the water contents of any two times.✓ (3)

3.5
- Purity
- Yield
- Energy requirement
- Rate of nucleation and growth (Any 2 × 1) (2)

3.6 Wet feed is admitted at top of dryer.✓ Particles are fluidised by air or gas in boiling bed unit.✓ Feed is heated by hot air or gas.✓ Mixing and heating transfer is rapid.✓ Dry product is taken out from side near bottom.✓ (5)

[50]

QUESTION 4

4.1 4.1.1 Instantaneous rate of heat transfer✓ in homogeneous body is directly proportional to temperature difference driving force✓ across body and to cross-sectional area of body✓ and rate of heat transfer is inversely proportional✓ to thickness of body✓ (5)

4.1.2 If drop of liquid water is brought into contact with large amount of unsaturated air✓ some of liquid will evaporate into air.✓ As water evaporates, it absorbs heat and liquid tends to cool.✓ When liquid becomes colder than air✓ sensible heat from air will be transferred into liquid.✓ Thus dynamic equilibrium is quickly obtained where amount of heat✓ absorbed by evaporation exactly equals amount of heat gained by liquid from surrounding air.✓ There is no gain or loss of heat.✓ (8)

4.1.3 In many types of evaporators heat source is submerged below surface of evaporating liquid.✓ Solution at outside of steam tubes has a higher pressure✓ than solution at surface of liquid because of presence of head of liquid.✓ If boiling occurs at steam tubes liquid temperature will be greater than at liquid surface.✓ Boiling point rise due to hydrostatic head is the difference in temperature✓ of liquid at heat source and liquid of evaporating surface.✓ Vapour evolved from liquid usually carried downward✓ with liquid and leaves at bottom of unit.✓ In appearance these evaporators resemble long vertical tubular exchanges✓ with a liquid-vapour separator at the bottom and distributed at the top.✓ (10)

4.2 4.2.1
- Caustic soda
- Salting liquids
- Foaming liquids
- Corrosive liquids/fluids
- Moderate heat-sensitive liquids (Any 2 × 1) (2)

4.2.2
- Spray ponds
- Cooling towers
- Fractionation towers
- Steam strippers
- Absorbers (Any 2 × 1) (2)

4.2.3
- Material that can be agitated
- Sugar/Sugar beet pulp
- Fine salt/Salt
- Granular material
- Crystalline material (Any 2 × 1) (2)

4.3 4.3.1 Total radiant energy emitted✓ from unit area of body in unit time✓ divided by total radiant energy emitted from unit area✓ of black body at same temperature✓ (4)

4.3.2 Instantaneous rate of heat transfer✓ in homogeneous body by conduction is directly proportional✓ to temperature difference driving force across body✓and to cross-sectional area of body✓ through which heat flows and rate of heat transfer is inversely proportional to thickness of body.✓ (5)

4.3.3 If dry-bulb temperature is suitably shielded✓ with respect to any thermal radiation and placed in air✓ the thermometer gives a temperature reading referred to as dry-bulb temperature.✓ (3)

4.4 $$H_p = \frac{H_a}{H_s} \times 100$$

$$= \left[\frac{18\,P_a}{29\,(P - P_a)}\right] \div \left[\frac{18\,P_s}{29\,(P - P_s)}\right]$$

$$H_p = \frac{P_a\,(P - P_s)}{P_s\,(P - P_a)}$$

$$H_R = \frac{p_a}{p_s} \times 100$$

$$H_p = H_R \times \frac{(P - p_s)}{(P - p_a)} \times 100$$

(9)
[50]

TOTAL SECTION B: 150
TOTAL: 200

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