higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

CHEMICAL PLANT OPERATION N6

18 November 2022

This marking guideline consists of 7 pages.

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INSTRUCTIONS TO MARKERS

1. Mark all the questions.
2. Follow the answers according to the numbering system used in the~~is~~ question paper.
3. Use only a red pen.
4. Put your ticks and crosses neatly and legibly.

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QUESTION 1

1.1 D
1.2 A
1.3 E
1.4 C
1.5 B

(5 × 1) **[5]**

QUESTION 2

2.1 True
2.2 False
2.3 False
2.4 True
2.5 False

(5 × 1) **[5]**

QUESTION 3

3.1 Process variables
3.2 Temperature
3.3 ~~p~~Primary
3.4 ~~s~~Self-contained
3.5 C-~~b~~Bourdon tube

(5 × 1) **[5]**

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QUESTION 4

4.1 Simple batch distillation refers to distillation in which only one vaporisation stage is involved,✓ while continuous distillation is a process in which a unit can be brought to a steady operation condition✓ where the amount of feed is exactly equal~~s~~ to the amount of material removed✓ and the vapour and liquid concentration at any point in the unit remain constant.✓ (4)

4.2
- The actual rate and mechanism of the adsorption process
- The nature of the adsorption equilibrium
- Fluid velocity
- The ~~C~~concentration of solute in the feed
- The length of the adsorption bed

(Any 4 × 1) (4)

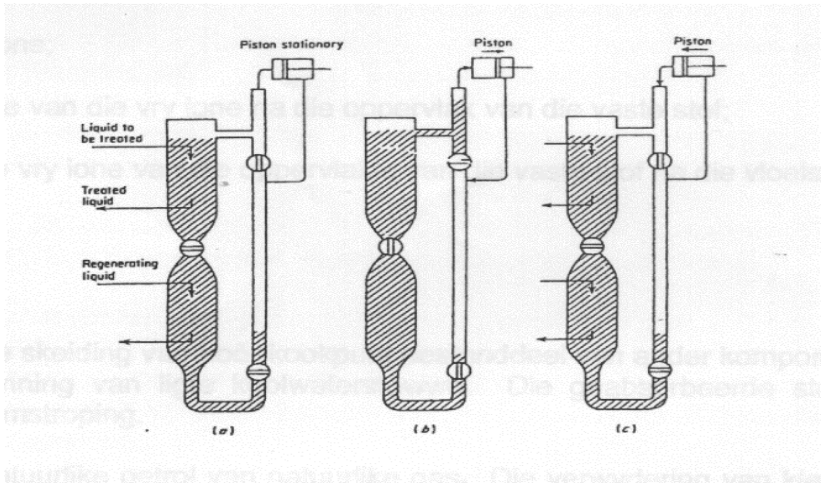
4.3

- The liquid is led from the one tray to the next by means of downspouts or down-comers.✓
- These may be circular pipes or preferably portions of the tower cross section set aside for liquid, which is agitated into a froth on the tray.
- , aAdequate residence time must be allowed in the downspout to permit disengagement of ing the gas from the liquid, so that only clear liquid enters the tray below.✓✓
- The downspout must be brought close enough to the tray below the seal into the liquid on that tray, thereby thus short-circuiting the tray above.✓
- Seal pots and seal-pot dams (inlet weirs) may be used, but they are best avoided, especially if there is a tendency to accumulate sediment.✓
- If they are used, weep holes (small holes through the tray) in the seal pot should be used to facilitate draining the tower on shutdown.✓ (6)

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4.4



(1 mark for the correct sketch and 5 marks for correct labelsling) (6)

[20]

QUESTION 5

5.1 5.1.1
- Hydrogen
- Methane
- Ethylene
- Carbon dioxide
- Hydrogen sulphide
- Ammonia
- Nitrogen (Any 4 × 1) (4)

5.1.2
- Water
- Tar
- Crude oil (Any 2 ×1) (2)

5.1.3
- As the temperature is raised, aliphatic carbon to carbon bonds are the first to break.✓
- Carbon to hydrogen linkages are severed next as the temperature of 600 °C is approached and exceeded.✓
- The decomposition during carbonisation is an essential reaction affecting the elimination of heterocycle complexes and progressive aromatisation.✓
- The average molecular weights of the volatile intermediate products constantly decrease as the temperature of carbonisation rises.✓
- This decrease is marked by the evolution of water, carbon, monoxide, hydrogen, methane and other hydrocarbons.✓
- The decomposition is at maximum between 600 and 800 °C.✓ (6)

5.2 5.2.1 The Aalteration of arrangement of the atoms in a molecule without changing the number of atoms.✓✓ (2)

5.2.2 The conversion of naphtha's to obtain products of a higher octane number.✓ (1)

5.3 The alkylation of hydrocarbons Rrefers to the combineation of lower-weight hydrocarbons✓ to form high-octane gasolines and the purpose is are essentially to reverse of the main reactions that occur during cracking.✓ It There for it builds hydrocarbon molecules in the gasoline range that possess high anti-knock qualities.✓ Low-molecular weight paraffin's, e.g. iso-butane and olefin's, may be united thermally without a catalyst or catalytically using sulfphuric acid as alkylating agent.✓ Thus iIt therefore refers vere to the union of an olefin with an aromatic or paraffin hydrocarbon.✓ (5)
[20]

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QUESTION 6

6.1 6.1.1 An acid is a substance that increases the concentration of hydrogen ~~ions~~ /-hydronium ions (H^+) in an aqueous solution✓ or that ~~which~~ is able to donate protons to another substance.✓ When an acid dissolves in water, it breaks up (dissociates) into small particles, called ions.✓ This is the reason why acids are so corrosive~~ly~~.✓ (4)

6.1.2 Bases are substances that ~~, which~~ also ionise when dissolved in water, but they f~~r~~orm hydroxide ions (OH^-).✓ A reaction of an acid and a base is known as protolysis.✓ This is the reaction during which protons are transferred in water.✓ Weak bases refer to $CaCO_3$ and Na_2CO_3 -(carbonates) ~~and~~✓ and ~~the~~ strong bases refer to ~~the~~ NaOH, $Ca(OH)_2$ and KOH~~.~~ (hydroxides).✓ (5)

6.2 This process is used on a large scale by industries to soften hard water.✓ Positively charged ions (cations)✓ will exchange with positive ions, e.g. Ca^{+2} + Na_2R ~~-~~⇒ CaR + Na_2.✓ "R" represents the residual material of the ~~Z~~zeolite,✓ which can be regenerated by contact with a solution of salt,✓ e.g. CaR + 2NaCℓ ⇒ Na_2R + $CaCℓ_2$.✓

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The rate of ion exchange depends ~~up~~on the rates of the following individual processes:

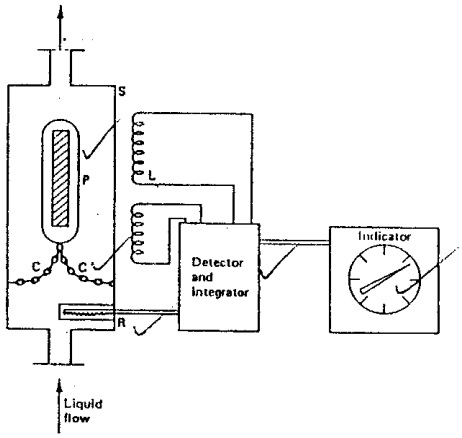
- Diffusion of ions from the bulk of the liquid to the internal surface of an exchanger particle~~.~~✓
- Inward diffusion of ions through the solid to the internal surface of an exchange of the ions~~.~~✓
- Outward diffusion of the released ions to the surface of the solid~~.~~✓
- Diffusion of the released ions from the surface of the solid to the bulk of the liquid~~.~~✓ (10)

6.3 To make a purer caustic soda and ~~a~~ lessen clogging of the cell diaphragm with a consequent increase,✓ ~~purification of~~ the NaCl solution, calcium ions and magnesium compounds are purified~~is practiced,~~ using soda ash with some caustic soda. ~~-~~Sometimes sulphates are removed with BaCl✓ or the hot brine is treated with hydroxyl and carbonate ions. ~~-~~The clear brine is neutrali~~z~~sed with hydrochloric acid.✓ (3)

6.4 Resins are pre-saturated with the same ions as in a solution.✓ They can reject ions in such a solution but at the same time absorb non-ionic organic substances such as glycerine,✓ which may also be in the solution. The organic matter can later be washed from the resin in an ion-free state.✓ (3)
[25]

QUESTION 7

7.1 S = Sampling chamber
L = Linear variable transformer
P = Plummet with metal core –supporting chains "C"
R = Resistance thermometer bulb



(1 mark for correct sketch and 7 marks for correct labelsling) (8)

7.2 It is composed of a platinum plate or wire covered with black platinum. , wWhen hydrogen is bubbled over such an electrode,✓ it is absorbed into its surface and the electrode behaves as a hydrogen electrode.✓ (2)

7.3 $^{o}F = 1,8\ ^{o}C + 32$
$203 – 32 = 1,8\ ^{o}C$✓
$= 171/1,8$✓
$= 95\ ^{o}C$✓ (3)

7.4 Advantages:
- If carefully made and calibrated, it gives the most accurate reading.
- It Ddoes not wear easily.
- Dirt or deposits are not kept behind.
- Pressure loss across the meter is less than in the case of the orifice plate.

Disadvantages:
- Due to the size and shape, it is more difficult to install than an orifice plate.
- Accurate machining is essential and the characteristics of each of the tubes have to be determined experimentally.
- Sharp corners and ridges affect the flow.
- The cost of the tube is higher than that of the orifice plate. (Any 7 × 1) (7)

[20]

TOTAL: 100

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