higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# MARKING GUIDELINE

## NATIONAL CERTIFICATE

## CHEMICAL PLANT OPERATION N4

**25 November 2022**

**This marking guideline consists of 6 pages.**

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## QUESTION 1

1.1 False
1.2 False
1.3 True
1.4 False
1.5 True

(5 × 1) **[5]**

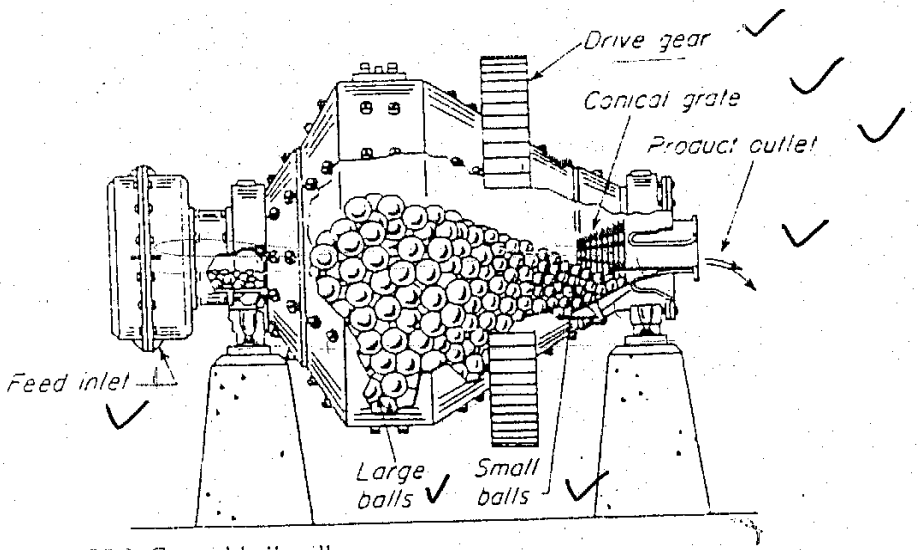
## QUESTION 2

2.1 Crushers
Grinders
Ultrafine grinders
Cutting machines (4)

2.2 The angle of nip is the angle between the roll faces at the level where they will just hold of a particle and draw it into the crushing zone. (2)

2.3 Product that might pass a 40 mesh screen (1)

2.4




(1 mark for correct sketch and 4 marks for correct labelling)

It contains a cylindrical shell slowly turning about a horizontal axis.✓ It is filled to about half its volume with a solid grinding medium that forms a tumbling, causing the grinding or crushing effect.✓ The shell is usually steel, lined with high-carbon steel plate, porcelain silica rock or rubber, depending on the application.✓ The grinding medium can be metal rods or balls, pebbles of porcelain, or wood or rubber balls, depending on the application.✓ For intermediate and fine reduction of abrasive materials, tumbling mills are unequalled.✓ Most of the reduction is done by impact as the balls or pebbles drop from near the top of the shell.✓ The feed enters from the left through a 60° cone into the primary grinding zone, were the diameter of the shell is at its maximum.✓

Product leaves through the 30° cone on the right. A mill of this kind contains balls of different sizes, all of which wear and become smaller as the mill is operated.✓ The largest balls dropping the greatest distance do the initial breaking of the feed particles.✓ Small particles are ground by small balls dropping a much smaller distance. The amount of energy expended is suited to the difficulty of the breaking operation, increasing with the mill.✓

(10 marks for operation) (15)
**[22]**

**QUESTION 3**

DATA:

$L = 25\,000\ cm = 250\ m$

$Q = 560\ \ell / \min = \frac{560}{1\,000 \times 60} = 9{,}333 \times 10^{-3}\ m^3 / s$

$D = 150\ mm = 0{,}15\ m$ ✓

$Z_1 = 20\ m$

$Z_2 = 70\ m$

$\eta = 45\%$

$A = \frac{\pi D^2}{4} = \frac{\pi(0{,}15)^2}{4} = 0{,}0177\ m^2$ ✓✓

$v = \frac{Q}{A} = \frac{9{,}333 \times 10^{-3}}{0{,}0177} = 0{,}527\ {}^{m}\!/_{s}$ ✓✓✓

$\Sigma F = \frac{2fv^2L}{gcD} = \frac{2 \times 0{,}0048 \times 0{,}527^2 \times 250}{1 \times 0{,}15} = 4{,}449\ {}^{J}\!/_{Kg}$ ✓✓✓✓

$W_O = Z_2 g - Z_1 g + \Sigma F$

$= 70 \times 9{,}8 - 20 \times 9{,}8 + 4{,}449$ ✓✓✓✓

$= 494{,}445\ {}^{J}\!/_{Kg}$

$P = \frac{Wo \times Q \times \rho}{\eta} = \frac{494{,}445 \times 9{,}333 \times 10^{-3} \times 990}{0{,}45} = 10152{,}320\ W$ ✓✓✓✓

$1H$ p = 745,7 W

$Horse\ Power\ Input = \frac{10152{,}320}{745{,}7} = 13{,}6Hp$ ✓✓ $A = \frac{\pi D^2}{4} = \frac{\pi(0{,}15)^2}{4} = 0{,}0177\ m^2$ ✓✓

**[20]**

## QUESTION 4

4.1 Sulphonation is the process where sulphur is chemically bonded to hydrocarbons, e.g. to benzene, naphthalene or aromatic amines.✓

- The purpose of this process is to make these hydrocarbons more soluble or to make it more reactive for further synthesis.✓
- The agents employed are various strengths of sulphur trioxide in water.✓
- During this process, isomers are formed, which makes it a costly process unless an application for the isomers can be found.✓
- Oxidation must be avoided.✓ (Any 4 × 1) (4)

4.2

- Natural rubber
- Silicone rubber
- Neoprene rubber
- Fluoroelastomers
- Polyvinyl chloride/thermoplastics (PVC) (5)

4.3

- It has excellent resistance to all acids except for HF
- It is attacked by hot alkaline solutions
- Corrosion resistant (Any 2 × 1) (2)

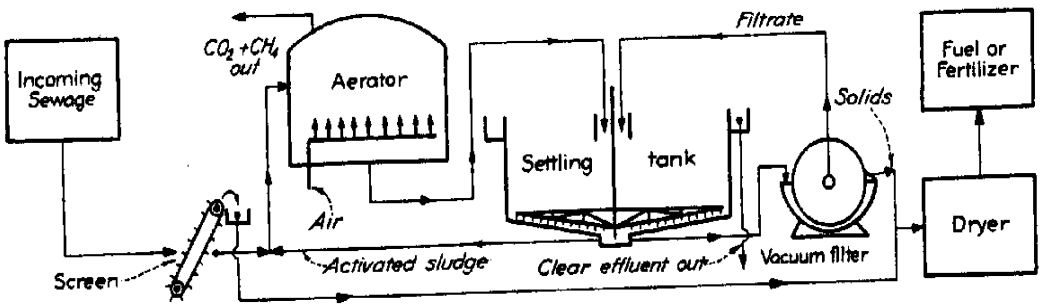
4.4

- Its physical properties are similar to mild steel, except that it has a higher melting point.
- It is ductile and malleable and can be worked into intricate forms.
- It can be welded by a number of techniques.
- The metal is practically inert to many oxidising and reduction acids, except fuming sulphuric acid.
- It is attacked by hot alkalis and hydrofluoric acid (HF).
- Its cost limits use to heating coils, coolers and condensers operating under severe conditions. (Any 4 × 1) (4)

**[15]**

## QUESTION 5

5.1




| Average technical data: | |
|---|---|
| Air required | 2.6 to 14.3 $m^3$ per cubic meter of sewage |
| Detention in aeration tank | 4 to 6 h |
| Detention in settling tank | 1½ to 2 h |
| Sludge return to aerator | 10 to 50 percent of total |

(7 marks for any correct labels)
(1 mark for correct diagram) (8)

5.2
- Analysis of the raw water
- Raw water is heated by exhaust steam
- Mixing and proportioning of the lime and soda ash
- Pumping of the lime soda mixture in the raw water
- Reacting of the lime soda, facilitated by mixing with or without previous heating
- Coagulation by various methods such as slow agitation or contact with seeds
- Settling or removal of the precipitate with or without final filtration (8)

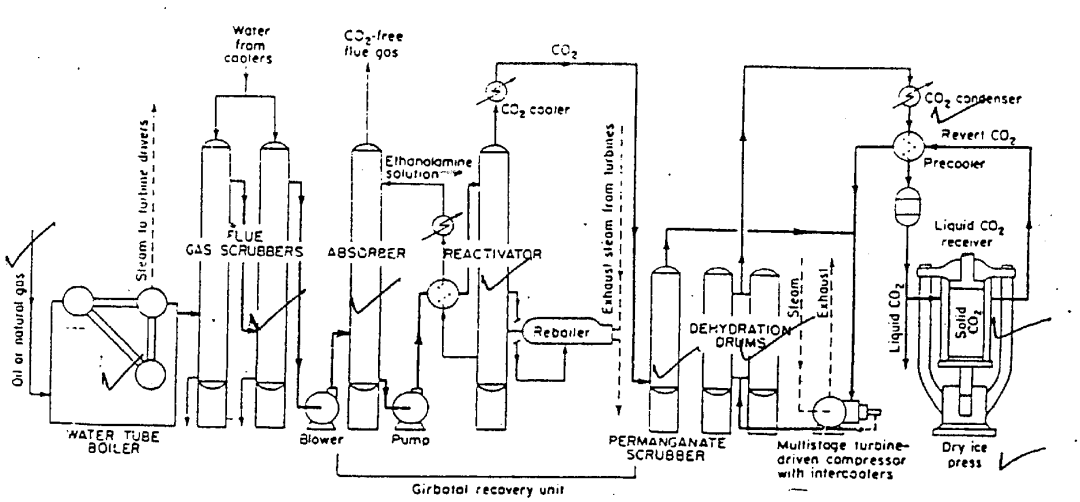
5.3 Refers to precipitation of, e.g., suspended solids and may be very important in combination with cold-water softening. (2)

5.4 Temporary✓ and permanent hardness✓ OR carbonate✓ and non-carbonate hardness✓ (2)
**[20]**

## QUESTION 6

6.1
- Manufacture ammonia
- Tertiary oil recovery
- As a gaseous blanket that excludes oxygen and moisture obtaining extremely low temperatures (-210 °C) in chemical industries. (3)

6.2




(7 marks for correct labelling)
(1 mark for correct sketch) (8)

DESCRIPTION

- Fuel, e.g. oil or natural, is burned.
- The flue gas is cooled, purified and washed by passing through two water scrubbers.
- $CO_2$ is removed by absorption into an aqueous solution of ethanol amine.
- $CO_2$ and steam leave the top of the reactivator, passing through a $CO_2$ cooler to condense the steam, which returns to the tower as reflux.
- $CO_2$ is then purified in a permanganate scrubber, which removes the traces of $H_2S$ and amines, and is then dried.
- The $CO_2$ is then compressed, cooled and liquefied.
- Liquid is drawn off from the $CO_2$ according to demand. (7)

**[18]**

**TOTAL: 100**

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