higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

CHEMICAL PLANT OPERATION N5

1 December 2023

This marking guideline consists of 6 pages.

Copyright reserved

QUESTION 1

1.1 B
1.2 G
1.3 D
1.4 E
1.5 A

(5 × 1) **[5]**

QUESTION 2

2.1 Nozzle-discharge centrifuge
2.2 Nitric acid
2.3 Masticator
2.4 Twin-shell blender
2.5 Atomising oil burner

(5 × 1) **[5]**

QUESTION 3

3.1 3.1.1 The heat of reaction involved in the formation of a compound✓ from its constituent elements✓ when all chemical species are in a stable state at 25 °C and 1 atm✓

3.1.2 The total capacity of a compound✓ is approximately equal✓ to the sum of the heat capacities of the constituent elements.✓

3.1.3 The formula weight of a substance✓ expressed in grams✓ and representing Avogadro's number of particles✓

(3 × 3) (9)

3.2 H-atom: (4,6 × 4) + (2,3 × 6) + (69,7 × 2) = 171,6✓
C-atom: (4,6 × 1) + (2,3 × 2) + (18,6 × 1) + (4,6 × 1) = 32,4✓
O-atom: (18,6 × 1) + (4,6 × 2) = 27,8✓

H-atom balance: 4M + 6E + 2S = 171,6…… (1) ✓
C-atom balance: M + 2E = 32,4 …… (2) ✓
O-atom balance: S = 27,8…… (3) ✓

Substitute (3) in (1):
4M + 6E +2(27,8) = 171,6
4M + 6E + 55,6 = 171,6
4M + 6E = 116✓

3 × (2): 3M + 6E = 97,2
4M + 6E = 116
(4)-(5): M = 18,8✓

Substitute M in (2):
18,8 + 2E = 32,4
2E = 13,6
E = 6,8✓

M = 18,8
E = 6,8
S =27,8

Molar ratio = M:E
= 18,8:6,8✓
= 2,76:1✓ (11)
[20]

QUESTION 4

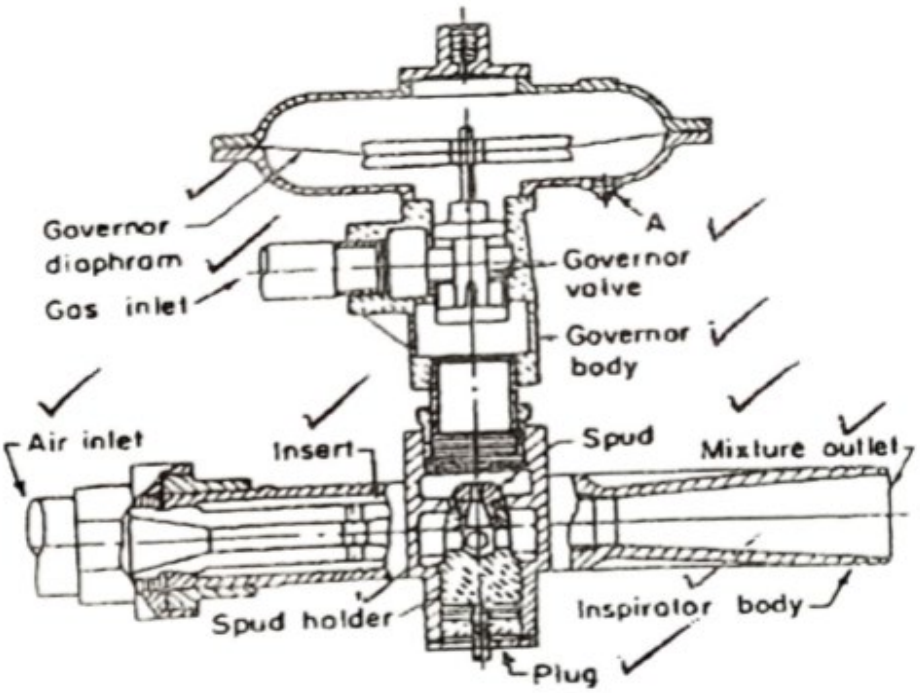
4.1 4.1.1
- The steam flows are parallel to the turbine axis.
- The total pressure in the nozzles drops.
- Steam is directed into the moving blades.
- The steam transfers its velocity to the moving blades.

4.1.2
- Steam flows from the centre outwards or from the outside to the centre.
- The pressure in the nozzles drops.
- The velocity increases due to the pressure drop.
- The velocity decreases as kinetic energy is given to move the blades.

4.1.3
- They mix air and gas at a burner tile.
- Gas can be emitted from the holes drilled in the end of the supply pipe.
- A small-diameter pipe can be inserted at the centre of the burner or large-diameter rings can be extended to the outside of the burner tile.
- These vanes are very small holes and give a better dispersion of the gas in air. Some burners use a spider through which gas is emitted.

(3 × 4) (12)

4.2



(1 mark for each correct label) (11)

4.3
- Time
- Temperature
- Turbulence

(Any 2 × 1) (2)
[25]

QUESTION 5

5.1
- Motor
- Light liquid spout
- Rotary bowl
- Feed
- Heavy liquid spout
- Solids

(Any 5 × 1) (5)

5.2 5.2.1
- The dust-laden air receives a rotating motion upon entrance into the cylinder.
- The vortex so formed develops a centrifugal force, which acts to throw the particles radially towards the wall.
- The path of the air in a cyclone follows a downward vortex or spiral adjacent to the wall and reaches the bottom of the cone.
- Particles leave the cyclone at the bottom.
- The air stream then moves upwards in a tighter spiral, concentric with the first, and leaves through the outlet pipe still whirling. Both spirals rotate in the same direction.

5.2.2
- Mulling is a smearing rubbing action similar to that used in a pestle and mortar.
- In large-scale processing, this action is given by the wide, heavy wheels of the mixer.
- In this design of muller, the pan is stationary, and the central vertical shafts are driven, causing the muller wheels to roll in a circular path over a layer of solids on the pan floor.
- The rubbing action results from the slip of the wheels on the solids.
- Plows guide the solids under the muller wheels or to an opening in the pan floor at the end of the cycle when the mixer is being discharged.

(2 × 5) (10)

5.3
- Disc centrifuge
- Tubular centrifuge

(2)

5.4
- Common sigma blade
- Double-naben/fishtail blade
- Dispersion blade

(3 × 2) (3)

5.5 $CC\ell_4 + 2H_2O \rightarrow CO_2\checkmark + 4HCl\checkmark$ (2)

[25]

QUESTION 6

6.1

6.1.1 $Mg + 2HNO_3 \rightarrow Mg(NO_3)_2$✓ + H_2✓

6.1.2 $Mn + 2HNO_3 \rightarrow Mn(NO_3)_2$ ✓+ H_2✓

6.1.3 $Zn + 2HNO_3 \rightarrow Zn(NO_3)_2$✓ + H_2✓

(3 × 2) (6)

6.2
- Equilibrium is an inverse function of temperature and a direct function of the oxygen to sulphur dioxide ratio.✓
- The rate of reaction is a direct function of temperature.✓
- The gas composition and number of catalysts affect the rate of conversion✓ and the kinetics of the reaction.✓
- The removal of sulphur trioxide formed allows more sulphur dioxide to be converted.✓ (5)

6.3
- Strong dibasic acid
- Oxidising agent
- Powerful protonating agent
- Dehydrating agent (Any 3 × 1) (3)

6.4
- Ammonia
- Air
- Water
- Platinum-rhodium gauze catalyst
- Sodium nitrate
- Concentrated sulphuric acid (Any 4 × 1) (4)

6.5
- Closed-cycle gas turbine
- Open-cycle gas turbine (2)

[20]

TOTAL: 100

Copyright reserved