higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

CHEMICAL PLANT OPERATION N5

24 November 2022

This marking guideline consists of 5 pages.

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QUESTION 1

1.1 B
1.2 G
1.3 D
1.4 E
1.5 A

(5 × 1) **[5]**

QUESTION 2

2.1 2.1.1 The heat of reaction is the difference in energy between the products of the reaction and the reactants. (2)

2.1.2 The heat of reaction equals the sum of the heat of formation of the products minus the sum of the heat of formation of the reactants. (3)

2.1.3 Kinetic energy is created due to the motion (velocity) of an object. (2)

2.2 $\Delta H = nc_P (T_F – 25\ °C) – nc_P(T_I – 25\ °C)$✓
$= 10 \times 31{,}27(1\ 100 – 25)$✓ $– 10 \times 29{,}69(600 – 25)$✓
$= 336\ 152{,}5 – 170\ 717{,}5$✓
$= 165\ 435$ cal✓ (5)

2.3
- Identical casing and moving blades
- Height of the blades
- Area through which the steam flows (3)

[15]

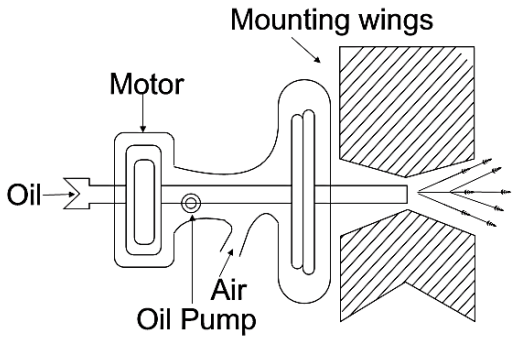
QUESTION 3

3.1 $CC\ell_4 + 2H_2O$✓ $\rightarrow CO_2$✓ $+ 4HC\ell$✓ (3)

3.2 Advantage: The working agent remains free from pollution✓ by the products of combustion✓ and hence the interior of the plant remains clean.✓

Disadvantage: Large and costly heating✓ and cooling surfaces are needed✓ and air has to be pumped into the system to make up for leakage.✓ (3 + 3) (6)

3.3



(4 for correct labels + 1 for the correct drawing) (5)

3.4
- The common stigma blade✓ is used for general-purpose kneading.✓
- The double-naben or fish tale blade✓ is particularly effective with heavy plastic material.✓
- The dispersion blade✓ develops the high shear forces needed to disperse powders and liquid into plastic or rubbery masses.✓ (3 × 2) (6)

[20]

QUESTION 4

4.1
- Weight cylinder
- Floating weight
- Feed hopper door
- Extended neck
- Drilled sides
- Discharge door
- Door support
- Door latch (Any 4 × 1) (4)

4.2 4.2.1 Steam flows from the centre outwards or from the outside towards the centre.✓ Pressure drops during the passage of steam through the nozzles✓ and then remains constant.✓ Velocity increases due to the pressure drop in the nozzles.✓ Velocity decreases as kinetic energy is given to the moving blades.✓ (5)

4.2.2 The shape of the nozzle must be such that the conversion from internal energy to kinetic energy is carried out with the greatest efficiency.✓ Nozzles are either converging or converging-diverging.✓ The minimum section of the nozzles is called the throat.✓ The corresponding pressure at the throat is called critical pressure.✓ If the discharge pressure is greater than the critical pressure,✓ converging nozzles are required.✓ If the discharge pressure is less than the critical pressure,✓ converging-diverging nozzles are required.✓ (8)

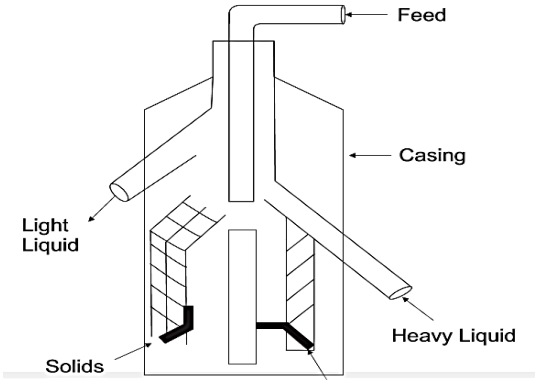
4.3 The nozzle converts the internal energy✓ of high-pressure steam into kinetic energy✓ so that the steam issues from the nozzles with high velocity.✓ (3)

[20]

QUESTION 5

5.1 Mulling is a smearing rubbing action similar to that in a mortar and pestle.✓ In large-scale processing this action is given by the wide, heavy wheel of the mixer.✓ In the particular design of a muller, the pan is stationary✓ and the central vertical shafts are driven causing the muller heels to roll in a circular path over the layer of solids on the pan floor.✓ The rubbing action results from the slips of the heels on the solids.✓ Plows guide the solids under the muller heels✓ or to an opening in the pan floor at the end of the cycle when the mixer is being discharged.✓ (7)

5.2



(1 for correct drawing + 4 for correct labels)

A short, wide bowl turns on a vertical axis.✓ Feed enters from above through a stationary pipe set into the neck of the bowl.✓ Two liquid layers are formed as in a tubular centrifuge that flows over adjustable dams into separate discharge spouts.✓ Inside the bowl and rotating with it are closely spaced disks which are actually cones of sheet metal set one above the other.✓ Heavier liquid is thrown outward, displacing lighter liquid toward the centre of the bowl.✓ (10)

5.3 5.3.1 The diameter for which one half of the inlet particles by mass are separated and the other half retained by air (2)

5.3.2 The efficiency of the cyclone (1)

[20]

QUESTION 6

6.1
- Manufacture of sulphate
- Manufacture of fertiliser
- Manufacture of tin blades
- Manufacture of leather
- Refining of petroleum
- Dying fabric
- Synthetic detergents
- Explosives
- Drugs (Any relevant 4 × 1) (4)

6.2 $S + O_2 \rightarrow SO_2$✓✓

$SO_2 + ½O_2 \leftrightarrow SO_3$✓✓

$SO_3 + H_2O \rightarrow H_2SO_3$✓✓ (3 × 2) (6)

6.3
- Anhydrous ammonia is evaporated continuously✓ and uniformly in an evaporator using swing to supply the necessary heat of evaporation.✓
- Air from a reaction is compressed in a steam-driven compressor✓ and passed through heat exchangers and filters.✓
- Ammonia gas is oxidised with air to NO.✓
- The NO with excess air necessary for the oxidising is then cooled.✓
- Oxidation✓ and hydration of the NO are carried out.✓
- The acid HNO_3 is drawn off.✓

(1 mark if the student got all points correct.)

OR

- Anhydrous NH_3 is evaporated.
- Air for the reaction is compressed and passed through a heat exchanger and air filters.
- NH_3 gas is oxidised to NO by air.
- NO with excess air is cooled and conducted to the bottom of the absorption tower.
- Successive oxidations and hydrations of NO are carried out to form HNO_3.
- The acid is drawn off through an acid trap.
- Waste gas is released. (10)

[20]

TOTAL: 100

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