higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

PLANT OPERATION THEORY N3

2 AUGUST 2019

This marking guideline consists of 5 pages.

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QUESTION 1: CHEMISTRY AND CHEMICAL PROCESSES

1.1
- The type of coal that is being used
- Products that are required
- Specific temperature of carbonisation
- Physical condition of the coal, e.g. size (4)

1.2 $NO_{(g)}$ + $O_{2(g)}$✓= $NO_{2(g)}$✓---------- intermediary medium

Catalysis Reagent

$$NO_{2(g)}\checkmark + CO_{(g)}\checkmark = CO_{2(g)} + NO_{(g)}\checkmark$$

↑ Reagent ↑ Product ↑ Catalyst (5)

1.3 1.3.1
- Polyethylene bags
- Film wrap
- Sweet wrappers
- Plastic bags
- Containers
- bottles (Any applicable 2 × 1) (2)

1.3.2
- Safety glasses
- Boats
- Bathroom applications
- Furniture applications (Any applicable 1 × 1) (1)

1.3.3
- Piping
- Tubing
- Cables
- Electronic applications (Any applicable 1 × 1) (1)

1.4 $2KCLO_{3\,(s)}\checkmark + MnO_{2(s)}\checkmark \longrightarrow MnO_2\checkmark + 2KCL\checkmark + 3O_2\checkmark$ (5)

1.5
- Promote a chain reaction of atoms within the reacting molecules.
- Re-arrangement of atoms in all the reacting molecules without loss of atoms (monomer and polymer).
- A ring bond of atoms split and bonds with another ring bond (molecule) with the aid of a catalyst.
- Polycondensation is where the molecules condense to form small molecules✓ like water, ammonia, hydrogen chloride and others.✓ (5)

1.6 Heterogeneous catalysis is when the reactants and the catalysts are in different phases✓✓ e.g. the reactants may be gaseous and the catalyst solid. (2)

[25]

QUESTION 2: COMBUSTION, FUELS AND THERMAL INSULATION

2.1 2.1.1 It has a natural resistance to dampness/vapour.
(Any applicable 1 × 1) (1)

2.1.2 Cork (Any applicable 1 × 1) (1)

2.1.3
- It consists of separate air-filled pieces of material.
- It and can be loose or in prepared sheets.
- The cells that are normally formed by this material have hollows that are filled with air or gas. (Any applicable 3 × 1) (3)

2.2
- The combustion process cannot be easily controlled.
- They form large amounts of ash and its disposal is a big problem.
- A large space is required for storage (Any applicable 2 × 1) (2)

2.3
- Cleanliness
- Easy to control
- The calorific value is comparatively lower.
- Less handling of equipment and thus less labour required
- Affordable
- Better for environment
- More dependable
- A domestic source of energy (Any applicable 4 × 1) (4)

2.4
- Enough air (oxygen)
- Thorough mixing of air and fuel
- Furnace temperature above ignition temperature of the fuel
- Enough time (4 × 1) (4)

[15]

QUESTION 3: STEAM BOILERS AND STEAM TRAPS

3.1 3.1.1
- It is the measure of the heat content✓ of a substance and is determined by both the temperature and pressure of the substance.✓

OR

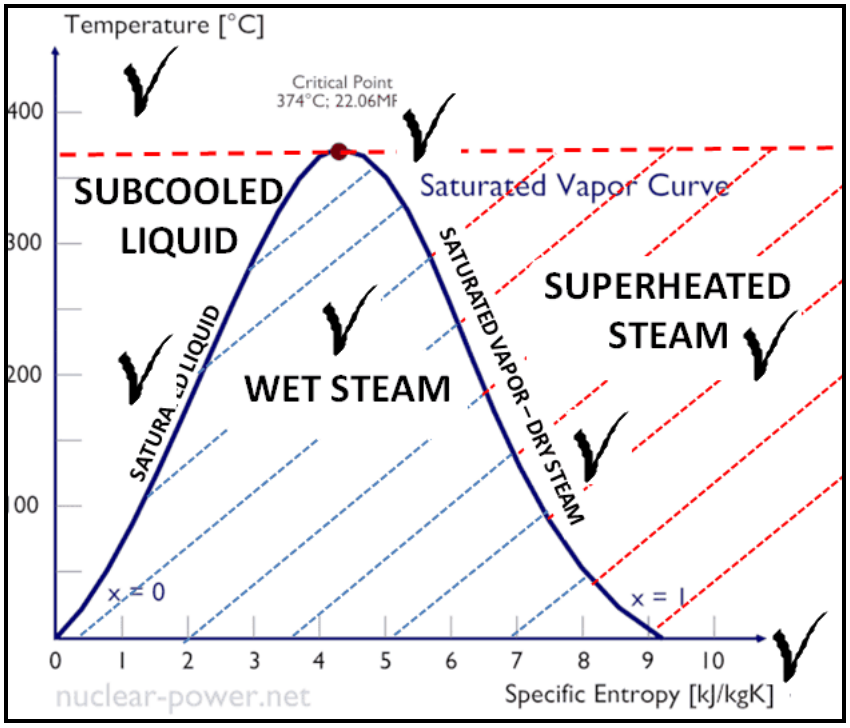
- The total amount of heat✓ in one kg of a substance calculated from accepted temperature base✓ (2)

3.1.2 After the flue-gas left the super-heated tubes, it still contains energy. This energy is utilised to heat feed-water by means of the economiser. This is conducted to the feed-water, causing the water temperature to rise. (2 × 1) (2)

3.2 $h_{Su} = hf + (x\ hfg) + [C_s\ (t_{Su} – ts)]$
Energy to be added = $(x\ hfg) + [C_s\ (t_{Su} – ts)]$
Energy to be added = $[(1-0,7)] \times 1802\ ] + [\ 6,8 \times (250 - 232)]$ ✓✓

= 540,6 + 122,4✓
= 663 KJ/Kg✓
Steam rate = 3 tons/h
∴ Amount of energy required = $3 \times 663 \div 10^3$ GJ/h✓
= 1,989 GJ /h✓ (6)

3.3



(7)

3.4
- Mechanical traps
- Thermostatic stream traps
- Thermodynamic stream traps

(3 × 1) (3)
[20]

QUESTION 4: HEAT TRANSFER

4.1
- Spray ponds
- Cooling towers
- Fractionation and distillation columns
- Steam strippers
- Absorbers (5 × 1) (5)

4.2
- Impure Material:✓ This media is sent through the tube side not to accumulate (tube replacing is easier than to cap).✓
- High Pressure Medium:✓ It is sent through the tubes because they can resist higher pressure than the shell side.✓
- Water:✓ Water is a scale former and flow velocity reduces scale forming, thus water is normally sent through the tubes.✓
- Pressure Loss:✓ When pressure losses are not a matter of importance the medium is sent through the tubes, because high-pressure losses result through the tubes.✓
- Smaller Volume:✓ The smaller volume medium goes through the tubes as the shell side can handle larger volumes.✓
- Non-condensable gasses:✓ E.g. air is usually sent through the tubes because the gases in the shell side can accumulate in stagnant areas and thus lower the efficiency of the exchanger.✓ (Any 6 × 2) (12)

4.3
- Convection
- Radiation
- Conduction (3 × 1) (3)

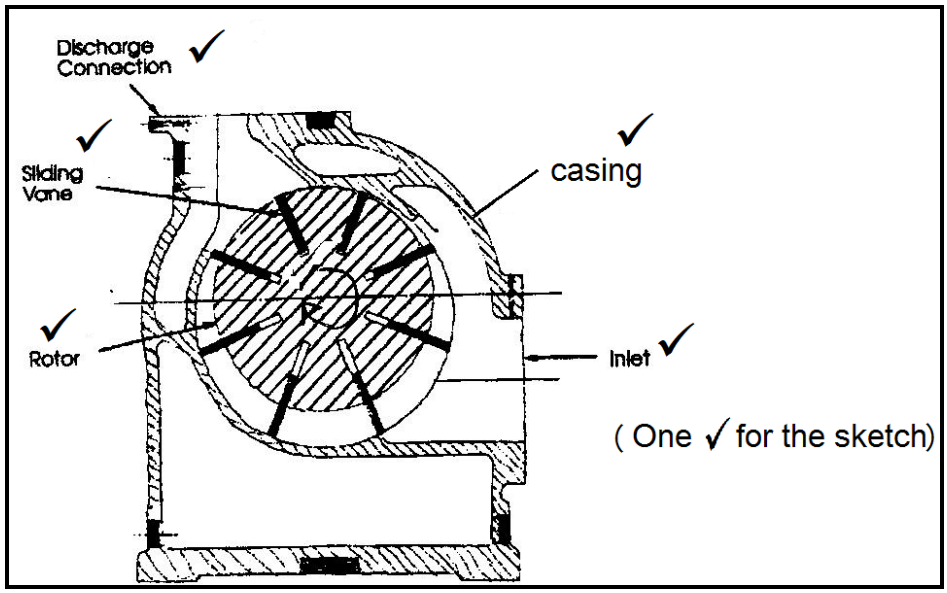
[20]

QUESTION 5: COMPRESSION, COOLING, PUMPS AND INSTRUMENTATION

5.1
5.1.1 False
5.1.2 False
5.1.3 False
5.1.4 True
5.1.5 False

(5 × 1) (5)

5.2



(6)

5.3 These pumps run silently at high speeds and force the liquid through the gears.✓ They build up high pressures but cannot handle large volumes and are used to displace liquids with a high viscosity like oil.✓

As a result of the small volume they handle, they are unable to build up a high suction side✓ and thus must be placed in a position at the inlet side where they are submerged in the liquid.✓ (4)

5.4
- Piston or plunger pumps
- Diaphragm pumps
- Rotary pumps (3 × 1) (3)

5.5
- Absolute pressure is gauge pressure plus atmospheric pressure at sea level.
- It is 101,32 KPa at sea level. (2 × 1) (2)

[20]

TOTAL: 100

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