



1st QUESTION PAPER

EXTERNAL INTEGRATED SUMMATIVE ASSESSMENT (EISA)

OCCUPATIONAL CERTIFICATE: INDUSTRIAL WATER PROCESS CONTROLLER

SAQA ID: 102578

NQF LEVEL: 5

CREDITS: 251

LEARNER DETAILS

Surname:														
Name:														
ID Number:														
Centre Name:														
Date:						Mark Allocation:	100 Marks							
Time:	09H00 to 12H00					Duration:	3 Hours							

INSTRUCTIONS TO CANDIDATES

Please read the questions carefully and then answer all the questions on the provided answer sheets.

PLEASE ENSURE THAT YOU ADHERE TO THE FOLLOWING INSTRUCTIONS:

- Cell phones are not allowed.
- Please use a black pen. No script will be marked if written in Pencil.
- Complete all your personal details in the space provided above.
- This is a closed book assessment; no reference material will be allowed, unless otherwise indicated.
- Carefully read through all the case exercises and questions and answer all questions
- Read the instructions for each question before answering.
- Structure all written answers logically.
- Use the mark allocation for each written question to guide the length of your answer.
- If additional paper is used, ensure that you write your Personal Details on each page and clearly mark which question you are answering.
- The invigilators will supply you with a stapler to attach the additional pages to the ANSWER SHEET.

SECTION A:

Analyse, interpret and apply legislation, regulations, and standards applicable to industrial water treatment.

Time: 54 Min

Maximum Marks – 30

QUESTION 1: MULTIPLE CHOICE QUESTIONS (2 MARKS)

Choose the correct answer from the choices provided. Write the letter only.

1.1 What can you do to prevent forming of LEGIONELLA in industrial water systems (1)

- A. Maintain proper disinfectant amounts
- B. Maintain proper water temperatures
- C. Prevent stagnation
- D. All of the above**
- E. None of the above

1.2 Which type of waste is NOT restricted or prohibited in terms of disposal? (1)

- A. Waste with a pH <6 or >12
- B. Liquid waste with a moisture content of <40% and which has been stabilized by treatment**
- C. Brine or waste with a salt content > 100 000 mg/l
- D. Waste with a Calorific Value of >6% TOC

Sub-Total Marks: (2)

QUESTION 2: CONSTRUCTED RESPONSE QUESTIONS (10 MARKS)

2. 1 What is the definition of industrial effluent? (2)

Answer:

"industrial effluent" means any liquid whether or not containing matter in solution or suspension (1), which is given off in the course of or as a result of any industrial trade, manufacturing, mining or chemical process or any laboratory, research, service, or agricultural activity (1), and includes matter discharged from a waste grinder

2. 2 Which limitations exist on the disposal of industrial effluent into a municipal sewer? Under which conditions would a reapplication for industrial effluent discharge be required? (2)

Answer:

When there is an increase or vary the quantity (1), nature, content or composition (Quality = 1) of any industrial effluent discharged into the sewer

2. 3 What are the objectives of Hazardous Waste handling before transportation (2) during transportation (2) and after (2) transportation? (6)

Answer:

1. To ensure the correct packaging, temporary storage and collection of waste prior to transportation, so as to prevent accidental spillage into the environment and minimise the impact should a spillage occur, (2)
2. To ensure that the hazardous waste is never "lost": This is achieved by use of a system of documentation or a manifest system; (1)
3. To ensure that emergency procedures are in place before an accident occurs, and that the hazardous waste is correctly marked so as to aid the emergency team. It should be noted that all aspects of handling explosive material, flammable material and radioactive material are covered by specific legislation, (2)
4. To ensure that the waste arrives safely at a permitted facility with appropriate documentation; (1)

Sub-Total Marks: (10)

QUESTION 3: EXTENDED CONSTRUCTED RESPONSE QUESTIONS (18 MARKS)

3.1. Describe what is meant by the Zero Liquid Effluent Discharge (ZLED) Philosophy, how it can be achieved, why it is necessary, and mention its two main objectives (6)

Answer

The ZLED philosophy refers to an integrated approach to water management by which a provision must be made to contain water originating from its operations (1)

It can be achieved through identifying the uses for different types of water and to try and integrate these into the system (1)

It is necessitated by legislation which requires that no effluents are to leave a Water Services Works unless quality conforms to strict specifications (1) and/or there are permits to discharge effluent (1)

Its objectives are prevention of environmental pollution (1) and conservation of water (1)

3.2. Calculate % compliance of the following results with the provided limits. Also indicate average, maximum and minimum values (12)

Determinant	Limit	Month 1	Month 2	Month 3	Average	Max	Min	% Compliance
pH	5.5 – 9.5	7.9	8.2	7.9				
TDS (mg/l)	450	467	563	538				
Sodium (mg/l)	90	87	93	105				

Answer:

Determinant	Limit	Month 1	Month 2	Month 3	Average	Max	Min	% Compliance
pH	5.5 – 9.5	7.9	8.2	7.9	8.0	8.2	7.9	100%
TDS (mg/l)	450	467	563	538	522.67	563	467	0%
Sodium (mg/l)	90	87	93	105	95	105	87	33%

External Integrated Summative Assessment (EISA)

1st Written Assessment Exemplar MEMO: OC: Industrial Water Process Controller

Sub-Total Marks: (18)

SECTION B:

Apply Safety and Emergency Protocols on an Industrial Water Treatment Plant.

Time: 18 Min

Maximum Marks – 10

QUESTION 1: MULTIPLE CHOICE QUESTIONS (2 MARKS)

Choose the correct answer from the choices provided. Write the letter only.

1. Which one of the following type of emergencies is not part of the emergency plan? (1)

- A. Fire & Explosion
- B. Bomb threats & armed confrontations
- C. Speeding on site**
- D. Medical emergency & Rescues
- E. Hazardous chemicals and natural disasters

2. Why is a lockout necessary? Select the incorrect answer (1)

If a lockout is not performed uncontrolled energy could cause

- A. Electrocution
- B. Cuts, bruises or crushing from entrapment with belts, chains, conveyors, rollers, shafts, impellers, etc.
- C. Flooding of an area**
- D. Fires & explosions
- E. Chemical exposure (gases or liquids released from pipelines)

Sub-total Marks: (2)

QUESTION 2: CONSTRUCTED RESPONSE QUESTIONS (3 MARKS)

2. 1 Name the three risk assessment categories that should be considered when conducting a risk assessment at an industrial water treatment plant (3)

Answer:

- Business Risk
- Operational Risk
- Financial Risk

Sub-total Marks: (3)

QUESTION 3: EXTENDED CONSTRUCTED RESPONSE QUESTIONS (5 MARKS)

- 3.1. Elaborate on aspects that need to be considered to ensure a pump is safely operated (5)

Answer:

- Pump only liquids designed for operation of pump. Do not pump flammable or corrosive liquids if the pump and piping are not designed for such.
- Note the direction of rotation - operating pump in the wrong direction can cause impeller to unscrew and damage the volute casing.
- When lifting pumps, use only lifting equipment in good repair and with adequate capacity.
- Never operate a self-priming pump unless the pump is filled with liquid
- Operating a pump with suction and discharge closed can cause of severe overheating. Overheated pumps can cause severe burns and injury. If overheating of pump casing occurs, stop pump immediately, allow to cool completely; slowly and cautiously vent pump; Refer to instruction manual before restart

Sub-total Marks: (5)

SECTION C:

Optimise, control and supervise all industrial water treatment processes.

Time: **90 Min**

Maximum Marks – **50**

QUESTION 1: MULTIPLE CHOICE QUESTIONS (8 MARKS)

Choose the correct answer from the choices provided. Write the letter only.

1.1 What laboratory intervention is used to optimize the Clarifier? (1)

- A. COD
- B. Ion exchange
- C. Jar Test**
- D. Titration
- E. OA

1.2 What is the Formula for Mass Flow? (1)

- A. $Q = VA$
- B. $Q = V/t$**
- C. $Q = Vt^2$
- D. $t = Q/V$
- E. $V = Q/t$

1.3 Which of the following two (2) chemicals are used during the coagulation process? (1)

- A. Aluminum Phosphate and Aluminum Sulphate
- B. Aluminum Chloride and Aluminum Sulphate**
- C. Calcium Chloride and Sodium Chloride
- D. Aluminum Sulphate and Calcium Chloride
- E. Sodium Chloride and Aluminum Sulphate

1.4 What is the unbiased measurement of water balance, as defined by CaCO₃ saturation? (1)

- A. RSI / CC
- B. PSI / PP
- C. **LSI / CCPP**
- D. TSI / PCV
- E. TDI / WV

1.5 What formation of unwanted material is deposited on heat transfer surfaces? (1)

- A. **Fouling & Scaling**
- B. Erosion
- C. Corrosion
- D. Dezincification
- E. Pitting

1.6 What is the purpose of the conductivity online analysers? (1)

- A. To determine the flow properties of water
- B. To monitor the quality of the water treatment process
- C. **To measure salinity of the water**
- D. Only B and C are correct
- E. A, B and C are correct

1.7 Why are chemicals added to Cooling Water? (1)

- A to increase Cooling Tower longevity
- B to prevent fouling and corrosion
- C to prevent legionella formation over time
- D A and B are correct
- E **A, B and C are correct**

1.8 Which are not advantages of having control instrumentation? (1)

- A. Give a continuous read-out on the operation processes and allow for automatic control of them
- B. Improve the maintenance of the equipment and hence its availability
- C. Provide for automatic shutdown if there is a mechanical failure or other untoward events
- D. Simplify preventative maintenance programmes
- E. **None of the above**

Sub-Total Marks: (8)

QUESTION 2: CONSTRUCTED RESPONSE QUESTIONS (10 MARKS)

2. 1 List two types of level measuring mechanisms (2)

Answer:

- Ultrasonic (1)
- Floats (1)
- Pressure (1)

2. 2 What are the main goals of process optimisation? (3)

Answer

1. Achieve the chemical cost performance
2. Manage and control energy consumption
3. Reduce water losses / wastes

2. 3 Define ion exchange (3)

Answer

Ion exchange is a reversible chemical reaction (1) whereby dissolved ions are removed from a solution and replaced by other ions of the same or similar electrical charge (1) by means of an ion exchange medium (resin) (1)

2. 4 Define “Feedback Control” as it relates to process automation (2)

Answer

Altering the process itself affects the parameter that is being measured and used to control the system. (1) Over-correction can therefore lead to oscillations on either side of the set point before equilibrium is reached (1)

Sub-Total Marks: (10)

QUESTION 3: EXTENDED CONSTRUCTED RESPONSE QUESTIONS (32 MARKS)

3.1 Briefly discuss Coagulation.

(5)

Answer

- Coagulation is the chemical process for removing particles in suspended or colloidal form (1)
- These particles do not settle on standing and cannot be removed by conventional physical treatment processes / Suspended solids and colloids resist agglomeration because of the similar electrical charge (usually negative) on their surfaces that creates a mutually repellent force (1)
- The charge repellent behaviors is depicted and explained by the concept of Zeta Potential (1)
- High-valence cation coagulants neutralize the negative charges thereby allowing the particles to come together or coagulate (1)
- Large floc can then precipitate and is removed via sedimentation or filtration (1)

3.2 What is the purpose of Jar Testing?

(3)

Answer

Jar testing is primarily used to determine the optimal chemical dosages (1) and treatment methods for specific water or wastewater streams. It allows operators to simulate (1) and assess the performance of different coagulants and flocculants (1) in a controlled environment before applying them on a larger scale in treatment plants.

3.3 How is exhausted resin regenerated?

(2)

Answer

- Cation: through acid injection
- Anion: through an alkaline treatment

3.4 How can Upflow Velocity be used to evaluate and troubleshoot the hydraulic loading of a settling tank? What is the formula for this calculation? (3)

Answer:

- The water in a settling tank flows upward through the clarifier as the solids settle to the bottom. (1)
- If the upflow velocity is too high, sludge settling will be hindered (1)
- This rate is calculated by dividing the flow (m^3/h) by the surface area (m^2)

3.5 Explain the backwashing process and factors that affect backwash efficiency (3)

Answer:

The backwash process typically involves reversing the flow of water through the filter (1), using a valve or other mechanism to change the direction of flow. The reversed flow of water dislodges and removes accumulated debris, dirt, and contaminants from the filter, restoring its effectiveness. (1)
It can be assisted by an air-scour (washing with a blower) (1)

3.6 Calculate the dosing rate (in ml/min) for flocculant dosing where the product needs to be dosed at 5 mg/l and is supplied as a 10% solution with a SG of 1.25. The flow through the plant is 375 m³/h (4)

Answer:

$5 \text{ mg/l} \times 375 \text{ m}^3/\text{h} = 1.875 \text{ kg/h}$
 $@10\% = 18.75 \text{ kg/h}$
 $@ \text{SG of } 1.25 = 15 \text{ l/h}$
 $= 250 \text{ ml/min}$

3.7 Calculate the dosing in mg/l for a plant where chlorine gas is dosed at a rate of 15.75 kg/d (24 hours) and the flow through the plant is 375 m³/h (4)

Answer

$15.75 \text{ kg/d} = 0.65625 \text{ kg/h}$
 $375 \text{ m}^3/\text{h} = 0.375 \text{ MI/h}$
 $0.65625 \text{ kg/h} / 0.375 \text{ MI/h} = 1.75 \text{ kg/MI}$
 $1.75 \text{ kg/MI} = 1.75 \text{ mg/l}$

3.8 What is the difference between Ultrafiltration and Reverse Osmoses (2)

Answer

In the case of ultrafiltration, distinct pores in the polymer allow for water to flow through the barrier but reject the passage of species larger than the pores.

Reverse osmosis barrier layers do not have distinct pores but do allow water to diffuse through the barrier layer and reject most of the dissolved ions in the mixture

3.9 Name any two performance trends that indicate the need for a CIP be performed on an RO system? (2)

Answer

- 10–15% drop in normalized permeate flow
- 15% increase in differential pressure (ΔP)
- 10% increase in salt passage (rejection drop)

3.10 What are four measures to be taken to reduce the cost of chemical consumption during plant optimization? (4)

Answer

- On-line and laboratory instruments verification (including weekly split-sampling)
- Data handling and reporting
- Following manufacturer's instructions related to instrument calibration
- Verification after changing reagents or doses or after doing any other maintenance on the instrument

Sub-Total Marks: (32)

SECTION D:

Use applicable control systems and on-line analysers to control the Industrial Water Treatment Plant.

Time: 18 Min

Maximum Marks – 10

QUESTION 1: MULTIPLE CHOICE QUESTIONS (2 MARKS)

Choose the correct answer from the choices provided. Write the letter only.

1.1 What online platforms are used to control an Industrial Water Treatment Plant? (1)

- A. HMI
- B. GSM
- C. PCL, SCD, Telemetry System
- D. PLC, SCADA, DCS, Telemetry System**
- E. Radio Control, Windows, HMI

1.2 What is the Formula for Mass Flow? (1)

- A. $Q = VA$
- B. $Q = V/t$**
- C. $Q = Vt^2$
- D. $t = Q/V$
- E. $V = Q/t$

Sub-Total Marks: (2)

QUESTION 2: CONSTRUCTED RESPONSE QUESTIONS (3 MARKS)

2.1 Define the term Calibration

(3)

Answer

Calibration is a procedure for establishing a relationship between a quantitative measurement (1) and a known reference (1) to determine if the instrument's readings are accurate (1)

Sub-Total Marks (3)

QUESTION 3: EXTENDED CONSTRUCTED RESPONSE QUESTIONS (5 MARKS)

1.1. How can the validity of measurements be determined?

(5)

Answer

- Regular use of reference materials or quality control;
- Regular use of alternative instrumentation that has been calibrated to provide traceable results;
- Functional checks of measuring and testing equipment;
- Use of check or working standards with control charts, where applicable;
- Periodic intermediate checks on measuring equipment;
- Replicate tests or calibrations using the same or different methods, with the use of standard deviation charts or range charts where applicable;
- Retesting or recalibration of retained items (e.g., customer items that are not immediately returned);
- Correlation of results for different characteristics of an item;
- Review of reported data by competent laboratory personnel;
- Intralaboratory comparisons;
- Blind tests.

GRAND TOTAL MARKS: 100