NIMASA OOW (Engine) PAST QUESTIONS AND ANSWERS ON BOILERS

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Prepared by Engr Matahula, Smart Pwashemeno

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QUESTION

a) Briefly describe why boiler water needs to be tested periodically and state two of the test

b) Before lighting up auxiliary oil fired boiler state the precaution to be taken

c) State briefly how scale and sludge are produced in a steam boiler

ANSWER

a) Boiler water needs to be tested periodically to ensure its quality and to maintain the efficient and safe operation of the boiler system. Two important tests for boiler water are:

1. Boiler Water pH Test: pH is a measure of the acidity or alkalinity of water. The pH of boiler water needs to be within a specific range to prevent corrosion of the boiler and its components. Regular testing helps identify any deviations from the desired pH range and allows for appropriate corrective measures to be taken.
2. Boiler Water Conductivity Test: Conductivity is a measure of the ability of water to conduct an electric current. High conductivity in boiler water indicates the presence of dissolved salts and impurities, which can lead to scale formation and reduced heat transfer efficiency. Conductivity testing helps monitor the level of dissolved solids and determines the need for water treatment, such as blowdown or chemical dosing.

b) Before lighting up an auxiliary oil-fired boiler, the following precautions should be taken:

1. Ensure Proper Ventilation: Before ignition, ensure that there is sufficient ventilation in the boiler room to prevent the accumulation of flammable gases and to provide a fresh air supply for combustion.
2. Check Fuel Supply: Verify that an adequate and clean supply of fuel oil is available for the boiler. Ensure that the fuel oil storage tanks are properly filled and that the fuel oil being used is compatible with the boiler specifications.

c) Scale and sludge are produced in a steam boiler due to the following reasons:

1. Scale Formation: When water is heated in a boiler, dissolved minerals, such as calcium and magnesium, can precipitate and form a hard, scale-like deposit on the boiler's internal surfaces. Scale acts as an insulator, reducing heat transfer efficiency and potentially leading to overheating of the metal surfaces. Factors such as high water hardness, inadequate water treatment, and improper blowdown practices can contribute to scale formation.
2. Sludge Accumulation: Sludge refers to solid particles and impurities that settle at the bottom of the boiler water. It consists of various substances like rust, debris, and organic matter. Sludge formation occurs due to inadequate water treatment, poor blowdown practices, and the presence of suspended solids in the feedwater. Sludge can impair boiler performance, hinder heat transfer, and promote corrosion if not properly removed through regular blowdown and cleaning procedures.

QUESTION

a) Why is oil in boiler water considered dangerous, where does it usually come from and how can it be removed

b) With the aid of a simple sketch, explain how a water gauge fitted directly to a boiler is tested for accuracy when the boiler is steaming

ANSWER

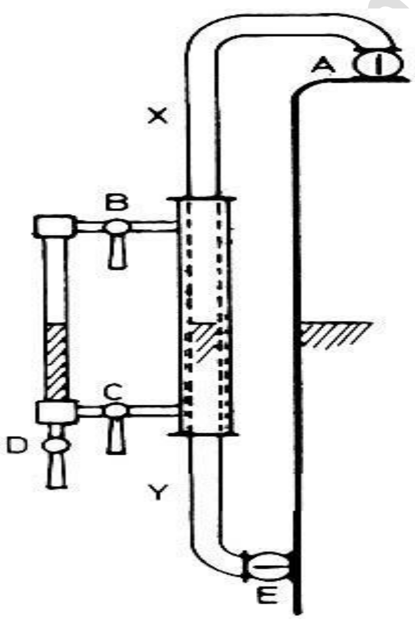
a) Oil in boiler water is considered dangerous because it can lead to various operational and safety issues. It usually comes from leaks or improper combustion of fuel oil in the boiler system. Oil contamination can have the following negative impacts:

1. Reduced Heat Transfer Efficiency: Oil forms a layer on the water's surface, acting as an insulator and reducing the efficiency of heat transfer from the combustion gases to the water. This can lead to decreased boiler efficiency and increased fuel consumption.
2. Corrosion: Oil can contribute to corrosion of the boiler and its components, especially when mixed with oxygen and water. Corrosion can weaken the boiler structure, leading to leaks, failures, and potential safety hazards.
3. Foaming and Carryover: Oil contamination can cause foaming in the boiler water, resulting in carryover of water droplets containing oil into the steam. This can contaminate downstream equipment and processes.

To remove oil from boiler water, various methods can be employed:

1. Skimming: A surface skimmer or oil separator can be used to remove the oil layer from the water surface. The oil is skimmed off and collected separately.
2. Coalescing Filters: Coalescing filters are designed to capture and separate oil droplets from water. These filters use specialized media to attract and trap the oil, allowing clean water to pass through.
3. Chemical Treatment: Chemical additives can be used to enhance the separation of oil from water. These chemicals help break down the oil emulsions and promote the formation of larger oil droplets, which can then be removed through mechanical means.

b) To test the accuracy of a water gauge fitted directly to a steaming boiler, the following steps can be followed:



- Cocks A, C and D open, Cocks B and E closed, this checks that A, pipe X and the column are clear
- Then with cocks E, B and D open, cocks A and C closed, checks that E and Pipe Y are clear

Next blow the water gauge glass with A and E open

- Close steam B and water cocks C the open drain D. Nothing should then blow out of the gauge if the steam and water cocks are not leaking
- Open and close water cock C to check that the water cock connection to the boiler i s clear
- Open and clock steam cock B to check that the steam cock connection to the boiler is clear
- Close the drain D
- Open the water cock C. water should then gradually rise up to the top of the gauge glass
- Open the steam cock and the water in the glass should fall to the level of the water in the boiler.

NOTE: Testing the accuracy of a water gauge should be performed by qualified personnel who are familiar with the specific boiler system and safety protocols.

QUESTION

Enumerate the cause of corrosion in boilers and state the precautions you would take to prevent corrosion

a) When boiler is steaming

b) When boiler is going to idle

ANSWER

Corrosion in boilers can occur due to various factors. Here are some common causes of corrosion in boilers:

1. Oxygen Corrosion: Dissolved oxygen in boiler water can cause oxygen corrosion, leading to the formation of rust and pitting on metal surfaces.
2. Acidic Corrosion: Acidic conditions in the boiler, often caused by improper water treatment or excessive acidic chemicals, can result in corrosion of metal components.
3. Galvanic Corrosion: Galvanic corrosion occurs when two dissimilar metals are in contact in the presence of an electrolyte (such as boiler water). This can accelerate the corrosion of the less noble metal.

4. Low pH Corrosion: Low pH levels in boiler water can lead to acidic corrosion and damage to metal surfaces.
5. High Temperature Corrosion: Elevated temperatures in the boiler can contribute to corrosion, especially in the presence of impurities or aggressive chemicals.

To prevent corrosion in boilers, the following precautions can be taken:

a) When the boiler is steaming:

1. Proper Water Treatment: Implement a comprehensive water treatment program to control water quality, including the use of corrosion inhibitors, pH control, and oxygen scavengers. This helps reduce the corrosive potential of the boiler water.
2. Oxygen Control: Minimize the presence of dissolved oxygen in the boiler water through proper deaeration and the use of oxygen scavengers. This reduces the likelihood of oxygen corrosion.
3. Regular Monitoring: Continuously monitor and maintain appropriate levels of pH, dissolved oxygen, and other relevant parameters to ensure water conditions are within the desired range.
4. Adequate Blowdown: Perform regular and proper blowdown to remove impurities, dissolved solids, and sludge from the boiler water, which can contribute to corrosion if allowed to accumulate.

b) When the boiler is going to idle:

1. Proper Shutdown Procedure: Follow the manufacturer's recommended shutdown procedure to ensure that the boiler is properly drained, cleaned, and protected during idle periods.
2. Dry Storage: If the boiler is going to be idle for an extended period, consider drying out the internal surfaces and applying appropriate protective coatings or desiccants to prevent moisture buildup and corrosion.
3. Regular Inspection: Conduct regular inspections of the boiler during idle periods to identify any signs of corrosion or deterioration. Take necessary corrective actions promptly.
4. Maintenance and Preservation: Perform scheduled maintenance activities, such as cleaning, lubrication, and inspection of boiler components, to prevent corrosion and ensure the boiler is in good condition when brought back into service.

It's important to consult with qualified professionals and follow industry standards and guidelines for boiler operation and maintenance to effectively prevent corrosion and ensure the safe and efficient operation of the boiler system.

QUESTION

a) Why is oil in boiler water considered dangerous, where does it usually come from and how can it be removed

b) What additional danger is involved if the oil is vegetable oil

c) What steps would you take in preparing boiler to be kept out of use for a prolonged period of time?

ANSWER

a) Oil in boiler water is considered dangerous due to several reasons:

- Decreased Heat Transfer Efficiency: Oil forms a layer on the water's surface, acting as an insulator and reducing the efficiency of heat transfer. This can lead to reduced boiler efficiency and increased fuel consumption.
- Corrosion and Fouling: Oil contamination can contribute to corrosion of boiler components and promote the buildup of deposits and fouling. This can impair heat transfer, reduce boiler lifespan, and increase maintenance requirements.
- Safety Hazards: Oil in boiler water can cause foaming and carryover, leading to potential damage to downstream equipment, operational issues, and safety hazards.

Oil in boiler water usually comes from leaks or improper combustion of fuel oil in the boiler system. It can be removed through the following methods:

- Skimming: A surface skimmer or oil separator can be used to remove the oil layer from the water surface. The oil is skimmed off and collected separately.
- Coalescing Filters: Coalescing filters are designed to capture and separate oil droplets from water. These filters use specialized media to attract and trap the oil, allowing clean water to pass through.
- Chemical Treatment: Chemical additives can be employed to enhance the separation of oil from water. These chemicals help break down oil emulsions and promote the formation of larger oil droplets, which can then be removed through mechanical means.

b) If the oil in the boiler water is vegetable oil, an additional danger is the potential for auto-ignition. Vegetable oils have lower flash points compared to mineral oils, meaning they can ignite at lower temperatures. This increases the risk of a fire or explosion in the boiler system.

c) When preparing a boiler to be kept out of use for a prolonged period of time, the following steps can be taken:

1. Clean the Boiler: Thoroughly clean the boiler internals, including the water side and fire side surfaces, to remove any scale, deposits, or fouling that may have accumulated. This helps prevent corrosion and ensures a clean start when the boiler is brought back into operation.
2. Drain the Water: Completely drain the boiler water to prevent the risk of freezing, which can cause damage to the boiler and its components. Ensure all water is properly drained, including from low points, piping, and equipment.
3. Dry the Boiler: After draining, dry out the boiler internals as much as possible to remove any remaining moisture. This can be done by using compressed air, applying heat, or employing desiccants to absorb moisture.
4. Protect Exposed Surfaces: Apply a suitable protective coating or corrosion inhibitor on exposed metal surfaces to prevent corrosion during the idle period. This is particularly important for surfaces vulnerable to moisture or environmental conditions.
5. Close and Seal the Boiler: Close all openings, valves, and access points of the boiler to prevent entry of debris, moisture, or pests. Seal the boiler to maintain its integrity and protect it from external elements.
6. Regular Inspection and Maintenance: During the idle period, periodically inspect the boiler for signs of corrosion, damage, or any other issues. Perform necessary maintenance tasks as recommended by the manufacturer or industry guidelines.

It's important to consult with boiler manufacturers or industry professionals for specific guidance on preparing a boiler for prolonged idle periods, as the steps may vary depending on the boiler type, size, and other factors.

QUESTION

a) Describe any two test normally applied to boiler water

b) Identify contaminants in a sample of boiler feed water that forms;

i) Soft Scales

(ii) Hard Scales

(iii) Initiating corrosion

(iv) Why is hydrazine used in boiler water treatment?

ANSWER

a) Two commonly applied tests for boiler water are:

1. Total Dissolved Solids (TDS) Test: This test measures the concentration of dissolved solids in boiler water. It provides an indication of the overall water quality and helps assess the need for water treatment. High TDS levels can lead to scale formation, reduced heat transfer efficiency, and potential boiler damage. The TDS test is typically conducted using a conductivity meter or by measuring the weight of dried residue after evaporating a known volume of water.
2. Chloride Test: The chloride test measures the concentration of chloride ions in boiler water. Chloride can contribute to corrosion and pitting of boiler components. Monitoring chloride levels helps ensure they are within acceptable limits to prevent damage. The test is typically performed using a colorimetric method or ion-selective electrode.

b) The contaminants in boiler feed water that can contribute to specific issues are as follows:

i) Soft Scales: Soft scales in boiler systems are often formed due to the presence of dissolved calcium and magnesium bicarbonates. These bicarbonates decompose upon heating, leading to the formation of calcium and magnesium carbonates. Other contaminants like silica and organic matter can also contribute to soft scale formation.

ii) Hard Scales: Hard scales are typically formed by the precipitation of calcium and magnesium sulfates or silicates from boiler feed water. High concentrations of sulfate and silica ions in the water can contribute to hard scale formation, which can reduce heat transfer efficiency and potentially lead to boiler overheating and failure.

iii) Initiating Corrosion: Various contaminants can initiate corrosion in boiler systems. Oxygen is one of the primary culprits, as dissolved oxygen in water can lead to oxygen corrosion on metal surfaces. Other contaminants like chlorides, sulfates, and acidic compounds can also contribute to corrosion initiation by creating corrosive environments.

iv) Hydrazine in Boiler Water Treatment: Hydrazine is used as a boiler water treatment chemical for several reasons:

- Oxygen Scavenging: Hydrazine reacts with dissolved oxygen in boiler water to form non-corrosive gases, such as nitrogen and water. This helps reduce the oxygen content in the water, minimizing the potential for oxygen corrosion.
- Passivation of Metal Surfaces: Hydrazine can passivate metal surfaces by forming a protective layer that inhibits corrosion.
- pH Control: Hydrazine has alkaline properties and can help maintain the desired pH range in the boiler water. Proper pH control is essential to prevent acidic corrosion and scale formation.
- Prevention of Dissolved Oxygen Carryover: Hydrazine helps reduce the likelihood of dissolved oxygen carryover from the feed water into the steam, which can cause corrosion in downstream equipment.

It's important to note that the specific contaminants and treatment requirements can vary depending on the boiler system, water source, and operating conditions. Regular water testing and consultation with water treatment professionals are crucial for effective boiler water treatment.

QUESTION

a) What is the purpose of boiler water treatment?

b) List five elements treated for and how is achieved

c) What are the sources of these elements c) What are effects on boiler if treatment is neglected

ANSWER

a) The purpose of boiler water treatment is to ensure the proper functioning, efficiency, and longevity of the boiler system. It involves the management and control of water quality to prevent various issues such as corrosion, scale formation, and microbiological growth. By treating boiler water, the following objectives are achieved:

1. Prevention of Corrosion: Boiler water treatment helps control the levels of dissolved oxygen, pH, and other corrosive substances in the water. This prevents corrosion of metal surfaces and extends the life of the boiler and its components.
2. Scale and Deposit Control: Treatment helps control the levels of dissolved solids, hardness, and silica in the water. By minimizing the formation of scale and deposits, heat transfer efficiency is maintained, preventing potential overheating, reduced performance, and equipment damage.

3. Control of Microbiological Growth: Boiler water treatment includes measures to inhibit the growth of bacteria, algae, and other microorganisms in the water. This prevents fouling, slime formation, and potential microbiologically induced corrosion (MIC).
4. Prevention of Carryover: Proper treatment reduces the risk of dissolved and suspended solids, including contaminants, from being carried over into the steam. Carryover can cause operational problems, damage downstream equipment, and affect the quality of steam.

b) Five elements commonly treated for in boiler water treatment are:

1. Oxygen: Oxygen scavengers, such as hydrazine or sulfite, are used to remove dissolved oxygen from the water and prevent oxygen corrosion.
2. Hardness: Water softening agents, like sodium zeolite or ion exchange resins, are used to remove calcium and magnesium ions responsible for hardness. This helps prevent scale formation.
3. Silica: Silica can be controlled by using a combination of mechanical filtration, ion exchange, or specialized silica-specific treatment chemicals.
4. Alkalinity: Alkalinity control agents, such as sodium hydroxide or sodium carbonate, are used to adjust and maintain the desired pH and alkalinity levels in the water.
5. pH: Acid or alkaline chemicals are added to adjust the pH of the water within the recommended range to prevent corrosion and scale formation.

c) The source of these elements can vary depending on the feed water source. Common sources include:

- Oxygen: Dissolved oxygen can enter the system through air leakage, inadequate deaeration, or ingress from the condensate return system.
- Hardness: Hardness is often present in natural water sources, such as groundwater or surface water, due to the presence of calcium and magnesium salts.
- Silica: Silica can be found in various natural water sources, including rivers, lakes, and groundwater. It originates from the erosion of rocks and minerals.
- Alkalinity: Alkalinity can come from bicarbonates, carbonates, or hydroxides present in the water source, such as natural waters or treated municipal supplies.
- pH: pH can be influenced by the water source's natural characteristics or by the addition of chemicals during treatment processes.

d) Neglecting boiler water treatment can lead to several detrimental effects on the boiler system:

- Corrosion: Without proper treatment, corrosion of metal surfaces can occur, leading to damage, leaks, and potential boiler failure.
- Scale Formation: Neglected treatment allows the accumulation of scale and deposits on heat transfer surfaces, reducing efficiency and increasing fuel consumption.
- Reduced Heat Transfer Efficiency: Scaling and deposits act as insulators, hindering heat transfer between combustion gases and water. This leads to decreased efficiency and increased energy costs.
- Boiler Overheating: Insufficient treatment can cause localized hotspots and overheating, leading to stress on boiler materials and potential structural failures.
- Operational Issues: Neglecting treatment can result in operational problems, such as foaming, carryover, and water chemistry imbalances, impacting

QUESTION

a) Two emergency valves are fitted in a boiler fuel oil system, what are the locations and functions?

b) List the safety fitting in a boiler fuel oil system

ANSWER

a) The two emergency valves fitted in a boiler fuel oil system are:

1. Emergency Shut-off Valve (ESOV): The emergency shut-off valve is typically located near the fuel oil storage tank or supply line, close to the boiler. Its function is to quickly and completely shut off the fuel oil supply in case of emergencies or when immediate fuel oil flow cessation is required. The ESOV helps prevent fuel oil leakage, fire hazards, or uncontrolled fuel flow in critical situations.
2. Emergency Pressure Relief Valve (EPRV): The emergency pressure relief valve is usually installed on the fuel oil burner assembly or within the fuel oil piping system. Its purpose is to relieve excess pressure in the fuel oil system, particularly in the event of an overpressure situation or blockage. The EPRV helps protect the system from potential damage due to excessive pressure buildup and ensures the safe operation of the boiler fuel oil system.

b) Safety fittings commonly found in a boiler fuel oil system include:

1. Flame Arrestor: A flame arrestor is installed at the fuel oil burner assembly to prevent the propagation of flames back into the fuel oil system. It helps ensure that

any ignition or combustion occurring in the burner is confined to the intended area and does not pose a risk to the rest of the fuel oil system.

2. High- and Low-Level Alarms: These alarms are used to monitor the fuel oil level in the storage tank and provide visual or audible warnings when the fuel level is too high or too low. They help prevent fuel oil overflow or depletion, which could lead to operational issues or damage to the system.
3. Pressure and Temperature Gauges: Pressure and temperature gauges are fitted at various points in the fuel oil system to monitor and display the pressure and temperature conditions. They provide operators with crucial information about the system's operating parameters, enabling them to take necessary actions or adjustments to ensure safe and efficient operation.
4. Flame Failure Safety Device: A flame failure safety device is installed to detect the presence or absence of a flame in the burner. If the flame is not detected during the ignition sequence or is extinguished during operation, the safety device shuts off the fuel supply to prevent the release of unburned fuel or potential hazards.
5. Ventilation and Exhaust Systems: Adequate ventilation and exhaust systems are essential safety features in a boiler fuel oil system. They ensure the proper removal of combustion byproducts, such as exhaust gases and fumes, to maintain a safe and healthy working environment and prevent the accumulation of hazardous substances.

NOTE; the specific safety fittings and their locations can vary depending on the design and regulations applicable to the boiler fuel oil system.

QUESTION

With reference to auxiliary boiler

a) Identify contaminants in a sample of boiler feed water that forms soft scales, hard scales and initiation corrosion

b) Give reasons why sodium phosphate, sodium hydroxide and hydrazine are each used in boiler water treatment

c) Describe any two test, normally applied to boiler water

ANSWER

a) The contaminants in a boiler feed water sample that can contribute to the formation of soft scales, hard scales, and initiation of corrosion are as follows:

Soft Scales:

- Calcium and Magnesium Bicarbonates: These dissolved ions can precipitate and form soft scales when heated. They are commonly found in water sources with high alkalinity and hardness.

Hard Scales:

1. Calcium and Magnesium Sulfates: These dissolved ions can precipitate and form hard scales when water is heated. They are often present in water sources with high sulfate concentrations.
2. Silica: Silica can form hard scales when it exceeds the solubility limit in the boiler water. It is commonly found in natural water sources and can cause severe scaling issues at high temperatures.

Initiation of Corrosion:

1. Dissolved Oxygen: Dissolved oxygen in the boiler feed water can initiate corrosion on metal surfaces, leading to pitting and damage. Oxygen can enter the system through air leakage or inadequate deaeration.
2. Chlorides: High chloride concentrations in the water can promote corrosion, especially in the presence of dissolved oxygen. Chlorides can come from various sources, including natural water supplies or improper water treatment.

b) Sodium phosphate, sodium hydroxide, and hydrazine are used in boiler water treatment for the following reasons:

- Sodium Phosphate: Sodium phosphate is used as a boiler water treatment chemical for two main reasons:
    1. pH Control: Sodium phosphate helps to maintain the desired pH level in the boiler water. Proper pH control is essential to prevent acidic or alkaline conditions that can lead to corrosion or scale formation.
    2. Phosphate Treatment: Phosphates act as a protective barrier on metal surfaces, inhibiting the formation of scale and preventing corrosion. They form a passivating layer that helps to maintain the integrity of the boiler system.

- Sodium Hydroxide: Sodium hydroxide, also known as caustic soda, is used in boiler water treatment for the following purposes:
    1. pH Adjustment: Sodium hydroxide is an alkaline substance that can be used to increase the pH of acidic boiler water. This helps to reduce the corrosive potential of the water and maintain it within the desired range.

2. Oxygen Scavenging: Sodium hydroxide can react with dissolved oxygen in the water, helping to remove oxygen and reduce the risk of oxygen corrosion. This is particularly important in systems where oxygen ingress is a concern.

- Hydrazine: Hydrazine is used in boiler water treatment for its oxygen scavenging properties. It helps to remove dissolved oxygen from the water, reducing the potential for oxygen corrosion. Hydrazine reacts with oxygen to form non-corrosive gases, such as nitrogen and water. It is an effective oxygen scavenger, especially at elevated temperatures found in boiler systems.

c) Two commonly applied tests for boiler water are:

1. Total Dissolved Solids (TDS) Test: The TDS test measures the concentration of dissolved solids in the boiler water. It provides an indication of the overall water quality and helps assess the need for water treatment. High TDS levels can lead to scale formation, reduced heat transfer efficiency, and potential boiler damage. The TDS test is typically conducted using a conductivity meter or by measuring the weight of dried residue after evaporating a known volume of water.
2. pH Test: The pH test measures the acidity or alkalinity of the boiler water. It is essential to maintain the water's pH within the recommended range to prevent corrosion or scale formation. The pH test is typically conducted using pH indicator strips or a pH meter. It helps operators monitor the water's chemical balance and take corrective actions if necessary to maintain optimal conditions.

Note that there are several other tests and parameters that can be measured to ensure proper boiler water quality, depending on the specific requirements of the boiler system and regulatory guidelines. Regular water testing and analysis are crucial for effective boiler water treatment.