Answers to the Questions

1. What are HCV and LCV? Mention the Units

HCV (Higher Calorific Value) is the total amount of heat produced when a unit mass of a fuel is completely burned under ideal conditions, including the heat released due to the condensation of water vapor formed during combustion.

LCV (Lower Calorific Value) is the total amount of heat produced when a unit mass of a fuel is completely burned under ideal conditions, excluding the heat released due to the condensation of water vapor formed during combustion.

Units: Both HCV and LCV are typically expressed in **kilojoules per kilogram (kJ/kg)** or **calories per gram (cal/g)**.

2. Write any five characteristics of good fuel.

1. **High calorific value:** A good fuel should produce a large amount of heat per unit mass.
2. **Low ash content:** Ash is non-combustible and reduces the effective calorific value of the fuel.
3. **Low moisture content:** Moisture reduces the calorific value and increases the cost of transportation and storage.
4. **Easy ignition:** A good fuel should ignite easily and burn readily.
5. **Low sulfur content:** Sulfur dioxide, a byproduct of sulfur-containing fuels, is a major air pollutant.

3. Describe the determination of percentage of moisture in a coal sample with its significance.

The moisture content in a coal sample can be determined using various methods, such as:

- **Direct drying method:** The coal sample is dried in an oven at a specific temperature (e.g., 105°C) until the weight becomes constant. The loss in weight is due to moisture.
- **Indirect drying method:** The coal sample is heated in a crucible, and the water vapor released is collected and measured.

Significance of moisture content:

- Affects the calorific value of the coal.
- Influences the handling and storage properties of the coal.
- Affects the combustion process and efficiency.

4. What is Dry Corrosion? Name the different types of oxide layer formed and state which oxide layers are non-protective in nature.

Dry corrosion is the chemical reaction between a metal and a dry atmosphere, resulting in the formation of a metal oxide layer on the surface.

Types of oxide layers:

- **Protective oxide layer:** This layer is dense, adherent, and resistant to further corrosion. Examples include aluminum oxide (Al_2O_3) and chromium oxide (Cr_2O_3).
- **Non-protective oxide layer:** This layer is porous, loose, and does not provide adequate protection against corrosion. Examples include iron oxide (Fe_2O_3) and copper oxide (CuO).

5. What is cathodic protection? Discuss sacrificial anode method of cathodic protection/impressed current method with its application.

Cathodic protection is a technique used to prevent corrosion by making the metal to be protected a cathode in an electrochemical cell.

Sacrificial anode method: A more reactive metal (e.g., zinc, magnesium) is connected to the metal to be protected. The sacrificial anode corrodes preferentially, protecting the main metal. This method is commonly used to protect underground pipelines, ships, and offshore structures.

Impressed current method: An external source of direct current is used to force a current flow

between the metal to be protected and a sacrificial anode. This method is suitable for large structures, such as oil tanks and bridges.

6. What are corrosion inhibitors? Discuss its types with suitable examples.

Corrosion inhibitors are substances added to a corrosive environment to reduce the rate of corrosion.

Types of corrosion inhibitors:

- **Anodic inhibitors:** These substances form a protective film on the metal surface, preventing the anodic reaction. Examples include chromates, phosphates, and molybdates.
- **Cathodic inhibitors:** These substances interfere with the cathodic reaction, reducing the rate of corrosion. Examples include zinc salts and nitrates.
- **Mixed inhibitors:** These substances act on both the anode and cathode, providing more comprehensive protection. Examples include organic compounds containing nitrogen, oxygen, or sulfur.

7. Define corrosion. Explain the mechanism of wet corrosion with respect to neutral medium/ Acidic medium.

Corrosion is the deterioration of a metal due to its reaction with the environment.

Wet corrosion:

- **Neutral medium:** In a neutral medium, corrosion occurs due to the differential aeration process. Oxygen concentration is higher at the metal surface exposed to the atmosphere, creating a concentration cell. The metal surface exposed to lower oxygen concentration becomes anodic and corrodes.
- **Acidic medium:** In an acidic medium, corrosion occurs due to the direct attack of hydrogen ions (H+) on the metal surface. The metal reacts with hydrogen ions to form metal ions and hydrogen gas.

8. Differentiate between galvanizing and tinning.

Galvanizing: This process involves coating a metal (usually steel) with zinc. Zinc is more reactive than steel and acts as a sacrificial anode, protecting the steel from corrosion.

Tinning: This process involves coating a metal (usually copper or steel) with tin. Tin is less reactive than the base metal and provides a barrier between the base metal and the environment, preventing corrosion.

9. Write a note on corrosion in electronic devices.

Corrosion is a major concern in electronic devices, as it can lead to component failure, reduced performance, and increased costs. Common types of corrosion in electronic devices include:

- **Electrochemical corrosion:** This occurs due to the presence of moisture, electrolytes, and a potential difference between different components.
- **Intergranular corrosion:** This occurs along grain boundaries in metals, leading to the formation of cracks and the eventual failure of the component.
- **Stress corrosion cracking:** This occurs when a metal is subjected to a combination of tensile stress and a corrosive environment.

10. What steps would you take while selecting the metal and designing chemical vessel, so that corrosion will be minimized?

- **Material selection:** Choose a metal or alloy that is resistant to the specific corrosive environment. Consider factors such as pH, temperature, and the presence of oxidizing or reducing agents.
- **Design considerations:** Avoid sharp corners and crevices, as these can act as stress concentration points and promote corrosion. Ensure proper drainage to prevent the accumulation of corrosive fluids.

- **Protective coatings:** Apply a suitable protective coating, such as paint, epoxy, or a metal coating, to provide a barrier between the metal and the corrosive environment.
- **Cathodic protection:** If necessary, implement cathodic protection measures to prevent corrosion.

11. What are the metallic coatings?

Metallic coatings are applied to a base metal to improve its corrosion resistance, wear resistance, or appearance. Common types of metallic coatings include:

- **Electroplating:** This involves depositing a metal onto a base metal using an electrochemical process.
- **Hot-dip coating:** This involves immersing a metal in a molten metal bath.
- **Cladding:** This involves bonding a thin layer of a different metal to a base metal.
- **Vapor deposition:** This involves depositing a metal onto a base metal in a vacuum chamber.

12. Explain how the moisture, pH, and temperature affect the corrosion?

- **Moisture:** Moisture is essential for most corrosion processes. It acts as an electrolyte, allowing the flow of ions and completing the corrosion circuit.
- **pH:** The pH of the environment affects the rate and type of corrosion. Acidic environments promote corrosion, while alkaline environments can inhibit corrosion.
- **Temperature:** Higher temperatures generally increase the rate of corrosion, as the rate of chemical reactions increases with temperature.

13. What are the purpose of making an alloy with an example

Alloys are mixtures of two or more metals or a metal and a non-metal. They are often created to improve the properties of the base metal, such as strength, hardness, corrosion resistance, or electrical conductivity.

Example: Stainless steel is an alloy of iron, chromium, and nickel. The addition of chromium and nickel increases the corrosion resistance of the steel, making it suitable for applications in harsh environments.

14. What are alloys?

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