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Div - J1

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Engineering Chemistry - II

Assignment in lieu of Term Test - 1

1.) Explain concenteration cell corrosion with the help of suitable example.

Ans i) Concenteration cell corrosion is due to electrochemical attack on the metal surface, exposed to varying aeration of varying electrolyte concenteration. Thus, concenteration cell corrosion occurs either due to varying ionic concenteration of electrolyte in contact with a metal or due to difference in aeration of air or oxygen over the metal surface. Due to this a potential difference is developed between the two areas resulting in corrosion. This may be the result of local difference in metal-ion concenteration, caused by local temperature differences or inadequate agitation or slow diffusion of metal ions produced by corrosion.

2) Differential aeration corrosion is the most common and important type of concenteration cell corrosion. This type of corrosion occurs when one part of the metal is exposed to a different air concenteration from the other part of the metal. This develops a difference in potential between differently aerated areas.

3) It has been found experimentally that poor oxygenated parts act as an anode and highly oxygenated act as cathode. Thus, a flow of electron from anode to cathode takes place due to differential aeration and is called differential current.

4) Differential aeration corrosion occurs when metals are partially immersed in solution just below the waterline.

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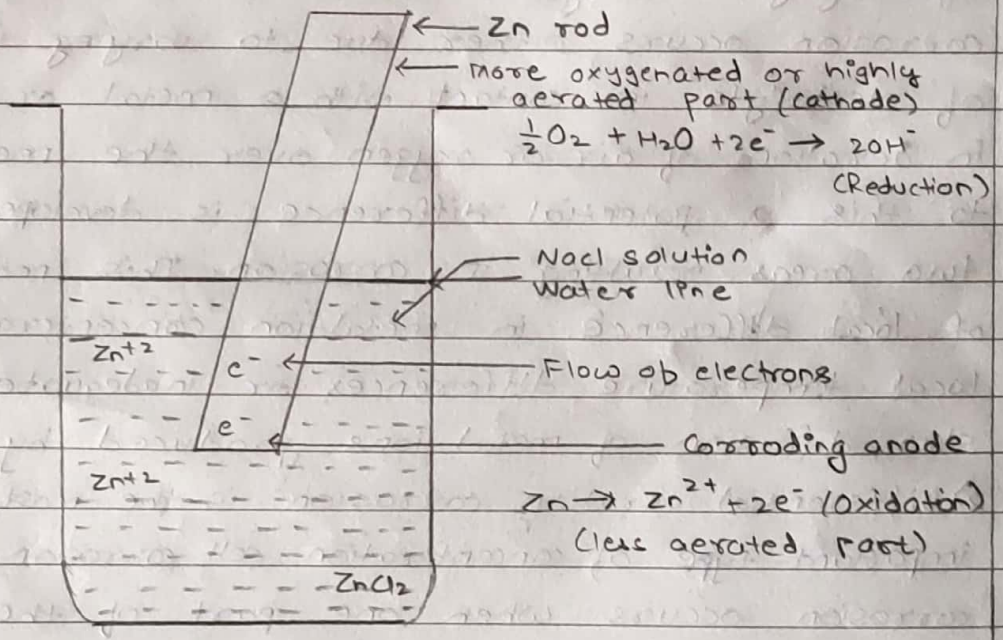
A metal (zinc) is partially immersed in a dilute solution of a neutral salt (say NaCl) and the solution is not agitated properly. The parts above the closely adjacent to the waterline and strongly aerated and acts as a cathode. The part immersed to greater depth show a smaller oxygen concenteration i.e. poorly aerated and act as anode.



Differential aeration corrosion of metal immersed partially in sol.

Hence, a difference of potential is developed which causes flow of current between the two differentially aerated areas of the same metal.

4) Zinc will dissolve at the anodic areas

$$Zn \rightarrow Zn^{2+} + 2e^- \text{ (oxidation)}$$

Oxygen will take up electrons at the cathodic areas to form hydroxyl ions.

$$\frac{1}{2}O_2 + H_2O + 2e^- \longrightarrow 2OH^- \text{ (reduction)}$$

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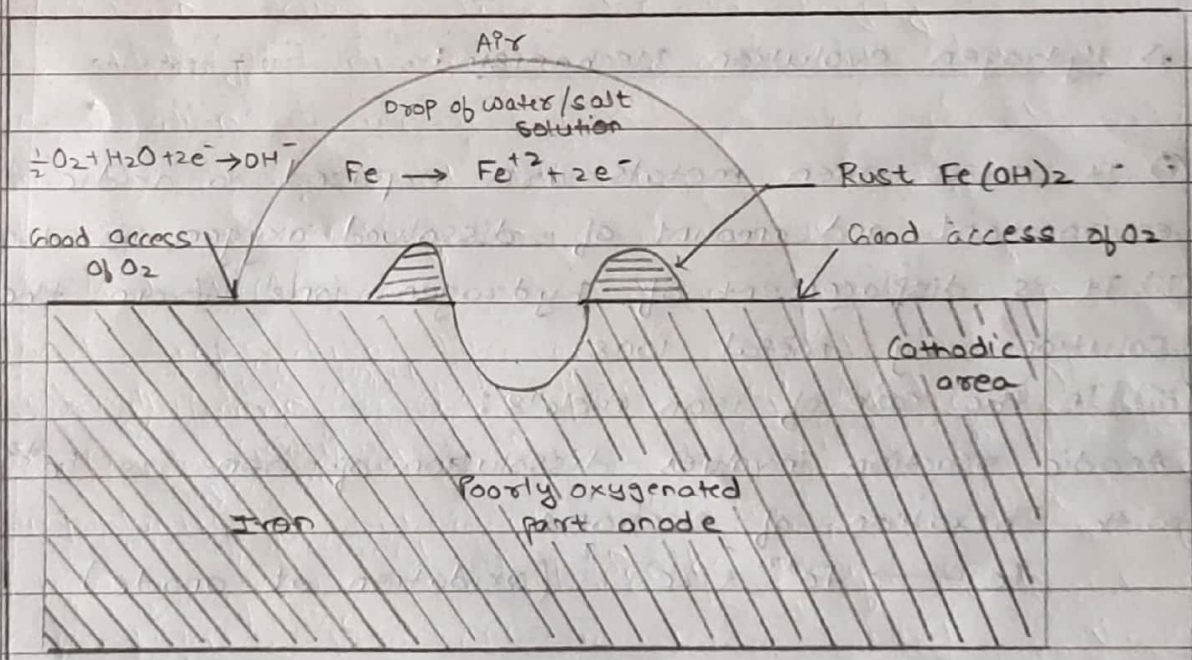
5) Circuit gets completed by flow of OH^- ions through the electrolyte and flow of electrons from anode to cathode through metal. In similar way, corrosion of iron by water drops can be easily explained. Areas covered by droplets, having no access of oxygen become anodic with respect to the other areas, which are freely exposed to air. From the above it is clear that oxygen concenteration cell increases corrosion but it occurs when the oxygen concenteration is lower.



Formation of an oxygen concenteration cell on metal under a drop of water/salt solution

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2> Explain wet corrosion in acidic medium with diagram and mechanism.

Ans 1> Wet corrosion in acidic medium:

When metal surface is in immediate contact of aqueous acidic solutions, the short circuited galvanic cells get set all along the surface of the metal. This give rise to corrossion which proceeds by electrochemical processes.

2> Hydrogen evolution mechanism:

(i) It occurs when metals are exposed to acidic environment and amount of dissolved oxygen is low.

(ii) It is displacement of hydrogen ions from the solutions by metal ions.

(iii) In the case of iron metals:

Anodic reaction involves dissolution of iron as Fe^{+2} ion with liberation of electrons.

$$Fe \longrightarrow Fe^{+2} + 2e^{-} \quad \text{(oxidation, at anode)}$$

These electrons flow from anode to cathode through the metal and H^{+} ions from acidic solution accepts them and gets reduced to hydrogen gas at cathode.

$$2H^{+} + 2e^{-} \longrightarrow H_2 \uparrow_{(g)} \quad \text{(reduction, at cathode)}$$

(iv) Overall reaction:

$$Fe + 2H^{+} \longrightarrow Fe^{+2} + H_2 \uparrow$$

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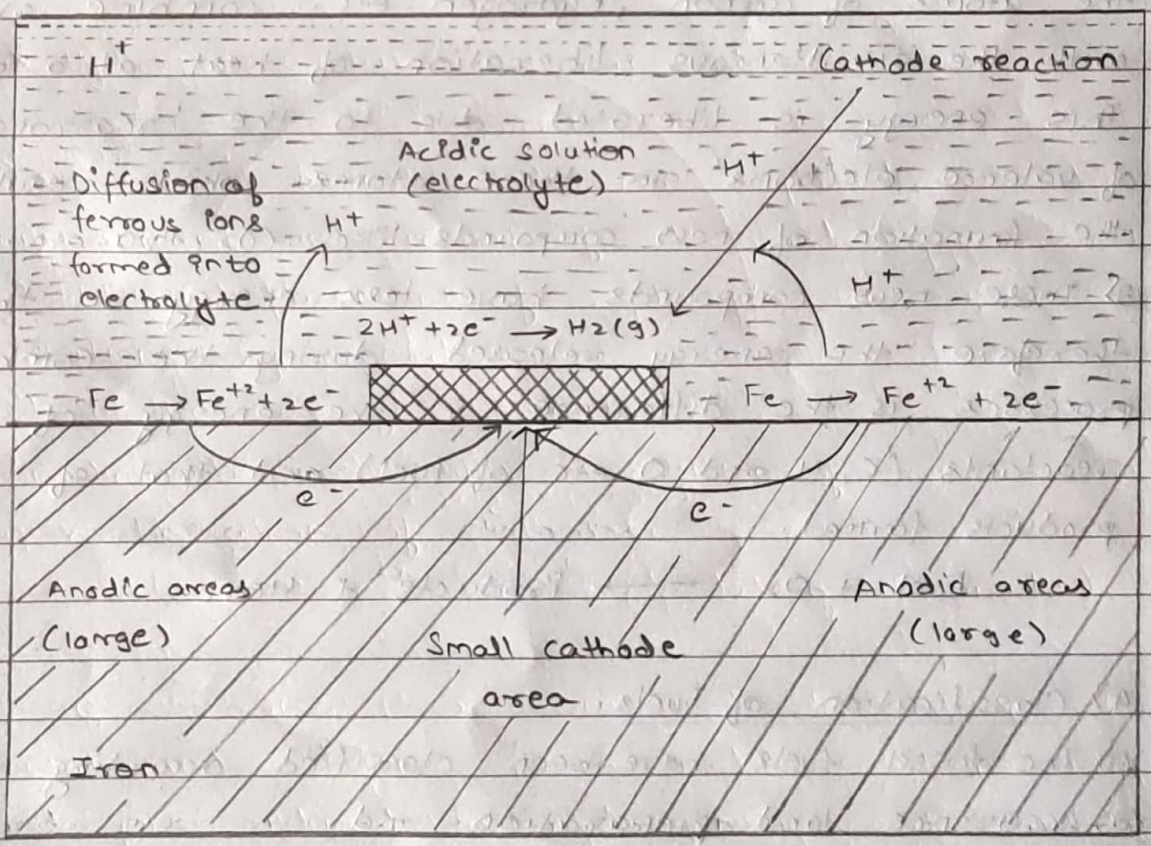
(v) The metal ions dissolve in solution and hydrogen ions come out of the solution in the form of gas. In general, all metals above hydrogen in electrochemical series have a tendency of dissolving in acid solution.

(vi) In the hydrogen evolution type of corrosion, the anodes are represented by large areas while cathodes are represented by small areas. Hence, rate of corrosion is little slower.

(vii) Diagram:



Mechanism of wet corrosion by hydrogen evolution.

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3) Define fuel and explain the classification of fuels.

Ans. 1) A fuel can be defined as a combustible substance, containing carbon as main constituent, which on proper burning gives large amount of heat, which can be used economically for domestic and industrial purposes. Wood, charcoal, kerosene, petrol, diesel, producer gas, oil gas etc are some of the fuels.

2) During the process of combustion of a fuel, the atoms of carbon, hydrogen etc. combine with oxygen with the simultaneous liberation of heat at a rapid rate. This energy is liberated due to the 'rearrangement of valence electrons' in these atoms which results in the formation of new compounds like CO_2, H_2O etc.

3) These new compounds have less energy in them and therefore the energy released during the combustion processes is the difference in the energy of the reactants (C, H and O etc. of fuel) and that of the products formed.

Fuel + O_2 ⟶ Products + Heat

4) Classification of Fuels:

(1) The fossil fuels have been classified according to their
(a) occurence land preparation and
(b) the state of aggregation.

(2) According to the first classification we have:
(a) natural or primary fuels which are found in nature as such. eg. wood, coal, petroleum, natural gas, etc.
(b) Artificial or secondary fuels are those which are prepared from the primary fuel. For example, charcoal,

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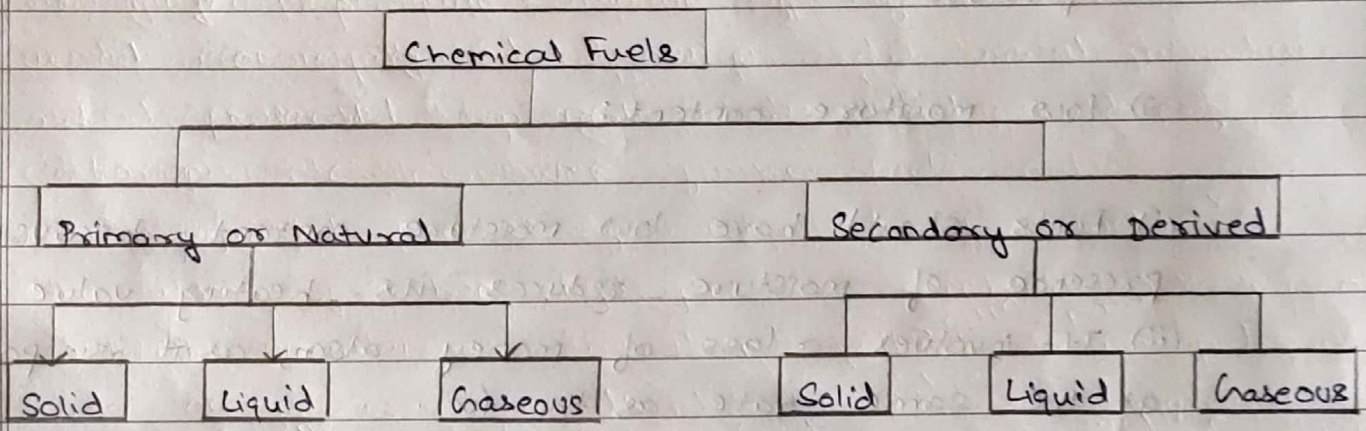
coke, diesel, oil, Kerosene, petrol, producer gas, etc.

5) The second method of classification is based on this state of aggregation as solid, liquid and gaseous fuels.



4) Give the characteristics of ideal fuel. (Any five)

Ans Characteristics of an ideal fuel:

1) High Calorific value:
As the amount of heat generated and temperature attained thereby depends on the calorific value of the fuel. Hence, a fuel should possess a high calorific value.

2) Modern ignition temperature:
(i) Ignition temperature is the temperature at which the fuel must be pre heated so that it starts burning smoothly.
(ii) low ignition temperature is dangerous for storage and transport of fuel, since it can cause fire hazards.

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(iii) High ignition temperature causes difficulty in igniting the fuel but the fuel is safe during storage, handling and transport.
(iv) Hence, an ideal fuel should have moderate ignition temperature.

3) Low moisture content:

(i) Fuels should have low moisture content because presence of moisture reduces its heating value.
(ii) It involves a loss of money also, as it is paid for at the same rate as the fuel.

4) Low non-combustible matter content:

(i) The non-combustile matter remains in the form of ash after combustion. Its presence reduces the calorific value of the fuel.
(ii) Each present of non-combustible matter in a fuel reduces the calorific value by about 1.5%.
(iii) It also cost of storage, handling and disposal of waste products.
(iv) Hence, a good fuel should have low non-combustible matter content.

5) Moderate velocity of combustion:
(i) If the rate of combustion is low, then the required high temperature is not attained and high rate of combustion is not desirable.
(ii) A fuel (ideal) should have moderate velocity of combustion.

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5) Explain the proximate analysis with significance.

Ans Proximate Analysis:

(1) This method is used for determination of moisture content, volatile matter, ash content and fixed carbon in the coal.

(2) It is carried about by using air dried sample. Moisture which is lost on air during is known as free moisture or surface moisture.

1.) Determine of moisture

- 1 g of finely powdered sample is weighed in crucible.
- It is placed inside an electric hot oven at 105-110°C for an hour.
- It is then cooled in dessicator and weighed.

$$\% \text{ moisture} = \frac{\text{loss in weight}}{\text{weight of air dried sample}} \times 100$$

- Significance:

(1) During combustion, a significant amount of heat is wasted in evapourating moisture which reduces the calorific value of coal.

(2) Due to excessive surface moisture, handling of coal becomes troublesome.

(3) However, upto 10% of it is desirable.

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2) Determination of volatile matter:

- Moisture free coal in crucible is covered with a lid.
- It is placed in an electric furnance at 925 ± 20°C for 7 minutes.
- It is cooled in a dessicator and weighed again.
- % volatile matter = $\frac{\text{loss in weight due to removal of volatile matter} \times 100}{\text{weight of coal sample taken.}}$

- Significance:

(1) The volatile matter evolved consists of combustible gases like CO, H_2 and incombustible gas and hydrocarbons.
(2) Coals with high volatile matter burns with long, smoky flame and have low heating value. Coals with low volatile matter burns with a shorter flame.
(3) Lesser the volatile matter, better the rank of the coal.

3) Determination of ash.

- The residual coal left in the crucible is heated without lid in a muffle furnance at 700 ± 50°C for half an hour.
- When the crucible is taken out, it is cooled in air and then in dessicator and weighed.
- The process is repeated till a constant weight is attained.

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$$\% \text{ ash} = \frac{\text{Weight of ash left}}{\text{weight of coal taken}} \times 100$$

- Significance:

(1) The ash consist of silica, alumina, iron oxide and small quantities of magnesia as well as lime.
(2) The ash reduces heating value of coal.
(3) It causes hindrance to the flow of air and heat, thereby lowering the temperature.
(4) Since ash has to be removed from the furnance and disposed off, it increases labour cost.

4) Fixed carbon:

- % fixed carbon = 100 - % (moisture + volatile matter + ash)

- Significance:

(1) Higher the percentage of fixed carbon, greater is its calorific value and better will be the quality of fuel.
(2) Hence, high percentage of carbon is desirable.
(3) It also helps in designing the furnance and shape of firebox because it is the fixed carbon that is burns in solid state.