VIV Corrosion

1. Corrosion Origin

1.1 Nature of Corrosion

- Corrosion is a spontaneous process that turns metals in alloy back to their natural state.
- The surface or the film could be protective to the corrosion.

1.2 The reason cause the corrosion

- The thermodynamics second law: entropy↑

1.3 The cost of the corrosion

- Corrosion costs will climb
- Need to work in more hostile environments.
- Life Cycle Costing
    - Investment in quality materials provides long-term savings on operations/maintenance.

2. The classification of the corrosion

- Dry oxidation
- Emulsions
- Aerosols and Mist
- Aqueous corrosion
    - Corrosion is an electrochemical process
    - It involves:
        - Removal of electrons(oxidation) in anode
        - Consumption of electrons(reduction) in cathode
- Necessary components of a corrosion cell:
    - Must have a anode and cathode
    - Must have metallic path connection
    - The double nodes must be immersed in a conductive electrolyte

3. Conservation of Energy

- The same rate at the double node.
- The anode becomes more acidic.
- The cathode becomes more alkaline.
- *eg* :

$$Anode : 2Fe - 4e^- = 2Fe^{2+}$$

$$Cathode : O_2 + 2H_2O + 4e^- = 4OH^-$$
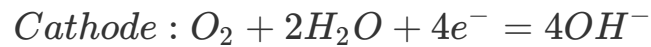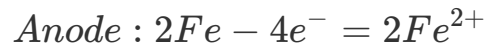
4.Reaction at the nodes surface

4.1 Anode reaction

- Metal = Metal Cation + electrons
  Cation + water = Metal Oxide + H_3O^+

4.2 Cathode reactions

- water + oxygen + electrons= Hydroxyl Anions
- water + electrons= Hydrogen + Hydroxyl Anions

5. Forms of Corrosion

5.1 Uniform attack

- Oxidation and reduction occur randomly across the surface
- can be predicted and eased

5.2 Localised corrosion

5.2.1 Introduction

- occurs when distinct anodic and cathodic regions formed
- difficult to spot

5.2.2 Galvanic attack and how to limit

- occurs between two metals having different composition and connected to a electrolyte
- How to limit:
    - Choose 2 metals are close together in galvanic series.
    - Insulate the different metals.
    - Large the size to nodes.
- *eg* :
    - Galvanised Steel,Zinc as a coating to be sacrificial anode and oxide choke. （Cathodic Protection using Sacrificial Anodes)

5.2.3 Pitting Corrosion

- Localised
- Leading to perforation failures
- Related to passive surfaces with defects or microstructural variations
- Oxygen Differential
    - Driven by oxygen
    - Cathodes in high oxygen areas
    - Anodes in low oxygen areas
- Coating Effects
    - The damaged paintwork blister is due to the oxygen differential.

6. Flow and Corrosion

6.1 Erosion-corrosion(by wind)

- Combined action of chemical and mechanical attack as a consequence of fluid motion
- Harmful to passivate metals
- Increasing fluid velocity increase corrosion rate
- solutions more erosive when bubbles and suspended particulate solids present

6.2 Cavitation

- Mechanical dominated the corrosion
- Due to bubbles collapsing on solid
- How to decrease:
    - Choose cavitation resistant alloy
    - using a more hydrodynamic propeller design

7. Faraday's Law

- Corrosion rate obeys,

$$Q = zFm$$

- Q=I.t=Coulombs;
- z=number of e^- in this reactions
- F=Faraday's constant(96500C/mol);
- m=number of moles of material reacted
- All aqueous corrosion obey the law including localised corrosion