Singh Research Group: Corrosion of Metallic Materials

**Group Overview**

**Environmental Degradation of Metallic Materials**

- **Corrosion Mechanisms in Different Alloy/Environment Systems**
  - General and Localized Corrosion
    - Aqueous Corrosion
    - High Temperature Oxidation
    - Molten Salt Corrosion
  - Environmental Sensitive Cracking
    - Stress Corrosion
    - Hydrogen Embrittlement
- **Understanding Passivity**
- **Corrosion Control**
  - Alloy Selection and Microstructural Effects
  - Environmental Modifications (Inhibitors etc.)
  - Surface Modification (Metallic and non-metallic coatings, Hydrophobic surfaces)

**Stress Corrosion Cracking**

- Aluminum alloys are increasingly replacing the steel in automotive vehicles due to its high strength to weight ratio.
- Unfortunately, some of these high strength aluminum alloys suffer from various structural forms of corrosion such as intergranular and stress corrosion cracking at peak aged tempers.
- **Objective**: The principle aim of this project is to assess the effect of composition and processing conditions on the microstructure of the high strength aluminum alloys resulting in stress corrosion cracking and corrosion fatigue.

**Corrosion in Fluoride and Chloride Molten Salts**

- Molten halide salts have been proposed as coolants for several emerging energy technologies, including advanced fission reactors, fusion reactors, and high temperature concentrated solar power storage.
- Corrosion of containment materials, which include nickel-based alloys and austenitic stainless steels, is a challenge due to the harsh chemical environment at typical operating temperatures, which exceed 650°C.

**High-Temperature Corrosion**

- **Objective**: To evaluate the resistance to high-temperature corrosion of candidate superalloy tube (shown in orange) materials for an increase in boiler operating temperature.
- These tubes are faced with various corrosive gaseous species and small deposits which accelerate tube failure, leading to boiler explosions.
- Samples were tested in a variety of gaseous environments with and without salt similar to that found in recovery boilers.

**Pitting Corrosion**

- Pitting corrosion behavior and mechanism of lean duplex stainless steels in paper machine white water was studied using potentiodynamic polarization test and scratch test method. Materials factors including alloying elements and heat treatment and environmental factors in terms of chloride and thiosulfate concentration were studied. Pitting behaves in the phase that is most susceptible to pitting corrosion.

**Corrosion Behavior of Additively Manufactured Alloys**

- Additive manufacturing (AM) or 3D printing is a disruptive approach to traditional manufacturing process, enabling creation of superior parts with more flexibility and efficiency.
- Microstructural differences due to AM processing conditions and much higher solidification rate in AM alloys, their corrosion or stress corrosion cracking (SCC) behavior can be different from the equivalent wrought alloys.

**Group Members**

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