

## 1 Objectives

1. Explain stages of environmental fracture
2. Explain mechanisms of crack growth in SCC
3. Explain mechanisms of crack growth in HIC
4. Explain stages of Creep
5. Identify creep fracture surface features
6. Use creep deformation map to Identify the dominant creep mechanism
7. Predict creep failure time using Larson-Miller Parameter

### 1.1 Stages of environmental fracture

A slow or stable fracture due to combined action of loads and the environment in a susceptible material

1. Crack nucleus formation
  - mechanical strength reduction(Temperature dependent)
  - formation of microstructural defects or surface micro-cracking
2. Nucleated crack turns into macroscopic crack
  - load opens the crack
  - corrosion is dominant
3. Fracture
  - not entirely mechanical
  - can happen at  $K < K_{IC}$

### 1.2 Mechanisms of crack growth in SCC

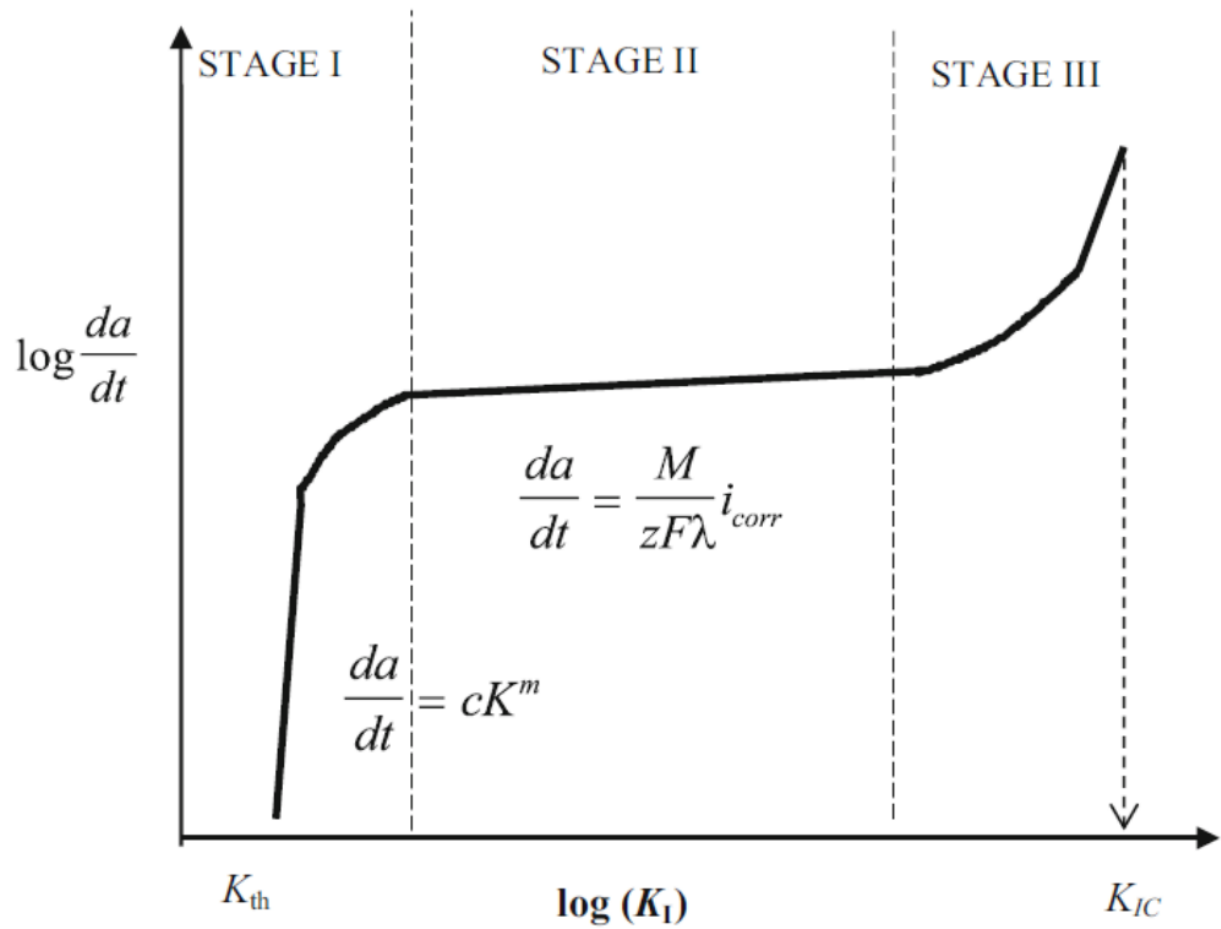
Stress corrosion cracking causes:

1. Slip
  - External stress causes dislocation and create slip steps
2. film rupture
  - Slip steps ruptures oxide film at the crack tip
3. anodic dissolution
  - ruptured oxide film causes exposes material to anodic dissolution (corrosion)
4. repassivation
  - new oxide film forms

### 1.2.1 Two types of SCC Mechanisms

1. Controlled by Environment:
  -
2. Controlled by Stress:
  -

### 1.2.2 Stages of SCC



## 2 Wear

### 2.1 Three types of wear

#### 2.2 Abrasive Wear

1. Occurs when a harder material is pressed against a softer one
- 2.

#### 2.2.1 Abrasive wear mechanisms

1. Plowing

2. Cutting
3. Fracture

### **2.2.2 Types of Abrasive Wear**

1. two body
2. three body
  - Occurs when theres a particle involved in between two podies

### **2.3 Adhesive Wear**

### **2.4 Fretting**

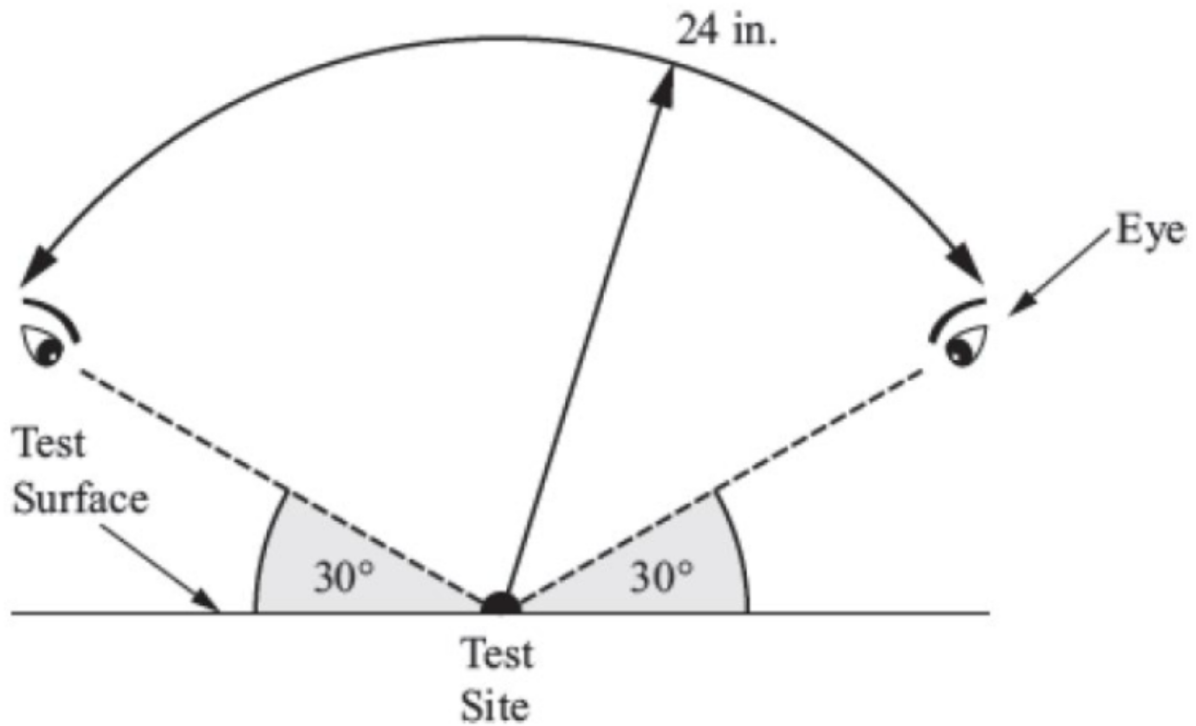
## **3 Non destructive testing(NDT)**

Evaluation of an object without changing it or altering it in any fashion.

### **3.1 Objectives**

1. Define NDT and name some NDT techniques
2. Principles and steps in penetrant testing
3. Principles of magnetic particle testing
4. Name advantages and disadvantages of NDT's

### 3.1.1 NDT Technique: Visual Inspection



### 3.1.2 NDT Technique: Penetrant testing (PT)

Take advantage of capillary action of Penetrant

- Good for surface discontinuities
- Can be used in production-type environment
- Flaws as fine as 1 micron can be detected
- Fluorescent dye can be used
- Portable

Advantages:

- Inexpensive
- Sensitive
- Minimal equipment
- Can be applied to irregular shapes
- Versatile and Portable
- Minimal training required
- Ease of interpretation

Disadvantages:

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### **3.1.3 NDT Technique: Magnetic-Particle Inspection**

Disadvantages:

- Crack direction matters

### **3.1.4 NDT Technique: Eddy-Current inspection**

## **3.2 Destructive testing**

Advantages:

- Generates useful data for design purposes
- Data can be used to establish standards and specifications
- Data achieved through ?destructive? testing ususally quantitative.
- Service conditions can be measured
- Useful life can be predicted

Disadvantages:

- specimens cant be used after testing
- expensive

## **3.3**

## 4 Slide 1

1. Stages of environmental fractures
2. Creep
3. Third item

## 5 Slide 2 - Environmental Fracture

slow or stable fracture due to combined action of loads and the environment in a susceptible material

### 5.1 example: Rolled up plastic hoses

## 6 Slide 3 - Stages of Environmental Fracture

- Stage 1: Accumulation of internal damage
- Stage 2: Nucleated crack turns into a macroscopic crack
- Stage 3: Rapid fracture, can happen  $K < K_{IC}$

## 7 Slide 4 - Creep

## 8 Stress corrosion cracking (SCC) Mechanism

- Slip-dissolution mechanism involves 4 stages: slip, film rupture, anodic dissolution, repassivation
- External stress causes dislocations to move and create slip steps, increasing plastic strain, and breaking the oxide film at the crack tip.

## 9 SCC Mechanisms

### 9.1 Stress corrosion cracking SCC

For stage I:  $\log(da/dt) = cK^m$

For stage II:  $\log(da/dt) = M/(zF\lambda)i_{curr}$

### 9.2 SCC - Effect of Microstructure

### 9.3 Example problem

$$PLM = (500 + 273)[17 + \log(28 * 365 * 24)]$$

$$PLM = 17190$$

using the graph,  $\sigma = 400MPa$