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Continuing Education Course #057
Forensic Engineering Part B
Four Classes of Metallurgical and Mechanical Failures

1. In aqueous corrosion, the oxidation electrochemical reaction occurs on which one of these areas of an
- a. Outside of crevices
- b. Cathodic
- c. Anodic
- d. Passive

2. All of the following actions can be effective control methods to aid in preventing the reoccurrence of a SCC failure except?
- a. Use stress-relief heat treatment to minimize residual stresses left in the material after welding or cold working
- b. Taking actions to prevent concentrating aggressive ions on the alloy surface
- c. Using stainless steels that contain 5 to 12% nickel in electrolytes with significant chloride ion concentrations
- d. Lowering the service temperature used in the application

3. Failure by the mechanism of static stress overload most often occurs when?
- a. Upset service conditions are not accounted for during the design stage
- b. Normal, applicable forms of service stress are not accounted for in the design stage, e.g., torsion or compressive loading
- c. The safety factor used was too small
- d. Failure began by another mechanism and ended with static stress overload

4. Most of the following are well-established characteristics of high-cycle fatigue failures except?
- a. Most of the total fatigue life of alloy in a given application is consumed in propagating existing fatigue cracks to failure
- b. Initiation occurs most frequently from surface stress concentration points on the metal
- c. Cyclic stresses are required
- d. Most of the total fatigue life of alloy in a given application is consumed in initiating fatigue cracks before crack propagation begins

5. The most important application factor in predicting the susceptibility of an alloy to failure by the adhesive wear mechanism is?
- a. Whether or not service stresses exceeded the yield strength of the alloy
- b. The lubricant selected; how well it is kept free of contamination and/or kept at a sufficient temperature
- c. The surface finish on the metal
- d. The maximum temperature at the interface of the two metals

6. Which of the following alloys will not have an endurance limit as revealed in their experimentally established S-N data?(Assume a non-corrosive test environment in each case.)
- a. Low alloy, carbon steels that display high strengths
- b. Plain carbon steels, i.e., mild steels

○ c. Aluminum-based alloys
○ d. Precipitation-hardened stainless steels

7. This mechanism of corrosion is relatively simple to detect, monitor and, therefore, is more easily controlled than other types of corrosion?
○ a. MIC
○ b. General
○ c. Galvanic
○ d. Pitting

8. The most important factor in successfully using an organic or inorganic paint coating as a means of corrosion control is?
○ a. Selecting a good primer
○ b. Using spray application
○ c. The dry film thickness attained
○ d. The quality of the surface preparation attained prior to coating

9. Erosion is most similar to which of the following?
○ a. Abrasive wear
○ b. Fretting
○ c. Adhesive wear
○ d. Dealloying

10. If one assumes nascent hydrogen has been available to charge into these alloys, hydrogen embrittlement (HE) that results in fracture is most probable in this class of materials?
○ a. Copper-based alloys, e.g., one of the brasses
○ b. Lightly cold-worked, plain carbon steels
○ c. Electroplated steels that have had a thorough bake-out process immediately after the plating process was completed
○ d. High hardness, high strength low alloy steels

11. In general, this is the most important material property to use as an indicator of an alloy's resistance to failure by abrasive wear?
○ a. Yield strength
○ b. Fracture toughness
○ c. Surface hardness
○ d. Density

12. Microbiological influenced corrosion (MIC) is often found in applications with this characteristic?
○ a. Service temperatures above 300 degrees F
○ b. Sulfate reducing bacteria (SRB) are confirmed to be present at the site of the corrosion
○ c. High levels of tensile stress are present
○ d. In water systems where a biocide that has been confirmed as effective is present

13. This mechanism of failure can be very dangerous in certain applications because it often acts as a precursor to significantly shortened fatigue life?
○ a. Case hardening of the surface
○ b. Fretting wear
○ c. Galvanic corrosion
○ d. MIC

14. Stagnant or low velocities of electrolytes have specific, major effects in accelerating the incidence of each of these two corrosion mechanisms?

○ a. Pitting and corrosion fatigue
○ b. Pitting and MIC
○ c. SCC and HE
○ d. Galvanic attack and pitting

15. Most classes of practical engineering alloys offer little resistance to MIC other than the possible exception of this alloy class?

○ a. High strength, low alloy carbon steels
○ b. Stainless steels
○ c. Nickel-based alloys
○ d. Titanium alloys

16. Which of the following statements regarding fatigue failures is <u>not true</u>?

○ a. It is essential to find striations to confirm that fatigue has occurred
○ b. Cyclic or fluctuating stresses are required
○ c. Plotted S-N data show that ferrous and titanium alloys have an endurance limit when no corrosive is present in the environment
○ d. The co-joint use of fracture mechanics theory and periodic non-destructive evaluations (NDE) is one method used to control failure by fatigue

17. The corrosion mechanism that involves two or more dissimilar metals in electrical contact when each is wetted by an electrolyte is?

○ a. Fretting corrosion
○ b. Crevice attack
○ c. Galvanic corrosion
○ d. IGSCC

18. Sensitization in alloys is a metallurgical phenomenon that occurs in certain alloys when this condition exists?

○ a. There is an insufficient percentage of molybdenum present in the alloy
○ b. There is not enough carbon present in the alloy
○ c. The alloy has been exposed for an extended period to a specific range of temperature
○ d. Unrelieved, residual stresses are present in the alloy

19. This mechanism of failure – while not a form of corrosion itself – can be initiated by the incorrect application of the cathodic protection (CP) form of corrosion control?

○ a. Crevice corrosion
○ b. Hydrogen embrittlement (HE)
○ c. Adhesive wear
○ d. Cavitation

20. Chemical corrosion inhibitor usage is most common in this class of applications?

○ a. Cooling water systems
○ b. Conditions where SCC is likely
○ c. For exterior corrosion protection on bare, underground pipelines
○ d. For alloys where dealloying is likely

21. If tensile stresses are present, SCC is very likely to eventually occur in this common, susceptible combination of specific alloy and specific electrolyte?

○ a. Carbon steels and high-temperature caustic(NaOH) solutions
○ b. Type 316 stainless steel and sulfuric acid

○ c. Copper alloys and potable water
○ d. Titanium alloys and seawater

22. Metal failure by the dealloying mechanism is most likely to occur in the following class of alloys?
○ a. Aluminum
○ b. Titanium
○ c. Gray cast iron
○ d. Ductile cast iron

23. This form of metal failure is characterized by the alternate formation and collapse of gas bubbles at or near a metal surface in a corrosive liquid?
○ a. Liquid metal induced embrittlement (LMIE)
○ b. Fretting due to flow-induced vibrations
○ c. Abrasive wear
○ d. Cavitation

24. The probability of pitting corrosion on austenitic stainless steels is minimized by this combination of service conditions?
○ a. A low concentration of chloride ions and very high service temperature
○ b. A low pH and very low flow velocities
○ c. A high pH and low service temperature
○ d. A high concentration of chloride ions and high service temperature

25. Erosion-corrosion (EC) is a combination of these two failure mechanisms?
○ a. SCC and turbulent flow conditions
○ b. Corrosion and abrasive wear
○ c. MIC and adhesive wear
○ d. High velocities and fretting wear