API RP 571
Test

1. _____ is a change in the microstructure of certain carbon steels and 0.5 Mo steels after long term operation in the 800º F to 1100º F range.
    A. Graphitization
    B. Softening
    C. Temper Embrittlement
    D. Creep

2. What structure is 304 stainless steel?
    A. Martensitic
    B. Austenitic
    C. Duplex
    D. Ferritic

3. _____ is the result of cyclic stress caused by variations in temperature.
    A. Creep
    B. Thermal Fatigue
    C. Cyclic Cracking
    D. Stress Corrosion Cracking

4. General or localized corrosion of carbon steels and other metals caused by dissolved salts, gases, organic compounds or microbiological activities is called _____.
    A. Flue Gas Corrosion
    B. Atmospheric Corrosion
    C. Cooling Water Corrosion
    D. None of the Above
    E. All of the Above

5. 5. What structure is 410 stainless steel?
    A. Martensitic
    B. Austenitic
    C. Duplex
    D. Ferritic

6. The sudden rapid fracture under stress (residual or applied) where the material exhibits little or no evidence of ductility or plastic deformation is called _____.
    A. 885º F Embrittlement
    B. Temper Embrittlement
    C. Stress Corrosion Cracking
    D. Brittle Fracture

7. What structure is 409 stainless steel?
    A. Martensitic
    B. Austenitic
    C. Duplex
    D. Ferritic

8. Low alloy steels contain a maximum of _____ chrome.
    A. 5%
    B. 6%
    C. 7.5%
    D. 9%

9. Which of the following can be affected by 885º F Embrittlement?
    A. 410 SS
    B. 430 SS
    C. 308 SS
    D. Alloy 2205
    E. A, B and D

10. For 5Cr-0.5Mo, what is the threshold temperature for creep?
    A. 500º F
    B. 800º F
    C. 600º F
    D. 700º F

11. _____ has been a major problem on coke drum shells.
    A. Thermal fatigue
    B. Stress cracking
    C. Erosion
    D. Temper embrittlement

12. Thermal fatigue cracks propagate _____ to the stress and are usually dagger shaped, transgranular and oxide-filled.
    A. Axial
    B. Diagonal
    C. Transverse
    D. Angular

13. Inspection for wet H2S damage generally focuses on _____ and _____.
    A. Weld seams
    B. Nozzles
    C. Trays
    D. Down comers
    E. A and B

14. _____ is a form of erosion caused by the formation and instantaneous collapse of innumerable tiny vapor bubbles.
    A. Condensate corrosion
    B. Cavitation
    C. Dew-Point corrosion
    D. Atmospheric corrosion

15. With CUI, corrosion rates _____ with increasing metal temperatures up to the point where the water evaporates quickly.
    A. Decrease
    B. Increase
    C. Stay the same
    D. None of the above

16. Which of the following metals is the most anodic?
    A. Zinc
    B. Carbon Steel
    C. Nickel
    D. Monel

17. Cracking of dissimilar weld metals occurs on the _____ side of a weld between an austenitic and a Ferritic material operating at high temperatures.
    A. Austenitic
    B. Ferritic
    C. Anodic
    D. Cathodic

18. Soil to Air interface areas are usually more susceptible to corrosion than the rest of the structure because of _____ and _____ availability.
    A. Moisture
    B. Bacteria
    C. Oxygen
    D. B and C
    E. A and C

19. Carburization can be confirmed by substantial increases in _____ and loss of _____.
    A. Hardness
    B. Tensile Strength
    C. Ductility
    D. A and B
    E. A and C

20. Liquid metal embrittlement can occur if 300 Series SS comes in contact with molten _____.
    A. Copper
    B. Mercury
    C. Zinc
    D. Lead

21. Cracks that are typically straight, non-branching, and devoid of any associated plastic deformation are likely associated with which type of failure?
    A. Stress corrosion cracking
    B. Brittle fracture
    C. Thermal fatigue
    D. Temper embrittlement

22. At high temperatures, metal components can slowly and continuously deform under load below the yield strength. This time dependent deformation of stressed components is known as _____?
    A. Creep
    B. Ductility
    C. Softening
    D. Hardening

23. Permanent deformation occurring at relatively low stress levels as a result of localized overheating is called _____.
    A. Stress cracking
    B. Brittle fracture
    C. Temper embrittlement
    D. Stress rupture

24. _____ usually occurs when a colder liquid contacts a warmer metal surface.
    A. Brittle fracture
    B. Thermal fatigue
    C. Thermal shock
    D. Stress rupture

25. Nickel based alloys usually contain _____ nickel.
    A. ≥30%
    B. ≥20%
    C. ≥10%
    D. ≥12%

26. _____ is a change in the microstructure of certain carbon steels and 0.5Mo steels after long-term operation in the 800º F to 1100º F range that may cause a loss in strength, ductility and/or creep resistance.
    A. Embrittlement
    B. Carburization
    C. Graphitization
    D. Sensitization

27. _____ is usually found in aqueous environments or services where water is sometimes or always present, especially where stagnant or low-flow conditions allow the growth of microorganisms.
    A. MIC
    B. HIC
    C. SOHIC
    D. None of the above

28. With chloride stress corrosion cracking, _____ temperatures _____ the susceptibility for cracking.
    A. Decreasing, Increases
    B. Increasing, Increases
    C. Increasing, Decreases
    D. Decreasing, Eliminates

29. _____ is a form of cracking that results when certain molten metals come in contact with specific alloys. Cracking can be very sudden and brittle in nature.

A. SCC
B. LME
C. AET
D. SOHIC

30. Amine cracking has been reported down to ambient temperatures with some amines. _____ temperatures and stress levels _____ the likelihood and severity of cracking.

A. Increasing increases
B. Increasing, decreases
C. Decreasing increases
D. Increasing, reduces

31. Carbonate stress corrosion cracking usually occurs at welds or cold worked areas that _____.

A. Have been stressed relieved
B. Have not been stressed relieved
C. Have high residual stress
D. Have high-applied stress

32. Nitriding is usually confined to the surface of most components and will have a dull, _____ appearance. In more advanced stages, the material will exhibit very hard surface hardness.

A. Gray
B. Black
C. Brown
D. White

33. Carbon steel is susceptible to SCC when used in _____ service.

A. Hydrogen
B. Ammonia
C. High temperature
D. High pressure

34. The grain size has an important influence on the high temperature ductility and on the reheat cracking susceptibility. A _____ grain size results in _____ ductile heat affected zones, making the material more susceptible to reheat cracking.

A. Large, more
B. Small. Less
C. Large, Less
D. Small, More

35. Equipment that is temper embrittled may be susceptible to _____ during start-up and shutdown.

A. Creep
B. Thermal fatigue
C. Brittle fracture
D. Stress fatigue

36. Amine stress corrosion cracking is a term applied to the cracking of steels under the combined actions of _____ and _____ in aqueous alkanolamine systems used to remove/absorb H^2S and/or CO^2 and their mixtures from various gas and liquid hydrocarbon streams.

A. Temperature, pressure
B. Pressure, stress
C. Temperature, corrosion
D. Tensile stress, corrosion

37. _____ is similar to HIC but is a potentially more damaging form of cracking which appears as arrays of cracks stacked on top of each other. The result is a through thickness crack that is perpendicular to the surface and is driven by high levels of stress.

A. MIC
B. SOHIC
C. Sulfuric SCC
D. None of the above

38. Weld heat affected zone graphitization is most frequently found in the heat-affected zone adjacent to welds in a narrow band, corresponding to the low temperature edge of the heat affected zone, In multi-pass welded butt joints, these zones overlap each other covering the entire cross section. Because of its appearance, this type of graphitization is called_____.

A. Half-moon
B. Eyebrow
C. Radii
D. None of the above

39. At a given pressure, the H^2S concentration in the sour water _____ as temperature _____.

A. Increases, increases
B. Decreases, decreases
C. Increases, decreases
D. Decreases, increases

40. In order for PASCC to occur the material must be _____.

A. PWHT
B. Non-PWHT
C. Sensitized
D. Austenetic

41. Which API RP recommends programs to monitor small-bore piping, flange faces, blistering and HIC/SOHIC in HF alky units?

A. 574
B. 751
C. 571
D. 980

42. Low creep ductility is _____ severe in high tensile strength materials and welds.

A. More
B. Less
C. Usually
D. Not

43. _____ is most likely found in hard weld and heat-affected zones and in high strength components.

A. HIC
B. SSC
C. SOHIC
D. Blistering

44. At elevated temperature, the carbide phases in certain carbon steels are unstable and may decompose into _____. This decomposition is known as graphitization.

A. Silicon
B. Graphite nodules
C. Carbon dust
D. Graphite dust

45. Hydrogen blisters may form as surface bulges on the ID, the OD on within the wall thickness of a pipe or pressure vessel. Blistering occurs from hydrogen generated by _____, not hydrogen gas from the process stream.

A. H^2S
B. Corrosion
C. Hydriding
D. Sulfur

46. Since all fuels contain some amount of sulfur, sulfuric and sulfurous acid _____ can occur if the metal temperature is below this temperature.

A. Corrosion
B. Pitting
C. Dew point corrosion
D. All of the above

47. The best way to prevent 885º F embrittlement is to use low _____ alloys, or to avoid exposing the susceptible material to the embrittling range.

A. Austenite
B. Martensite
C. Ferrite
D. Chromium

48. The amplitude and frequency of vibration as well as the _____ of the components are critical factors in vibration-induced fatigue.

A. Velocity
B. Temperature
C. Fatigue resistance
D. Material properties

49. Cavitation is best prevented by avoiding conditions that allow the absolute pressure to fall below the _____ of the liquid or by changing the material properties.

A. Minimum pressure
B. Pressure/vapor ratio
C. Maximum pressure
D. Vapor pressure

50. Hardness levels above _____ are highly susceptible to hydrogen stress cracking (HF).Time-to-failure decreases as the hardness increases.

A. 225 BHN
B. 237 BHN
C. 241 BHN
D. 247 BHN

51. _____ are the most common type of equipment susceptible to carburization in the refining industry.

A. Reactors
B. Heat exchangers
C. Heater tubes
D. Fin Fans

52. Different organisms thrive on different nutrients including inorganic substances (Sulfur, H^2S), and organic substances (Hydrocarbons, Organic acids). In addition, all organisms require a source of carbon, nitrogen and _____ for growth.

A. Oxygen
B. Water
C. Manganese
D. Phosphorous

53. In design and fabrication, it is advisable to avoid sharp changes in cross section, such as short radius fillets or undercut that can give rise to _____. Long-seam welds are particularly susceptible to reheat cracking due to mismatch caused by fit up problems.

A. Stress concentrations
B. Cracking
C. Circumferential stress
D. All of the above

54. The most important factors affecting graphitization are the chemistry, stress, temperature and _____.

A. Velocity
B. Time at exposure
C. Pressure
D. Ductility

55. Creep damage is found in high temperature equipment operating above the _____. Fired heater tubes and components, Catalytic reactors, FCC reactors and FCC fractionator and regenerator internals all operate in or near this.

A. Transition range
B. MADT
C. Creep range
D. None of the above

56. Amine stress corrosion cracking is most often associated with lean amine services. The pure alkanolamine does not cause cracking. Cracking in rich amine services are most often associated with _____ problems.

A. H^2S
B. Stress
C. Wet H^2S
D. Temperature

57. The loss in strength from spheroidization (Softening) is usually accompanied by a(n) _____ in ductility, which allows for deformation at stress concentrations.

A. Increase
B. Decrease
C. Reduction
D. Yield

58. Which of the following materials is not susceptible to high temperature hydrogen attack?

A. 300 Series SS
B. 5 Cr-1Mo
C. 9Cr-1Mo
D. All of the above

59. Which of these materials are susceptible to creep damage?

A. Carbon steel
B. Stainless steel
C. Low alloy steel
D. All of the above

60. High temperature hydrogen attack results from exposure to hydrogen at elevated temperatures and pressures. The hydrogen reacts with _____ in steel to produce _____, which cannot diffuse through the steel. The loss of carbides causes an overall loss in strength.

A. Carbides, oxygen
B. Alloys, hydrogen dioxide
C. Carbides, methane
D. Hydrogen dioxide, H^2S

61. Ferritic stainless steels are usually not used in _____ applications.

A. Non-pressure boundary
B. Pressure boundary
C. High temperature
D. Low temperature

62. Stress ruptures are characterized by _____ failures and are usually accompanied by thinning at the fracture surface.

A. Rapid
B. Fish-mouth
C. Tensile
D. None of the above

63. With hydrofluoric acid corrosion, corrosion rates increase with _____ temperatures and _____ HF concentrations.

A. Increasing, decreasing
B. Decreasing, increasing
C. Increasing, increasing
D. Decreasing, decreasing

64. Which of the following materials is susceptible to CO^2 corrosion?

A. Carbon steel
B. Stainless steel
C. Duplex stainless steel
D. Both B and C

65. Steel hardness, _____ and stress are critical factors in causing hydrogen stress cracking.

A. Temperature
B. Alloy composition
C. Strength
D. None of the above

66. If the BHN is 400-500 it may indicate _____.

A. Carburization
B. Hydriding
C. Temper embrittlement
D. Caustic embrittlement

67. The graphitization rate _____ with increasing temperature.

A. Increases
B. Decreases
C. Stops
D. Proceeds

68. The level of creep damage is a function of the material and the coincident _____ level at which the creep deformation occurs.

A. Pressure/Temperature
B. Pressure/Stress
C. Temperature/Stress
D. None of the above

69. Titanium should not be used in known hydriding services such as _____ or _____.

A. Caustic, amine
B. Amine, sour water
C. Sour water, Alkylation
D. All of the above

70. Convert these temperatures – 156º C and 450º F

A. 304º F, 151º C
B. 284º F, 218º C
C. 312º F, 232º C
D. 296º F, 246º C

71. Which of the following alkanolamine systems is the most aggressive in causing amine corrosion?

A. Monoethanolamine (MEA)
B. Diglycolamine (DGA)
C. Diethanolamine (DEA)
D. Methyldiethanolamine (MDEA)

72. _____ is a loss in toughness due to a metallurgical change that can occur in alloys containing a ferrite phase, as a result of exposure in the temperature range 600º F to 1000º F.

A. Caustic embrittlement
B. Notch toughness
C. 885º F embrittlement
D. Ductile embrittlement

73. Hydrochloric acid corrosion is a general and localized corrosion and is very aggressive to most common materials of construction. Damage in refineries is often associated with dew point corrosion in which vapors containing _____ and hydrogen chloride condense from the overhead stream of a distillation, fractionation, or stripping tower.

A. O^2
B. O
C. H^2O
D. CO^2

74. When connected to a more anodic material, titanium may suffer severe _____.

A. Corrosion
B. Hydriding
C. Stress
D. Notch toughness

75. _____ is a form of stress corrosion cracking normally occurring during shutdowns, startups or during operation when air and moisture are present. Cracking is due to sulfur acids forming from sulfide scale, air and moisture acting on sensitized stainless steel.

A. Caustic SCC
B. Chloride SCC
C. Polythionic acid SCC
D. None of the above

76. _____ usually occurs when a colder liquid contacts a warmer metal surface.

A. Stress cracking
B. Thermal fatigue
C. Thermal shock
D. Stress shock

77. Which of these materials is not susceptible to amine cracking?

A. Carbon steel
B. 300 Series SS
C. 400 Series SS
D. Both B and C

78. The presence of _____ in H^2S streams increases the severity of high temperature sulfide corrosion at temperatures above about 500º F

A. Amine
B. Hydrogen
C. Sulfides
D. All of the above

79. Increasing chromium content in the alloy improves resistance to sulfidation. However, there is little improvement with increasing chromium content until about _____ Cr.

A. 3-5
B. 5-7
C. 7-9
D. 9-12

80. _____ is the sudden rapid fracture under stress (residual or applied) where the material exhibits little or no evidence of ductility or plastic deformation.

A. Thermal fatigue
B. Thermal shock
C. Brittle fracture
D. Stress fracture

81. Caustic embrittlement cracking can be effectively prevented by means of PWHT at a temperature of _____.

A. 1100º F
B. 1150º F
C. 1200º F
D. 1250º F

82. General or localized corrosion of carbon steels and other metals caused by dissolved salts, gases, organic compounds or microbiological activity is called _____.

A. Cooling water corrosion
B. Oxidation
C. MIC
D. None of the above

83. With CO^2 corrosion, increasing temperatures _____ corrosion rates up to the point where CO^2 is vaporized.

A. Decrease
B. Increase
C. Eliminate
D. None of the above

84. Units where graphitization may be suspected are the FCCU and the _____ unit.

A. Hydrotreater
B. Coker
C. Alky
D. None of the above

85. Where is PASCC normally located?

A. Adjacent to welds
B. On impellers
C. At stress risers
D. At flanges

86. All _____ based materials and low alloy materials, 300 Series SS and 400 Series SS are susceptible to Sulfidation.

A. Carbon
B. Steel
C. Chromium
D. Iron

87. Sulfuric acid promotes general and localized corrosion of carbon steel. Carbon steel heat affected zones may experience severe corrosion. Acid concentration, temperature, alloy content and _____ are critical factors affecting sulfuric acid corrosion.

A. Pressure
B. Stress
C. Velocity
D. Ductility

88. Which of these materials are susceptible to brittle fracture?

A. Carbon steels
B. Low alloy steels
C. 400 Series SS
D. All of the above

89. _____ is a form of environmental cracking that can initiate on the surface of high strength low alloy steels and carbon steels with highly localized zones of high hardness in the weld metal and HAZ as a result of exposure to aqueous HF acid service.

A. Sulfide stress cracking
B. Hydrogen stress cracking
C. Caustic stress cracking
D. Hydrogen induced cracking

90. HCl acid corrosion is found in several units, especially _____ and _____, units, hydroprocessing units and catalytic reformer units.

A. Amine, crude
B. Crude, Alkylation
C. Vacuum, Amine
D. Crude, Vacuum

91. Cracking can occur at low caustic levels if a concentrating mechanism is present. In such cases, caustic concentrations of _____ ppm are sufficient to cause cracking.

A. 50-100
B. 100-150
C. 150-200
D. 200-250

92. Which of these materials is susceptible to 885º F embrittlement?

A. 400 Series SS
B. Duplex SS
C. 5Cr-1Mo
D. Both A and B

93. Spheroidization and graphitization are competing mechanisms that occur at overlapping temperature ranges. Spheroidization tends to occur preferentially above _____ while graphitization predominates below this temperature.

A. 1000º F
B. 1025º F
C. 1050º F
D. 1100º F

94. Sulfidation is primarily caused by _____ and other reactive sulfur species as a result of the thermal decomposition of sulfur compounds at high temperatures.

A. Sulfur dioxide
B. H^2S
C. Sulfur trioxide
D. Sulfates

95. Damage from sigma phase appears in the form of _____.

A. Corrosion
B. Hardness
C. Cracking
D. Ductility

96. The extent and depth of decarburization is a function of temperature and _____.

A. Pressure
B. Material properties
C. Exposure time
D. Velocity

97. Corrosion of the anode may be significantly higher _____ to the connection to the cathode, depending on solution conductivity.

A. Parallel
B. Adjacent
C. Diagonally
D. Perpendicular

98. Conditions favoring carburization include a high gas phase carbon activity and _____ oxygen potential.

A. Low
B. High
C. Negative
D. Positive

99. Susceptibility to temper embrittlement is largely determined by the presence of the alloying elements manganese and _____.

A. Chromium
B. Moly
C. Silicon
D. None of the above

100. Improved resistance to erosion is usually achieved through increasing substrate _____ using harder alloys, hard facing or face-hardening treatment.

A. Composition
B. Stress
C. Hardness
D. None of the above

101. Alloys with nickel content above _____ are highly resistant to Cl SCC. The greatest susceptibility is 8% to 12% nickel.

A. 15%
B. 20%
C. 30%
D. 35%

102. _____ corrosion rates are found in a gas oil desulfurizers and hydrocrackers than naphtha desulfurizers and hydrocrackers by a factor of almost “2”.

A. Lower
B. Higher
C. Sulfidization
D. Hydrogen corrosion

103. The accepted way to test for temper embrittlement is _____.

A. Impact testing
B. Metallographic
C. RT
D. UT Shear wave

104. _____ eliminates the susceptibility of most common steels to SCC.

A. Preheat
B. High temperature
C. PWHT
D. All of the above

105. Changing to a more corrosion resistant and/or higher hardness material _____ improve cavitation resistance.

A. Will
B. May
C. Will not
D. May not

106. Dew point corrosion can occur if the metal temperature is below the dew point. The dew point of sulfuric acid is _____.

A. 280º F
B. 220º F
C. 310º F
D. 190º F

107. All piping and equipment exposed to HF acid at any concentration with hardness levels above _____ are subject to hydrogen stress cracking.

A. 200 BHN
B. 210 BHN
C. 227 BHN
D. 237 BHN

108. Cooling water corrosion and _____ are closely related and should be considered together.

A. Stress
B. Velocity
C. Fouling
D. Erosion

109. Which of the following materials is not susceptible to SCC?

A. Carbon steel
B. 300 Series SS
C. Low alloy steel
D. Both A and C

110. Graphitization can be prevented by using chromium containing low alloys steels for long-term exposure above _____.

A. 650º F
B. 700º F
C. 750º F
D. 800º F

111. Welds joining dissimilar materials (ferritic and austenetic) may suffer _____ related damage at high temperatures due to differential thermal expansion stresses.

A. Stress
B. Creep
C. Fatigue
D. Thermal stress

112. Carbon steel and low alloy steels are subject to excessive hydrochloric acid corrosion when exposed to any concentration of HCl acid that produces a pH below_____.

A. 6.0
B. 5.5
C. 5.0
D. 4.5

113. Amine corrosion depends on the design, operating practices, the type of amine, amine concentration, temperature and _____.

A. Pressure
B. Velocity
C. Stress
D. None of the above

114. _____ is the main concern during start-up, shutdown and/or hydro testing for equipment/piping operating at elevated temperatures. This event can also occur in an auto refrigeration event in units processing light hydrocarbons.

A. Stress fracture
B. Carburization
C. Spheroidization
D. Brittle fracture

115. If wet electrodes or high moisture content flux weld electrodes are used to weld carbon steel, hydrogen can be charged into the steel resulting in _____.

A. Reduced tensile strength
B. Loss of ductility
C. Delayed cracking
D. All of the above

116. Thermal fatigue cracks usually initiate on the _____ of the component. They are generally wide and filled with oxides due to the elevated temperatures.

A. Surface
B. ID
C. Welds
D. None of the above

117. _____ caustic concentrations and _____ temperatures increase the likelihood and severity of cracking with caustic embrittlement.

A. Increasing, Decreasing
B. Decreasing, Increasing
C. Decreasing, Decreasing
D. Increasing, Increasing

118. For pressure vessels, inspection should focus on welds of _____ operating in the creep range.

A. CrMo alloys
B. Carbon steel
C. Stainless steel
D. Low hydrogen electrodes

119. With Cl SCC, _____ levels of chloride _____ the likelihood of cracking.

A. Decreasing, Increases
B. Increasing, Decreases
C. Increasing, Increases
D. Increasing, Eliminates

120. Dissimilar weld metal cracking forms at the toe of the weld in the heat affected zone of the _____ material.

A. Ferritic
B. Austenitic
C. Martensitic
D. Both B and C

121. The major factors affecting high temperature sulfidation are the temperature, the presence of hydrogen, the concentration of H^2S and the _____.

A. Alloy content
B. Velocity
C. Pressure
D. Water content

122. Stainless steels have higher coefficients of thermal expansion than carbon steel or low alloy steel or nickel based alloys and are more likely to see _____.

A. Higher temperatures
B. Higher stresses
C. Higher pressure
D. None of the above

123. What standard refers to Risk-Based-Inspection?

A. RP 581
B. RP 579
C. RP 588
D. RP 568

124. Carburization can be confirmed by a substantial increase in hardness and a _____ in ductility.

A. Loss
B. Gain
C. Change
D. None of the above

125. In vessels and piping, creep cracking can occur where high metal temperatures and _____ occur together.

A. Pressures
B. Stress concentrations
C. Velocities
D. None of the above

126. Temper embrittlement _____ be prevented if the material contains critical levels of the embrittling impurity elements and is exposed in the embrittling range.

A. Can
B. Cannot
C. Will
D. None of the above

127. Cl SCC usually occurs at metal temperatures above _____.

A. 125º F
B. 175º F
C. 140º F
D. 200º F

128. Corrosion rates of the anode will be less affected if there is a _____ anode to cathode ratio.

A. Large
B. Small
C. Severe
D. None of the above

129. Hydrogen permeation or diffusion rates have been found to be minimal at pH _____ and increase at both higher and lower pH's.

A. 4
B. 5
C. 6
D. 7

130. Cooling water corrosion can result in many different forms of damage including general corrosion, pitting corrosion, _____, stress corrosion cracking and fouling.

A. MIC
B. HIC
C. SOHIC
D. All of the above

131. Ammonium chloride salts may be whitish, greenish or _____.

A. Reddish
B. Brownish
C. Yellowish
D. Bluish

132. Stainless steel cyclones, piping ductwork and valves in high temperature FCC regeneration service are susceptible areas for _____.

A. Brittle fracture
B. Sigma phase
C. Cavitation
D. Corrosion fatigue

133. Non-stressed relieved _____ is susceptible to stress corrosion cracking when in contact with moist HF vapors in the presence of oxygen.

A. Carbon steel
B. Alloy 400
C. 300 Series SS
D. 400 Series SS

134. Higher _____ containing alloys are used for improved resistance to naphthenic acid corrosion.

A. Chromium
B. Carbon
C. Molybdenum
D. All of the above

135. Which material below is not susceptible to caustic corrosion?

A. Carbon steel
B. 400 Series SS
C. 300 Series SS
D. Low alloy steel

136. If weld repairs are required, the effects of temper embrittlement can be temporarily reversed (de-embrittled) by heating at _____ for 2 hours per inch of thickness and rapidly cooling to room temperature.

A. 1000º F
B. 1150º F
C. 1200º F
D. 1250º F

137. For carbon steel, common velocity limits are generally limited to _____ fps for rich amine and _____ fps for lean amine.

A. 8-10, 30
B. 6-9, 15
C. 4-8, 10
D. 3-6, 20

138. Heat treatment can have a significant effect on the toughness and hence fatigue resistance of a metal. In general, _____ grained microstructures tend to perform better than _____ grained.

A. Fine, Course
B. Austenetic, martensitic
C. Course, Fine
D. Martensitic, austenetic

139. Short term overheating is a permanent deformation occurring at relatively _____ stress levels as a result of localized overheating. This usually results in bulging and failure by stress rupture.

A. Low
B. High
C. Even
D. None of the above

140. Temperature, _____ and stress are critical factors of stress rupture. This is usually found in furnaces with coking tendencies and fired heater tubes.

A. Pressure
B. Ductility
C. Time
D. Tensile strength

141. The effects of hydrogen embrittlement _____ with _____ temperatures.

A. Increase, increasing
B. Decrease, decreasing
C. Increase, decreasing
D. Decrease, increasing

142. Temper embrittlement can be identified by a(n) shift in the ductile-to-brittle transition temperature measured in a Charpy impact test.

A. Upward
B. Downward
C. Abrupt
D. None of the above

143. Cooling water corrosion is a concern with water-cooled _____ and cooling towers in all applications across all industries.

A. Pumps
B. Vessels
C. Piping
D. Exchangers

144. _____ is a change in the microstructure of steels after exposure in the 850º F to 1400º F range, where the carbide phases in carbon steels are unstable and may agglomerate from their normal plate-like appearance.

A. Carburization
B. Spheroidization
C. Graphiding
D. 885º Embrittlement

145. Corrosion rates of the anode can be high if there is a _____ anode to cathode ratio.

A. Large
B. Small
C. Severe
D. None of the above

146. Application of a post-fabrication stress relieving heat treatment of about _____ is a proven method of preventing carbonate cracking.

A. 1100º F
B. 1150º F
C. 1200º F
D. 1250º F

147. Ammonium chloride corrosion is the general or localized corrosion, often pitting, normally occurring under ammonium chloride or amine salt deposits. All commonly used materials are susceptible to ammonium chloride corrosion. A small amount of _____ can lead to very aggressive corrosion.

A. Ammonium chloride
B. Amine
C. Water
D. Salt

148. _____ is a mechanical form of degradation that occurs when a component is exposed to cyclical stresses for an extended period, often resulting in sudden, unexpected failure.

A. Stress fatigue
B. Mechanical fatigue
C. Thermal fatigue
D. Cyclic fatigue

149. _____ and _____ damage develop without applied or residual stress so that PWHT will not prevent them from occurring.

A. SOHIC, Blistering
B. SCC, SOHIC
C. HIC, SCC
D. Blistering, HIC

150. Corrosion protection in the boiler is accomplished by laying down and continuously maintaining a layer of _____.

A. Manganese
B. Magnetite
C. Carbon monoxide
D. Carbonate

151. Susceptibility to hydrogen stress cracking _____ with _____ hardness.

A. Increases, increasing
B. Decreases, increasing
C. Decreases, Decreasing
D. Both A and C

152. Which of these materials are not susceptible to Spheroidization?

A. Carbon steel
B. 9Cr-1Mo
C. 316 SS
D. Both A and B

153. Naphthenic acid corrosion is most severe in _____ flow; in areas of high velocity or turbulence and in distillation towers where hot vapors condense to form liquid phase droplets.

A. Single phase
B. Two phase
C. Three phase
D. Negative phase

154. Nitriding begins above _____ and becomes severe above _____.

A. 500º F, 800º F
B. 600º F, 900º F
C. 800º F, 1000º F
D. 700º F, 1100º F

155. In fired heater tubes, dissimilar weld metal cracking forms primarily on the _____ of the material.

A. Outside
B. Inside
C. Welds
D. All of the above

156. Which of these materials exhibit an endurance limit below which fatigue cracking will not occur?

A. Carbon steel
B. 300 Series SS
C. 400 Series SS
D. None of the above

157. Soil corrosion of carbon steel can be minimized through the use of special backfill, coatings and _____.

A. Cathodic protection
B. Resistivity
C. Temperature
D. None of the above

158. Which of the following materials are generally not suitable for HF service?

A. 300 Series SS
B. Carbon steel
C. 400 Series SS
D. Both A and C

159. In piping and equipment, creep cracking can occur where high metal temperatures and _____ occur together. Creep cracking, once initiated, can progress rapidly.

A. Pressures
B. Stress risers
C. Velocities
D. None of the above

160. At elevated temperatures, dissimilar weld metal cracking is aggravated by the diffusion of carbon out of the weld metal and into the base metal. The temperature at which carbon diffusion becomes a concern is above _____.

A. 700º F
B. 750º F
C. 800º F
D. 900º F

161. Exposure to high solution strength caustic can result in general corrosion or high corrosion rates above _____.

A. 175º F
B. 150º F
C. 125º F
D. 100º F

162. Typical HF Alkylation units operate with 1% to 3% water in the acid, equivalent to an HF-in-water concentration of 97% to 99% and the temperatures are generally below _____.

A. 300º F
B. 250º F
C. 200º F
D. 150º F

163. With decarburization, the decarburized layer will be free of carbide phases. Carbon steel will be _____.

A. Annealed
B. Quenched
C. Pure iron
D. None of the above

164. What is the chemical symbol for ethane or ethylene?

A. C^2
B. C3
C. C4
D. CH4

165. Naphthenic acid corrosion is a form of high temperature corrosion that occurs primarily in crude and vacuum units and downstream units that process certain fractions that contain naphthenic acid. Which of the following materials is susceptible to naphthenic acid corrosion?

A. Carbon steel
B. 300 Series SS
C. 400 Series SS
D. All of the above

166. A form of corrosion caused by living organisms such as bacteria, algae or fungi is _____ .

A. HIC
B. SOHIC
C. MIC
D. None of the above

167. _____ are characterized by a localized loss in thickness in the form of pits, grooves, gullies, waves, rounded holes and valleys. These losses often exhibit a directional pattern.

A. Erosion
B. Corrosion/Erosion
C. Environmental corrosion
D. Both A and B

168. The best method to inspect for SCC is ____.

A. WFMT
B. UT Shear wave
C. AET
D. All of the above

169. Stainless steels with sigma can normally withstand normal operating stresses but upon cooling to temperatures below _____ may show a complete lack of fracture toughness as measured by a Charpy impact test.

A. 800º F
B. 600º F
C. 500º F
D. 400º F

170. Regular and controlled carbon grades of stainless steels such as types 304/304H and 316/316H are particularly susceptible to sensitization in the weld HAZ. Low carbon “L” grades are less susceptible and usually can be welded without sensitizing. The “L” grades will not sensitize provided long term operating temperatures do not exceed about _____.

A. 700º F
B. 750º F
C. 800º F
D. 900º F

171. Increasing the chromium in steels offers no major improvement in resistance to CO^2 corrosion until a minimum of _____ is reached.

A. 9%
B. 12%
C. 5%
D. 7%

172. _____ significantly increases the probability and severity of blistering, HIC and SOHIC.

A. Hydrogen
B. Oxygen
C. Cyanide
D. Caustic

173. Annealed steels are more resistant to Spheroidization than normalized steels. _____ grained steels are more resistant than _____ grained steels.

A. Fine, Course
B. Course, Fine
C. PWHT, Non-PWHT
D. Non-PWHT, PWHT

174. High strength, low allow steels such as A193-B7 bolts and compressor parts are susceptible to hydrogen stress cracking. A193-B7M bolts are susceptible if _____.

A. Exposed
B. Overtorqued
C. Double nutted
D. None of the above

175. Which of the following materials is not susceptible to Cl SCC?

A. 400 Series SS
B. Duplex SS
C. Nickel based alloys
D. All of the above

176. Caustic embrittlement is a form of stress corrosion cracking characterized by surface-initiated cracks that occur in piping and equipment exposed to caustic, primarily adjacent to non-PWHT welds. Which of the following materials is the most resistant to embrittlement?

A. Carbon steel
B. Nickel based alloys
C. Low alloy steels
D. 400 Series SS

177. _____ is the result of cyclic stresses caused by variations in temperature.

A. Cyclic cracking
B. Stress cracking
C. Stress fatigue
D. Thermal fatigue

178. Corrosion due to acidic sour water containing H^2S at a pH between 4.5 and 7.0 is called sour water corrosion. Carbon dioxide (CO^2) may also be present. Which of the following materials is susceptible to sour water corrosion?

A. Carbon steel
B. 300 Series SS
C. 400 Series SS
D. Both B and C

179. _____ of a component is the most important factor in determining a components resistance to mechanical fatigue.

A. Design
B. Temperature
C. Stress
D. Pressure

180. A condition where steel loses strength due to the removal of carbon and carbides leaving only an iron matrix is called decarburization. This occurs during high temperatures, during PWHT and from exposure to fires. Which of the following materials is not affected by this?

A. Low alloy steel
B. Duplex SS
C. Carbon steel
D. None of the above

181. Dissimilar metal welds with a 300 Series stainless steel weld metal on a ferritic steel may also result in narrow region of _____ at the toe of the weld, near the fusion line on the ferritic side.

A. Ductility
B. Hardness
C. Cracking
D. None of the above

182. Stress levels and _____ are the critical factors causing carbonate stress corrosion cracking.

A. Temperature
B. Velocity
C. Water chemistry
D. None of the above

183. Cracking of dissimilar weld metals occurs in the _____ side of a weld joining 300 Series SS and carbon steel.

A. Austenitic
B. Ferritic
C. Both of the above
D. None of the above

184. Wet H^2S services or _____ acid services are process where hydrogen diffuses into the steel and hydrogen embrittlement (HE) is an issue.

A. HF
B. Sulfuric
C. Caustic
D. HCL

185. Which of the following materials is susceptible to sigma phase embrittlement?

A. Carbon steel
B. Low alloy steel
C. 300 Series SS
D. Both A and B

186. A quick test for embrittlement from _____ is a bend test or crush test. Unaffected material will be crushed in a ductile fashion while embrittled components will crack with no signs of ductility.

A. Titanium Hydriding
B. Temper embrittlement
C. Caustic embrittlement
D. None of the above.

187. Refractory anchors must be resistant to _____ in high temperature services.

A. Thermal fatigue
B. Thermal cracking
C. Stress cracking
D. Oxidation

188. For a specific material, HTHA is dependent on temperature, hydrogen partial pressure, time and _____.

A. Stress
B. Pressure
C. Velocity
D. Alloy composition

189. The severity of hydrochloric acid corrosion _____ with _____ HCl concentration and increasing temperatures.

A. Decreases, decreasing
B. Increases, increasing
C. Decreases, increasing
D. Increases, decreasing

190. Corrosion from oxygen tends to be _____ type damage and can show up anywhere even if only very small amounts break through the scavenging system.

A. General
B. Localized
C. Pitting
D. Cracking

191. Vessels constructed after December, 1987 are subject to the requirements of _____ of ASME Section VIII, Division 1.

A. UW-26
B. UG-31
C. UB-54
D. UCS-66

192. In most cases, brittle fracture occurs only at temperatures below the Charpy impact transition temperature. Steel cleanliness and _____ have a significant influence on toughness and resistance to brittle fracture.

A. Alloy composition
B. Tensile strength
C. Grain size
D. Pressure

193. Which of the following materials is affected by high temperature corrosion?

A. Carbon steel
B. 300 Series SS
C. 400 Series SS
D. All of the above

194. For some materials such as titanium, carbon steel and low alloy steel, the number of cycles to fatigue fracture decreases with _____ until an endurance limit is reached. Below this endurance limit, fatigue cracking will not occur, regardless of the number of cycles.

A. Temperature increases
B. Stress endurance
C. Pressure decreases
D. None of the above

195. In HF service, carbon steel forms a protective fluoride scale in dry concentrated acid. Loss of the protective scale through high _____ or turbulence will result in greatly accelerated corrosion rates.

A. Temperature
B. Pressure
C. Velocities
D. None of the above

196. Oxidation of carbon steel begins to become significant above _____.

A. 800º F
B. 900º F
C. 1000º F
D. 1100º F

197. Cracks connecting hydrogen blisters are referred to as _____.

A. SOHIC
B. HIC
C. SCC
D. None of the above

198. PWHT is _____ in preventing caustic SCC.

A. Effective
B. Not effective
C. Not practical
D. None of the above

199. Sulfur and chlorine species in fuel will form sulfur dioxide, sulfur trioxide and hydrogen chloride within the combustion products. At low enough temperatures, these gases and the water vapor in the flue gas will condense to form _____ acid.

A. Hydrochloric
B. Hydrofluoric
C. Sulfuric
D. Both A and C

200. With thermal fatigue, time to failure is a function of the magnitude of the stress and the number of cycles and decreases with _____ stress and _____ cycles.

A. Increasing, Decreasing
B. Increasing, Increasing
C. Decreasing, Decreasing
D. Decreasing, Increasing

201. Carbonate cracking typically propagates _____ to the weld; the pattern of cracking observed on the surface is sometimes described as _____.

A. Transverse, Eyebrow
B. Parallel, Spider web
C. Diagonal, Half moon
D. Perpendicular, Stair step

202. Dissimilar weld metal cracking occurs because the coefficients of thermal expansion between ferritic steels and 300 Series stainless steels differ by _____ or more.

A. 10%
B. 15%
C. 20%
D. 30%

203. _____ is when oxygen reacts with carbon steel and other alloys at high temperatures converting the metal to oxide scale.

A. High temperature corrosion
B. Oxidation
C. Dealloying
D. Thermal fatigue

204. With steam blanketing, failure occurs as a result of _____ in the tube from the internal steam pressure at the elevated temperature.

A. Stress risers
B. Velocity
C. Hoop stress
D. Tensile strength

205. Once cracking from LME has occurred, grinding out the affected area _____ an acceptable fix.

A. Is
B. Is not
C. Can be
D. Can not be

206. Cavitation is a form of erosion caused by the formation and instantaneous collapse of innumerable tiny vapor bubbles. Temperatures approaching the boiling point of the liquid are _____ to result in bubble formation.

A. Less likely
B. More likely
C. Not likely
D. None of the above

207. Hardness is primarily an issue with SSC. Typical low strength carbon steels should be controlled to produce weld hardness less than _____.

A. 225 BHN
B. 237 BHN
C. 200 BHN
D. 240 BHN

208. Characteristic stress corrosion cracks have many branches and may be visually detectable by a _____ appearance on the surface.

A. Tree shaped
B. Craze-cracked
C. Multiple crack
D. None of the above

209. Which of these materials are not susceptible to PASCC?

A. Carbon steel
B. 300 Series SS
C. 400 Series SS
D. Both A and C

210. _____ cooling water outlet temperatures and/or process side outlet temperatures tend to _____ corrosion rates as well as fouling tendency.

A. Increasing, decrease
B. Decreasing, decrease
C. Decreasing, increase
D. Increasing, increase

211. Localized corrosion due to the concentration of caustic or alkaline salts that usually occurs under evaporative conditions is ___.

A. Carbonate corrosion
B. Caustic corrosion
C. Alkaline corrosion
D. None of the above

212. _____ is the reduction in toughness due to a metallurgical change that can occur in some low alloy steels as a result of long-term exposure in the temperature range of about 650º F to 1100º F.

A. Hardening
B. Graphitization
C. Spheroidization
D. Temper embrittlement

213. Vibration-induced fatigue can be eliminated or reduced through _____ and the use of supports and vibration dampening equipment. Material upgrades are not usually a solution.

A. Hangers
B. Dummy legs
C. Design
D. None of the above

214. Lean amine is generally not corrosive because they have either low conductivity and/or high pH. Corrosion rates increase with increasing temperatures, particularly in rich amine service. Temperatures above _____ can result in acid gas flashing and severe localized corrosion.

A. 170º F
B. 190º F
C. 220º F
D. 240º F

215. Cracking of a metal due to stress relaxation during PWHT or in service at elevated temperatures is called _____. It is most often found in heavy wall sections.

A. Thermal cracking
B. Reheat cracking
C. Step-like cracking
D. None of the above

216. Which if the following materials are not susceptible to hydrogen stress cracking?

A. Carbon steel
B. Low alloy steel
C. Stainless steel
D. None of the above

217. Carbon dioxide corrosion results when CO^2 dissolves in water to form _____ acid.

A. Sulfuric
B. Hydrochloric
C. Carbonic
D. None of the above

218. In pressure containing equipment, SOHIC and SCC damage is most often associated with _____.

A. Internals
B. Weldments
C. Branches
D. None of the above

219. Refractory lined equipment should be designed for erosion, thermal shock and _____.

A. Thermal fatigue
B. Thermal expansion
C. Thermal contraction
D. All of the above

220. Amine corrosion refers to the general and/or localized corrosion that occurs principally on _____ in amine treating processes. Corrosion is not caused by the amine itself, but results from dissolved acid gases (CO^2 and H^2S), amine degradation products, heat stable amine salts and other contaminants.

A. Carbon steel
B. Duplex SS
C. 300 Series SS
D. 400 Series SS

221. Naphthenic acid is _____ by catalytic reactions in downstream hydroprocessing and FCC units.

A. Enhanced
B. Destroyed
C. Concentrated
D. Diluted

222. MIC is often found in _____, bottom water of storage tanks, piping with stagnant or low flow and piping in contact with some soils.

A. Vessels
B. Heat exchangers
C. Drums
D. All of the above

223. Thermal fatigue cracks usually propagate _____ to the stress and they are usually dagger-shaped.

A. Parallel
B. Diagonal
C. Transverse
D. Across

224. Surface initiated cracks caused by environmental cracking of 300 Series SS and some nickel based alloys under the combined action of tensile stress, temperature and an aqueous chloride environmental is called _____. The presence of dissolved oxygen _____ the propensity for cracking.

A. Cl SCC, Increases
B. Stress cracking, Increases
C. Cl SCC, Decreases
D. Stress cracking, Decreases

225. What is the chemical symbol for propane or propylene?

A. C^2
B. C3
C. C4
D. CH4

226. In general, the resistance of iron and nickel based alloys to sulfidation is determined by the _____ content of the material.

A. Chromium
B. Carbon
C. Molybdenum
D. Alloying

227. SSC is a form of hydrogen stress cracking resulting from the absorption of _____ that is produced by the sulfide corrosion process on the metal surface.

A. Sulfur dioxide
B. Hydrogen sulfide
C. Atomic hydrogen
D. Hydrogen chloride

228. For galvanic corrosion to take place, three conditions must be met, presence of an electrolyte, two different materials or alloys and _____.

A. A cathode
B. An anode
C. An electrical connection
D. None of the above

229. The signature mark of a fatigue failure is a _____ type fingerprint that has concentric rings.

A. Eyebrow
B. Half-Moon
C. Radii
D. Clam Shell

230. With creep, increased stress due to loss in thickness from corrosion will _____ time to failure.

A. Increase
B. Reduce
C. Not affect
D. None of the above

231. In general, the resistance of carbon steel and other alloys to High temperature corrosion is determined by the _____ content of the material.

A. Molybdenum
B. Chromium
C. Carbon
D. All of the above

232. Susceptibility of an alloy to sulfidation is determined by its ability to form protective _____.

A. Oxide scales
B. Sulfide scales
C. Carbide scales
D. None of the above

233. With high temperature sulfide corrosion (Sulfidization), noticeable increases may be found downstream of _____ injection points.

A. Hydrogen
B. Caustic
C. Ammonia
D. Water

234. 300 Series SS, 400 Series SS and duplex SS are subject to pitting and localized corrosion under insulation. In addition, _____ are also subject to SCC if chlorides are present, while _____ are less susceptible.

A. Duplex SS, Low alloys
B. 300 Series SS, Duplex SS
C. Duplex SS, 300 Series Ss
D. None of the above

235. Sulfide stress cracking (SSC) is defined as cracking of metal under the combined action of tensile stress and corrosion in the presence of _____ and _____.

A. Sulfur, Oxide
B. Hydrogen, water
C. H^2S, Oxygen
D. Water, H^2S

236. Corrosion in boiler feedwater and condensate return systems is usually the result of dissolved gases, oxygen and _____.

A. Carbon monoxide
B. Carbon dioxide
C. Material properties
D. H^2S

237. Hydrogen blisters may form at many different depths from the surface of the steel, in the middle of the plate or near a weld. In some cases, neighboring or adjacent blisters that are at slightly different depths (planes) may develop cracks that link them together. Interconnecting cracks between the blisters often have a _____ appearance.

A. Crescent
B. Eyebrow
C. Step like
D. Jagged

238. There is currently no known metal alloy that is immune to _____ under all conditions.

A. Carburization
B. Metal dusting
C. Decarburization
D. None of the above

239. Low creep ductility is _____ prevalent at the lower temperatures in the creep range. Or low stresses in the upper creep range.

A. More
B. Less
C. Equally
D. None of the above

240. A hard, brittle surface layer will develop on some alloys due to exposure to high temperature process streams containing high levels of nitrogen compounds such as ammonia or cyanides, particularly under reducing conditions, is called _____.

A. Carburization
B. Spheroidization
C. Nitriding
D. None of the above

241. Formation of a metallurgical phase known as sigma phase results in a loss of _____ in some stainless steels as a result of high temperature exposure.

A. Ductility
B. Fracture toughness
C. Embrittlement
D. None of the above

242. Metallic components form a surface _____ when exposed to sulfur compounds. This may react with air (oxygen) and moisture to form sulfur acids (polythionic acid).

A. Oxide
B. Sulfide scale
C. Sulfate scale
D. Caustic scale

243. A form of mechanical fatigue in which cracks are produced as a result of dynamic loadings is _____.

A. Spheroidization
B. Vibration-induced cracking
C. Fatigue cracking
D. Stress cracking

244. Which of the following materials are susceptible to nitriding?

A. Carbon steel
B. 300 Series SS
C. 400 Series SS
D. All of the above

245. A loss in ductility of high strength steels due to the penetration of atomic hydrogen can lead to brittle cracking called hydrogen embrittlement. Which of the following materials is susceptible to HE.

A. Carbon steel
B. 400 Series SS
C. Low alloy steel
D. All of the above

246. Sulfidation of iron-based alloys usually begins at metal temperatures above _____.

A. 500º F
B. 600º F
C. 800º F
D. 1000º F

247. Cracks associated with brittle fracture will typically be _____.

A. Jagged
B. Branching
C. Straight
D. Perpendicular

248. Corrosion under insulation becomes more severe at metal temperatures between _____ and _____, where water is less likely to vaporize and insulation stays wet longer.

A. 100º C, 121º C
B. 92º C, 116º C
C. 114º C, 132º C
D. None of the above

249. High strength steels are susceptible to LME when they come in contact with molten _____.

A. Cadmium
B. Zinc
C. Lead
D. Both A and C

250. The more noble material, called the _____, is protected by sacrificial corrosion of the more active material, called the _____. The more active metal corrodes at a higher rate than it would if it were not connected to the more noble metal.

A. Anode, Cathode
B. Cathode, Anode
C. Alpha, Omega
D. None of the above

251. What standard refers to Fitness-For-Service evaluations?

A. RP 581
B. RP 579
C. RP 588
D. RP 568

252. Metal dusting is preceded by _____ and is characterized by rapid metal wastage.

A. Decarburization
B. Carburization
C. Graphitization
D. None of the above

253. _____ testing is the best method to determine the susceptibility of a material to hydrogen stress cracking.

A. Hardness
B. Acoustic
C. SWUT
D. AUT

254. In a pump, the difference between the actual pressure, or head, of a liquid available (measured on the suction side) and the vapor pressure of that liquid is called Net Positive Suction Head (NPSH) available. The minimum head required to prevent cavitation with a given liquid at a given flow rate is called Net Positive Suction Head _____. Inadequate NPSH can result in cavitation.

A. Surplus
B. Required
C. Reserve
D. None of the above

255. Which of the following are affected by sulfidation?

A. Carbon steel
B. 300 Series SS
C. 400 Series SS
D. All of the above

256. What is the chemical symbol for butane of butylenes?

A. C^2
B. C3
C. C4
D. CH4

257. When carbon is absorbed into a material at elevated temperatures while in contact with a carbonaceous substance it is called carburization. Temperatures usually have to be above _____ for this to occur.

A. 1000º F
B. 1100º F
C. 1200º F
D. 1400º F

258. The most common method used for monitoring underground structures is measuring the structure to soil _____ using dedicated reference electrodes near the structure.

A. Resistivity
B. Corrosiveness
C. Potential
D. Electrolyte

259. With short term overheating, time to failure will _____ as internal pressures or loading decrease.

A. Increase
B. Decrease
C. Remain the same
D. None of the above

260. Which of the following are susceptible to thermal fatigue?

A. SA-516-70
B. SA-182 Gr B
C. SA-53 Gr B
D. All of the above

261. Amine cracking is _____ likely to occur in lean MEA and DEA services than in MDEA and DIPA services.

A. More
B. Less
C. As
D. None of the above

262. _____ is a form of carburization resulting in accelerated localized pitting which occurs in carburizing gases and/or process streams containing carbon and hydrogen. Pits usually form on the surface and may contain soot or graphite dust.

A. Hydrate corrosion
B. Carbide corrosion
C. Spheroidization
D. Metal dusting

263. Fatigue cracks usually initiate on the surface at notches or _____ under cyclic loading.

A. Branches
B. Laterals
C. Stress concentrations
D. Grinding marks

264. _____ greatly increases the probability and severity of blistering, HIC and SOHIC damage.

A. Acids
B. Caustics
C. Amines
D. Cyanides

265. Proper application of _____ will control but not eliminate microbes that cause MIC so that continued treatment is necessary.

A. Ozone
B. Caustic
C. Biocides
D. None of the above

266. Carbonate stress corrosion cracking is the term applied to surface breaking or cracks that occur adjacent to carbon steel welds under the combined action of _____ and _____ in carbonate containing systems.

A. Temperature, stress
B. Tensile stress, corrosion
C. Corrosion, velocity
D. Tensile stress, velocity

267. Soils having high moisture content, high dissolved salt concentrations and high _____ are the most corrosive.

A. Oxygen content
B. Resistivity
C. Acidity
D. All of the above

268. Erosion-corrosion is a description for the damage that occurs when corrosion contributes to erosion by removing protective films or scales, or by exposing the metal surface to further _____ under the combined action of corrosion-erosion.

A. Stress
B. Corrosion
C. Oxidation
D. None of the above

269. Although the loss of toughness from temper embrittlement is not evident at operating temperatures, equipment that is temper embrittled may be susceptible to _____ during start-up and shutdown.

A. Thermal fatigue
B. Cyclic stress
C. Notch toughness
D. Brittle fracture

270. Alloys with increased amounts of _____ show improved resistance to naphthenic acid corrosion.

A. Chromium
B. Molybdenum
C. Nickel
D. Carbon

271. Steam blanketing is when the heat flow balance is disturbed; individual bubbles join to form a steam blanket, a condition known as Departure from Nucleate Boiling (DNB). Once a steam blanket forms, tube rupture can occur rapidly, as a result of _____.

A. Thermal fatigue
B. Short term overheating
C. Brittle fracture
D. Stress

272. Caustic stress corrosion cracking typically propagates _____ to the weld in adjacent base metal but can occur in the weld deposit or heat affected zone.

A. Transverse
B. Perpendicular
C. Parallel
D. Across

273. Start-up and shutdown of equipment increase the susceptibility of thermal fatigue. There is no set limit on temperature swings; however, as a practical rule, cracking may be suspected if the temperature swing exceeds about _____.

A. 150º F
B. 200º F
C. 250º F
D. 300º F

274. Corrosion of carbon steel and other alloys from their reaction with sulfur compounds in high temperature environments is called _____. The presence of hydrogen accelerates corrosion.

A. Sulfide corrosion
B. High temperature corrosion
C. H^2S corrosion
D. Sulfidation

275. Primarily hot-wall piping and equipment in the following units can be affected by graphitization. FCC, catalytic reformer and _____.

A. Hydrotreater
B. Hydrocracker
C. Coker
D. Alky

276. Preventative measures to minimize the potential for brittle fracture in existing equipment are limited to controlling _____ and _____, minimizing pressure at ambient temperatures during start-up and shutdown and periodic inspections at high stress locations.

A. Temperature, stress
B. Stress, pressure
C. Velocity, stress
D. Temperature, Pressure

277. _____ is most likely found in hard welds and heat affected zones and in high strength components.

A. SOHIC
B. HIC
C. Carburization
D. SSC

278. MIC is often characterized by _____ within pits in carbon steel.

A. Oxide
B. Tubercles
C. Worm holes
D. Cup shaped pits

279. Hydriding of titanium is a metallurgical phenomenon in which hydrogen diffuses into the titanium and reacts to form an embrittling phase. This can result in a complete loss of _____ with no noticeable sign of corrosion or loss of thickness.

A. Strength
B. Ductility
C. Carbides
D. Hardness

280. Which of the methods are effective for finding thermal fatigue cracks?

A. MT
B. PT
C. VT
D. All of the above

281. Which of the following alkanolamine systems is the least aggressive in causing amine corrosion?

A. Monoethanolamine (MEA)
B. Diglycolamine (DGA)
C. Diethanolamine (DEA)
D. Methyldiethanolamine (MDEA)

282. 300 Series SS is susceptible to LME when it comes in contact with molten _____.

A. Cadmium
B. Mercury
C. Zinc
D. Lead

283. A form of corrosion that can occur at the junction of dissimilar metals when they are joined together in a suitable electrolyte is ____.

A. Galvanic corrosion
B. Anodic corrosion
C. Cathodic corrosion
D. All of the above

284. Which of the following materials is susceptible to carburization?

A. Low alloy steels
B. 300 Series SS
C. 400 Series SS
D. All of the above

285. Corrosion by HF (Hydrofluoric) acid can result in high rates of general or localized corrosion and may be accompanied by hydrogen cracking, blistering and _____.

A. HIC
B. Delayed cracking
C. SOHIC
D. Both A and C

286. SCC generally occurs below about _____.

A. 150º F
B. 180º F
C. 210º F
D. 240º F

287. Titanium Hydriding damage occurs primarily in sour water strippers and amine units in the overhead condensers, heat exchanger tubes and other titanium equipment operating above _____.

A. 300º F
B. 270º F
C. 210º F
D. 165º F

288. Geometry, stress level, _____ and material properties are the predominate factors in determining the fatigue resistance of a component.

A. Temperature
B. Pressure
C. Velocity
D. Number of cycles

289. Sigma phase occurs in Ferritic, martensitic, austenitic and duplex stainless steels when exposed to temperatures in the range of _____.

A. 537º C – 954º C
B. 621º C – 926º C
C. 676º C – 760º C
D. 584º C – 840º C

290. Which of the following materials are subject to mechanical fatigue?

A. Carbon steels
B. Stainless steels
C. Low alloy steels
D. All of the above

291. Hydrogen stress cracking is the same mechanism that is responsible for sulfide stress corrosion cracking in wet H^2S environments except that HF acid is generating the _____.

A. Sulfide
B. Caustic
C. Hydrogen
D. Water

292. Sulfidation is also known as _____.

A. Sulfur corrosion
B. Sulfate corrosion
C. Sulfidic corrosion
D. None of the above

293. _____ is a selective corrosion mechanism in which one or more constituents of an alloy are preferentially attacked leaving a lower density often-porous structure.

A. Phenol corrosion
B. Dealloying
C. Carburization
D. Preferentially weld attack

294. Amine units are used in refineries to remove H^2S, CO^2 and _____ from process streams originating in many units including the coker, crude, FCC and hydrogen.

A. NA^2
B. Cl^2
C. Mercaptans
D. None of the above

295. Areas of vulnerability in sulfuric acid Alkylation units include reactor effluent lines, reboilers, deisobutanizer, overhead systems and the _____ treating system.

A. Caustic
B. Sulfuric acid
C. Catalyst
D. H^2S

296. Alloy 400 is susceptible to LME when it comes in contact with molten _____.

A. Cadmium
B. Mercury
C. Zinc
D. Lead

297. Thermal fatigue damage is in the form of cracking that may occur anywhere in a metallic component where relative movement is constrained, particularly under repeated _____.

A. Cyclic stresses
B. Thermal cycling
C. Pressure variations
D. All of the above

298. _____ is often found in piping and equipment that handles caustic, including H^2S and mercaptan removal units, as well as equipment that uses caustic for neutralization in sulfuric acid and HF acid units.

A. Carburization
B. Sulfide corrosion
C. Caustic embrittlement
D. Hydrogen cracking

299. Soil corrosion appears as external thinning with localized losses due to _____.

A. Resistivity
B. Pitting
C. General corrosion
D. Potential

300. At high temperatures, metal components can slowly and continuously deform under load below the yield stress. This time dependent deformation of stressed components is known as _____.

A. Deformation
B. Fatigue
C. Creep
D. Thermal fatigue

301. Foul smelling water may be a sign of fouling and/or _____

A. MIC
B. HIC
C. SOHIC
D. All of the above

302. Caustic is sometimes added to process streams for _____ or as a reactant.

A. Stability
B. Corrosion control
C. Neutralization
D. Inhibiting

303. Contrary to a pure mechanical fatigue, there is no _____ load in corrosion-assistant fatigue. Corrosion promotes failure at a lower stress and number of cycles than the materials normal endurance.

A. Tensile
B. Stress
C. Ductile
D. Fatigue limit

304. A form of fatigue cracking in which cracks develop under the combined effects of cyclic loading and corrosion is called _____. Cracking often initiates at stress concentrations such as a pit in the surface.

A. Cyclic cracking
B. Corrosion fatigue
C. Stress fatigue
D. Stress cracking

305. Refractory anchor material must be compatible with the _____ of the base metal

A. Composition
B. Welding
C. Thermal coefficient
D. Ductility

306. _____ material sections also have a _____ resistance to brittle fracture due to higher constraint, which increases triaxial stresses at the crack tip.

A. Thinner, Lower
B. Thicker, Lower
C. Thinner, Higher
D. Thicker, Higher

307. Stresses acting on the weldments are significantly _____ when austenitic stainless steel filler metal is used. A nickel based filler metal has a coefficient of thermal expansion closer to carbon steel resulting in significantly lower stress at elevated temperatures.

A. Lower
B. Higher
C. Altered
D. None of the above

308. SCC usually occurs at pH values above two (2). SCC tendency _____ toward the alkaline pH region.

A. Increases
B. Decreases
C. Stabilizes
D. None of the above

309. _____ cracking has been a major problem in coke drum shells.

A. Stress
B. Carburization
C. Thermal fatigue
D. Sulfide

310. Damage due to _____ is not visible and can only be observed by metallographic examination.

A. Galvanic corrosion
B. Brittle fracture
C. Cavitation
D. Graphitization

311. Temper embrittlement is a metallurgical change that is not readily apparent and can be confirmed through _____.

A. Metallographic examination
B. Impact testing
C. Metallography
D. None of the above

312. With 885º F embrittlement, increasing amounts of _____ increase susceptibility to damage when operating in the high temperature range of concern.

A. Chromium
B. Hardness
C. Ferrite
D. Hydrogen

313. In susceptible materials, the primary factor that affects sigma phase formation is the _____ at elevated temperatures.

A. Time of exposure
B. Pressure
C. Stress
D. Velocity

314. Sigma phase in welds can be minimized by controlling ferrite in the range of _____ for Type 347 SS.

A. 3%-5%
B. 5%-7%
C. 7%-9%
D. 5%-9%

315. Steel cleanliness and _____ have a significant influence on toughness and resistance to brittle fracture.

A. Composition
B. Alloy
C. Grain size
D. None of the above

316. In most cases, brittle fracture occurs only at temperatures _____ the Charpy impact transition temperature.

A. Above
B. Below
C. Around
D. Inside

317. The rate of creep deformation is a function of the material, load and temperature. The rate of damage is sensitive to both load and temperature. Generally, an increase of about _____ or an increase of _____ on stress can cut the remaining life in half.

A. 25º F, 15%
B. 50º F, 10%
C. 50º F, 15%
D. 25º F, 10%

318. Creep and stress rupture is more likely in a _____ grained material than a _____ grained material.

A. Course, Fine
B. Fine, Course
C. Austenetic, Martensitic
D. None of the above

319. The creep threshold temperature for 1 ¼, 2 ¼, 5 and 9 Cr is _____.

A. 600º F
B. 700º F
C. 800º F
D. 1000º F

320. The creep threshold temperature for carbon steel is _____.

A. 315º C
B. 371º C
C. 426º C
D. 538º C

321. Key factors affecting thermal fatigue are the magnitude of the temperature and the _____.

A. Number of cycles
B. Pressure
C. Stress
D. Alloy composition

322. A form of thermal cracking, _____, can occur when high and non-uniform thermal stresses develop over a relatively short period of time in a piece of equipment due to differential expansion and contraction.

A. Thermal expansion
B. Thermal stress
C. Thermal shock
D. Linear expansion

323. Geometry, stress level, number of cycles and _____ are the predominate factors in determining the fatigue resistance of a component.

A. Temperature
B. Material properties
C. Pressure
D. Velocity

324. With cooling water corrosion, _____ oxygen content tends to _____ carbon steel corrosion rates.

A. Increasing, increasing
B. Decreasing, decreasing
C. Decreasing, increasing
D. Increasing, decreasing

325. 300 Series SS can suffer pitting corrosion, crevice corrosion and _____ in fresh, blackish and salt water.

A. General corrosion
B. Oxidation
C. SCC
D. None of the above

326. With very few exceptions, cooling water should always be on the _____ side to minimize stagnant areas.

A. Tube
B. Shell
C. Inlet
D. Outlet

327. Corrosion in boiler feedwater and condensate return systems is usually the result of dissolved gases, oxygen and _____.

A. Carbon monoxide
B. H^2O
C. Temperature
D. Carbon Dioxide

328. Carbon dioxide (CO^2) corrosion results when CO^2 dissolves in water to form _____.

A. Carbon monoxide
B. Carbonic acid
C. Hydrofluoric acid
D. None of the above

329. The primary factors affecting high temperature oxidation are metal temperature and _____.

A. Pressure
B. Alloy composition
C. Stress
D. Oxygen

330. _____ is the primary alloying agent that affects resistance to oxidation.

A. Chromium
B. Molybdenum
C. Silicon
D. Aluminum

331. With sulfidation, the presence of oxygen _____ corrosion

A. Increases
B. Decreases
C. Has no effect on
D. Stops

332. Major factors affecting sulfidation are alloy composition, temperature and _____.

A. Time
B. Stress
C. Concentration of hydrogen
D. Concentration of sulfur

333. _____ is a form of carbon that may promote carburization, particularly during decoke cycles where temperatures exceed the normal operating temperatures.

A. Carbonic acid
B. Coke
C. Crude oil
D. None of the above

334. Components that have been carburized may have a change in the level of _____.

A. Carbon
B. Chromium
C. Ferromagnetism
D. Stress

335. To prevent carburization, select alloys with a strong surface oxide or sulfide film former such as _____.

A. Silicon
B. Molybdenum
C. Aluminum
D. Both A and C

336. Decarburization results in a _____, which can be confirmed by hardness testing.

A. Hardness
B. Softness
C. Brittleness
D. Oxidizing

337. _____ is accelerated high temperature wastage of materials that occurs when contaminants in the fuel form deposits and melt on the metal surfaces.

A. Spheroidization
B. Dealloying
C. Fuel ash corrosion
D. None of the above

338. Nitriding layers are magnetic. Therefore, _____ should be checked for magnetism as an initial screening for nitriding.

A. 300 Series SS
B. 400 Series SS
C. Duplex SS
D. Low alloy steel

339. _____ is surface initiated cracks caused by environmental cracking of 300 Series SS and some nickel based alloys under the combined action of tensile stress, temperature and an aqueous chloride environment. The presence of dissolved oxygen increases the propensity for cracking.

A. SSC
B. SOHIC
C. Cl SCC
D. HIC

340. A fatigue fracture is brittle and the cracks are most often _____.

A. Parallel
B. Transgranular
C. Intergranular
D. Transverse

341. When caustic stress corrosion cracking is a concern, steam out of _____ carbon steel piping and equipment should be avoided.

A. PWHT
B. Non-PWHT
C. Ferritic
D. Hardened

342. Although cracks may be seen visually, crack detection for caustic stress corrosion cracking is best detected by WFMT, EC, RT and _____.

A. PT
B. MT
C. ACFM
D. All of the above

343. With ammonia stress corrosion cracking weld hardness should not exceed _____ BHN.

A. 237
B. 225
C. 235
D. 218

344. Galvanized steel components should not be welded to _____ due to LME.

A. 300 Series SS
B. 400 Series SS
C. Carbon steel
D. Duplex SS

345. If wet electrodes or high moisture content flux is used, _____ can be charged into the steel resulting in delayed cracking.

A. Atomic hydrogen
B. Hydrogen
C. Oxygen
D. H^2O

346. To prevent hydrogen embrittlement, use lower strength steels and _____ to temper the microstructure, improve ductility and reduce residual stresses.

A. Alloys
B. Preheat
C. PWHT
D. All of the above

347. Amine cracking is a form of _____ stress corrosion cracking.

A. Hydrogen
B. Caustic
C. Polythionic
D. Alkaline

348. SSC is a form of _____ stress corrosion cracking.

A. Hydrogen
B. Caustic
C. Polythionic
D. Alkaline

349. _____ of the amine system is the most effective way to prevent amine corrosion.

A. Proper concentration
B. Proper operation
C. Proper design
D. Proper startup

350. Ammonium chloride salts are hydroscopic and readily absorb water. A _____ amount of water can lead to very aggressive ammonium chloride corrosion.

A. Large
B. Small
C. Proper
D. Improper

351. The major factors affecting high temperature sulfidation are the temperature, the presence of hydrogen, the H^2S concentration and the _____.

A. Pressure
B. Stress
C. Alloy composition
D. Velocity

352. With HF acid corrosion, oxygen contamination _____ the corrosion rate of carbon steel and promotes accelerated corrosion and SCC of Alloy 400.

A. Increases
B. Decreases
C. Maintains
D. Eliminates

353. With sour water corrosion, at a given pressure, the H^2S concentration in the sour water _____ as temperatures _____.

A. Increases, increases
B. Decreases, decreases
C. Increases, decreases
D. Decreases, increases

354. With sulfuric acid corrosion, carbon steel corrosion rates increases significantly if the flow velocity exceeds about _____m fps or at acid concentrations below _____.

A. 6-9, 80%
B. 5-7, 75%
C. 2-3, 65%
D. 4-6, 85%

355. Blistering, HIC and SOHIC have been found to occur between ambient and _____.

A. 250º F
B. 300º F
C. 350º F
D. 400º F

356. SSC generally occurs below about _____.

A. 225º F
B. 200º F
C. 180º F
D. 150º F

357. SOHIC is driven by localized stresses so that _____ is somewhat effective in preventing SOHIC damage.

A. PWHT
B. Preheat
C. Temperature
D. None of the above

358. Blistering, HIC, SOHIC and SSC damage can occur wherever there is a _____ environment.

A. Wet H^2S
B. Hydrogen
C. Sulfur
D. Aqueous

359. Cracking susceptibility increases with _____ pH and carbonate concentration.

A. Increasing
B. Decreasing
C. Low
D. High

360. Dissimilar weld metal cracking can be aggravated by _____.

A. Stress
B. Pressure
C. Thermal cycling
D. Cyclic stresses

361. Stress relief and stabilization heat treatment of 300 Series SS for maximizing chloride SCC and PASCC resistance can cause _____ problems, especially in thicker sections.

A. Thermal fatigue
B. Reheat cracking
C. Hydrogen
D. HIC

362. The dewpoint of hydrochloric acid depends on the concentration of hydrogen chloride. It is typically about _____.

A. 180º F
B. 160º F
C. 130º F
D. 110º F

363. SCC tendency _____ towards the alkaline pH region.

A. Decreases
B. Increases
C. Remains constant
D. Varies

364. It is generally accepted that stresses approaching _____ are required for SCC to occur so that thermal stress relief is effective in preventing caustic SCC.

A. MAWP
B. Yield
C. Creep range
D. Critical

365. Cadmium and lead will cause LME on _____.

A. Copper alloys
B. 300 Series SS
C. Aluminum alloys
D. High strength steel

366. The regenerator reboiler and the regenerator are areas where the temperature and _____ of the amine stream are the highest and can cause significant corrosion problems.

A. Pressure
B. Stress
C. Turbulence
D. Concentration

367. With sour water corrosion, corrosion increases with _____ NH4HS concentration and _____ velocity.

A. Increasing, Decreasing
B. Increasing, Increasing
C. Decreasing, Decreasing
D. Decreasing, Increasing

368. Oxygen and iron in the wash water injected into reactor effluent can lead to _____ corrosion and fouling.

A. Increased
B. Decreased
C. Substantial
D. Minimal

369. _____ injection downstream of the desalter is another common method used to reduce the amount of HCl going overhead.

A. Hydrogen
B. Nitrogen
C. Water
D. Caustic

370. Susceptibility to sulfidation is determined by the _____ of the material.

A. Corrosion resistance
B. Tensile strength
C. Chemical composition
D. Yield strength

371. High temperature H^2 / H^2S corrosion damage is minimized by using alloys with high _____ content.

A. Carbon
B. Molybdenum
C. Chromium
D. Stainless

372. In HF service, carbon steel forms a protective _____ scale in dry concentrated acid. Loss of the protective scale through high velocities or turbulence will result in greatly accelerated corrosion rates.

A. Chloride
B. Fluoride
C. Iron sulfide
D. Iron oxide

373. The presence of _____ can destabilize the scale and turn it into a nonprotective scale.

A. H^2S
B. O^2
C. H^2
D. H^2O

374. In HF service, carbon steel operating above _____ should be closely monitored for loss in thickness and may need to be upgraded to Alloy 400.

A. 150º F
B. 175º F
C. 160º F
D. 200º F

375. A minimum of _____ to _____ molybdenum is needed in an alloy to resist naphthenic acid corrosion.

A. 2%, 3%
B. 1 ½ %, 2 ½ %
C. 2%, 2 ½ %
D. 1%, 2%

376. NAC may be found in hot hydrocarbon streams downstream of the crude and vacuum units, _____ any hydrogen mix point.

A. Upstream of
B. Downstream of
C. Adjacent to
D. Around

377. _____ acid is most often used as a catalyst in polymerization units.

A. Polythionic
B. Naphthenic
C. Phosphoric
D. Sulfuric

378. With sour water corrosion, streams with a pH below _____ indicate the presence of a strong acid.

A. 7.0
B. 5.5
C. 6.0
D. 4.5

379. Sour water corrosion in _____ containing environments may be accompanied by carbonate SCC.

A. H^2O
B. H^2S
C. CO^2
D. O^2

380. Phosphoric acid corrosion is usually found in _____ areas.

A. High velocity
B. Low velocity
C. High temperature
D. Low temperature

381. Type 304L SS is satisfactory for phosphoric acid concentration of 100% up to about _____. Type 321 is required from there to 225º F.

A. 140º F
B. 150º F
C. 100º F
D. 120º F

382. 300 Series SS can be used for sour water service at temperatures below _____, where Chloride SCC is not likely.

A. 120º F
B. 140º F
C. 150º F
D. 175º F

383. With sulfuric acid corrosion, mix points with _____ cause heat to be released and high corrosion rates can occur where the acid becomes diluted.

A. Water
B. Hydrogen
C. H^2S
D. Caustic

384. With sulfuric acid corrosion, the presence of oxidizers can _____ the corrosion rate.

A. Increase
B. Decrease
C. Stabilize
D. Eliminate

385. With sulfuric acid corrosion, alloys such as Alloy 20 resist dilute acid corrosion and form a protective _____ film on the surface.

A. Sulfide
B. Chloride
C. Iron sulfate
D. Iron oxide

386. Which of the following materials are susceptible to polythionic acid SCC?

A. 300 Series SS
B. Alloy 600
C. Alloy 800
D. All of the above

387. Sensitization occurs in the _____ to _____ range.

A. 800º F, 1400º F
B. 750º F, 1500º F
C. 600º F, 1120º F
D. 1000º F, 1750º F

388. For furnaces, to prevent PASCC, keep the firebox heated above the dewpoint to keep _____ from forming.

A. Water
B. Acids
C. Moisture
D. Corrosion

389. The “L” grade of stainless steels will sensitize if exposed more than several hours above _____ or long term above _____.

A. 1200º F, 800º F
B. 1000º, 600º F
C. 1000º F, 750º F
D. 1100º F, 800º F

390. In order to minimize and prevent amine SCC, PWHT all carbon steel welds in accordance with API RP _____.

A. 751
B. 912
C. 510
D. 945

391. SSC is a form of hydrogen stress cracking resulting from the absorption of atomic hydrogen that is produced by the _____ corrosion process on the metal surface.

A. HCl
B. HF
C. Sulfide
D. Wet H^2S

392. _____ significantly increases the probability and severity of blistering, HIC and SOHIC damage.

A. Caustic
B. Cyanides
C. Stress
D. Temperature

393. All piping and equipment exposed to HF acid at any concentration with hardness levels above the recommended limit (237 BHN) are subject to _____.

A. Hydrogen stress cracking
B. Sulfide stress cracking
C. Chloride stress cracking
D. None of the above

394. Hydrogen stress cracking is the same mechanism that is responsible for sulfide stress corrosion cracking in wet H^2S environments except that HF acid is generating the _____.

A. Sulfide
B. Corrosion
C. Hydrogen
D. None of the above

395. Carbonate SCC can occur at relatively low levels of _____ but usually occurs at welds that have not been stressed relieved.

A. Residual stress
B. Applied stress
C. Acid concentration
D. None of the above

396. Carbonate SCC may easily be mistaken for SSC or SOHIC; however, the carbonate cracks are usually _____ the toe of the weld and have multiple parallel cracks.

A. Further from
B. Closer to
C. Diagonal to
D. Perpendicular to

397. 300 Series SS, 5Cr, 9Cr and 12Cr alloys are not susceptible to _____ at conditions normally seen in refineries.

A. Cl SCC
B. SOHIC
C. HTHA
D. HTLA

398. With high temperature hydrogen attack, _____ using a combination of velocity ratio and backscatter have been the most successful in finding cracking.

A. MT
B. UT
C. RT
D. EC

399. Reheat cracking is most frequently observed in _____ grained sections of a heat-affected zone.

A. Course
B. Fine
C. Dense
D. Treated

400. HTHA is dependant on temperature, hydrogen partial pressure, time and _____.

A. Pressure
B. Stress
C. Yield
D. Tensile strength

401. _____ is a form of damage found mostly in older vintage carbon steels and C-0.5 Mo low alloy steels under the combined effects of deformation and aging at an intermediate temperature.

A. Spheroidization
B. Thermal fatigue
C. Strain aging
D. None of the above

402. A vacuum tower operating at 740º F is being entered to inspect. Several sets of Type 410 SS trays are bent at various angles. The trays are removed in order to straighten them. When an attempt is made to straighten them cracks form at the bends. What type of damage mechanism would cause the cracks to form?

A. Hydrogen embrittlement
B. Sulfide stress corrosion cracking
C. 885º F embrittlement
D. High temperature corrosion

403. A steam actuated soot blower has condensate in the first steam exiting the soot blower. What type of damage can be expected to be found when the furnace is brought down for maintenance and inspection?

A. Thermal fatigue
B. Steam blanketing
C. Creep
D. Stress rupture

404. A 6", A106 Gr B, flanged line carrying caustic wash water at 200º F has signs of atmospheric corrosion. Which of the following may have help accelerate the corrosion?

A. Sulfides
B. Fly ash
C. Caustic
D. None of the above

405. Corrosion under insulation is more severe between _____ and _____.

A. 175º F, 212º F
B. 212º F, 250º F
C. 250º F, 300º F
D. 25º F, 250º F

406. Mitigation of CUI is best achieved by _____.

A. A properly documented inspection program
B. A properly installed insulation system
C. A properly applied coating system
D. A properly documented NDE program

407. A 5Cr-1Mo piping system in the hydrogen unit shows significant internal wall loss after 2 years in service due to CO^2 corrosion. Which material would be best suited to use to install a new pipe system?

A. Titanium
B. 9Cr-1Mo
C. A-106 Gr B
D. 316 SS

408. Which of these cast irons are not susceptible to graphitic corrosion?

A. Gray cast iron
B. Black Cast iron
C. White cast iron
D. None of the above

409. Which of the following materials are the least susceptible to caustic embrittlement?

A. Carbon steel
B. Stainless steel
C. 9Cr-0.5 Mo
D. Nickel base alloys

410. A carbon steel bundle from the overhead condenser in the crude unit operates at 300º F and is in hydrochloric acid service. It showed severe pitting type corrosion when pulled for inspection. What type of material would be best suited for this service?

A. 5Cr-0.5Mo
B. 316 stainless steel
C. 9Cr-1Mo
D. Titanium

411. 300 series stainless steel heater tubes in an oil-burning furnace in the hydrocracker began to leak and the furnace was brought down. What was the probable cause of the cracking?

A. Chloride stress corrosion
B. Polythionic acid stress corrosion
C. Amine stress corrosion
D. Stress oriented hydrogen induced cracking

ANSWERS

1. A
2. B
3. B
4. C
5. A
6. D
7. D
8. D
9. E
10. B
11. A
12. C
13. E
14. B
15. B
16. A
17. B
18. E
19. E
20. C
21. B
22. A
23. D
24. C
25. A
26. C
27. A
28. B
29. B
30. A
31. C
32. A
33. B
34. C
35. C
36. D
37. B
38. B

39. D
40. C
41. B
42. A
43. B
44. B
45. B
46. C
47. C
48. C
49. D
50. B
51. C
52. D
53. A
54. B
55. C
56. C
57. A
58. D
59. D
60. C
61. B
62. B
63. A
64. A
65. C
66. B
67. A
68. C
69. B
70. C
71. A
72. C
73. C
74. B
75. C
76. C
77. D
78. B
79. C
80. C
81. B
82. A
83. B
84. B

85. A
86. D
87. C
88. D
89. B
90. D
91. A
92. D
93. B
94. B
95. C
96. C
97. B
98. A
99. C
100. C
101. D
102. B
103. A
104. C
105. D
106. A
107. D
108. C
109. D
110. D
111. B
112. D
113. B
114. D
115. C
116. A
117. D
118. A
119. C
120. A
121. A
122. B
123. A
124. A
125. B
126. B
127. C
128. A
129. D
130. A

131. B
132. B
133. B
134. C
135. B
136. B
137. D
138. A
139. A
140. C
141. D
142. A
143. D
144. B
145. B
146. B
147. C
148. B
149. D
150. B
151. D
152. C
153. B
154. B
155. A
156. A
157. A
158. D
159. B
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