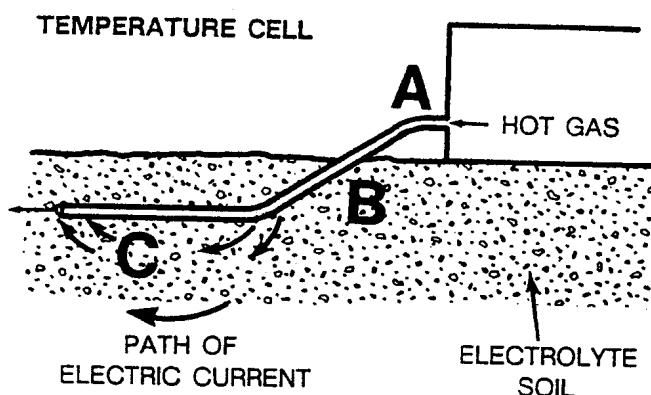


EXTERNAL FACTORS

102. There are several other factors that can alter the rate of corrosion.



The section of pipe that is hotter becomes the anode. In the above diagram the area which you would expect to be the anode is area _____.

103. Area A cannot be the anode because it is not completely surrounded by an _____.
104. The higher the temperature, the (faster / slower) corrosion occurs.
105. Stress can also increase the corrosion rate. Stress can be caused by such factors as pressure being applied to a metal or a bend in the metal.
- Stress tends to break a protective coating. So, the area under stress (will corrode / will not corrode).
106. The area under stress becomes the _____.
107. Another factor increasing the corrosion rate is stray electric currents in underground structures and pipes.

The structure or pipe then becomes the anode in the area in which the electric current (leaves / enters).

108. So, the area or surface that the current enters is the _____.

EVIDENCE OF CORROSION DAMAGE

109. When iron corrodes a layer of rust is visible.
- Many times the corrosion process leaves behind a corrosion _____, like rust.
110. Often a black powder is left behind. This product is usually iron sulfide. But, probably the most familiar form of a corrosion product to you is _____.

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111. Also, corrosion may cause weight loss in the metal and this causes the metal to (become thin / change color).

112. In addition, corrosion damage can be seen in many different forms.

Corrosion damage usually takes one of two forms — either uniform or localized.

As the name implies, uniform corrosion occurs when damage is relatively (evenly spread out / concentrated in a few spots) over the surface.

113. Uniform corrosion is directly related to area effect. Uniform corrosion would appear in a situation where there is a (large cathode and small anode / small cathode and large anode).

114. Localized corrosion, on the other hand, is corrosion that is relatively concentrated in a few areas.

Failures would occur (more rapidly / less rapidly) in localized corrosion than in uniform corrosion.

115. With regard to area effect, localized corrosion is more likely to occur when you have a (large cathode and small anode / small cathode and large anode).

116. More corrosion takes the form of localized corrosion than uniform corrosion.

Pitting is a very common form of localized corrosion in oilfield equipment. Damage tends to be (mild / severe).

117. Pitting can also take place on metal that had a protective coating. Pits occur when that layer has been _____ .

118. Pitting may also result from small droplets of moisture condensing on the metal. Corrosion will occur (under / on top of) these droplets.

EROSION CORROSION

119. Another form of localized corrosion is erosion corrosion. Erosion corrosion may be in the form of cavitation or impingement.

But, erosion corrosion occurs only in the presence of high velocity water or fluids containing water. Therefore, erosion corrosion would be more likely to appear on (pumps / storage tanks).

120. Pump cavitation occurs with the formation of bubbles in the liquid being pumped. When these bubbles collapse, energy is released.

When this energy comes into contact with metal, it can destroy the _____ coating.

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121. Pits occur where the coating (is destroyed / is not destroyed).
122. Impingement has very similar effects as cavitation. During impingement, the protective film is also _____.
123. Also, the visible damage is seen in the form of _____.
124. Small particles of debris or bubbles may "impinge" or cling to the metal. The velocity of the water causes the particles to break down into smaller particles. As with cavitation, energy is being _____.
125. Cavitation is a result of collapsing _____.

CORROSION FATIGUE

126. Corrosion fatigue, which usually shows up as cracks, is often caused by stress as a result of continuous reciprocating (back and forth) action.
In beam pumping units, _____ make frequent up and down movement.
127. Corrosion fatigue may also be caused by "cyclical" stress. If an object is rotating unevenly, stress or pressure is also applied unevenly.
So, the area that receives more stress will become the _____.
128. This corrosion fatigue increases stress and (increases / shortens) the time before a breakdown.
129. In addition, increasing rotation speed of equipment further _____ the life-span of the equipment.
130. Another type of corrosion fatigue is called "wear" corrosion.
As sucker-rods move up and down, _____ is continually applied and relieved.
131. As you learned earlier, stress (increases / decreases) the rate of corrosion.
132. Therefore, you expect corrosion to be a significant problem on _____.
133. The areas on sucker rods especially hard hit by this form of corrosion fatigue are the couplings.
For this reason, couplings are often made of special wear _____ metals.
134. Actually, the effect is more additive. The stress increases corrosion and the corrosion increases the _____.

HYDROGEN EMBRITTLEMENT

135. Another type of corrosion that results in cracking is hydrogen embrittlement.
As the name implies, hydrogen embrittlement involves _____ atoms.

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136. Hydrogen is often produced at the cathode during a _____ reaction.
137. This hydrogen, in atom form, is absorbed into the pores of the metal. The hydrogen then converts to molecules of hydrogen gas and expands.
- This causes (a decrease / an increase) in pressure inside the metal.
138. When enough hydrogen becomes trapped and the metal is in tension, a brittle failure or _____ can occur.

SULFIDE STRESS CRACKING

139. Yet another form of corrosion is found in sour crude locations.
- "Sour" indicates the presence of _____.
140. In this case, the presence of hydrogen sulfide aids in the penetration of hydrogen into certain steels.
- The hydrogen then creates enough internal pressure to cause _____.
141. However, special steel has been manufactured to _____ sulfide stress cracking.
142. When replacing steel components, you should always be certain to use a replacement made of the correct _____ in (sweet / sour) environments.

CORROSION AGENTS

143. Several environmental factors will affect the rate of corrosion.
- As you recall, temperature is one environmental factor that will influence corrosion. The higher the temperature, the (slower / faster) corrosion will occur.
144. The effects of water velocity were previously mentioned. The area with a higher water velocity will be (less corrosive / more corrosive).
145. This occurs because a protective layer is continuously broken and/or corrosion products are continuously removed. This type of corrosion is _____.
146. However, a small amount of velocity is desirable because it keeps particles from settling and forming deposits. As you will remember, the area under the deposits tends to _____.
147. Since oxygen cannot get under these deposits, an _____ - _____ cell can form.

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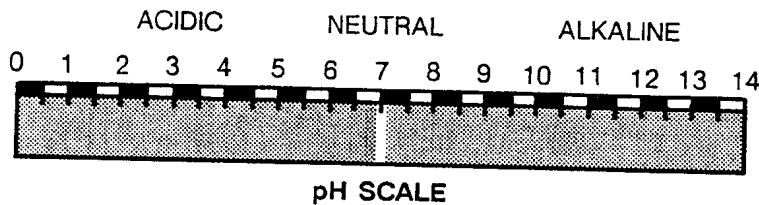
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148. Another factor influencing corrosion is the pH level of the electrolyte solution.

pH is an indication of the concentration of hydrogen in the solution.



pH 7 indicates a _____ solution.

149. A solution is acidic when the pH is (above / below) 7 and alkaline with pH (above / below) 7.
150. If you had two solutions, one with a pH of 6 and the other with a pH 1, the solution that would be more acidic is the solution with a pH of _____.
151. The lower the pH level in the electrolyte solution, the more corrosive it becomes.

Therefore, you would prefer to have an electrolyte with an (acidic / alkaline, or neutral) level.

GASES

152. Other factors influencing corrosion are the gases present in the environment.
- Many gases, such as carbon dioxide, hydrogen sulfide and oxygen, are basically only corrosive in the presence of moisture.
- If pipes above ground are exposed to these gases, corrosion will occur because the air contains _____.
153. Even pipes lying within soil or clay that are exposed to these gases will corrode because moisture is present in these (electrolytes / conductors).
154. When the gas, hydrogen sulfide, mixes with water, it becomes (passive / corrosive).
155. At low concentrations, hydrogen sulfide gives off an odor of rotten eggs. Therefore, when hydrogen sulfide is present in corrosion, it is known as (sweet / sour) corrosion.
156. This combination of hydrogen sulfide and water is especially corrosive to iron or steel. A black, porous substance is formed. This corrosion product is (iron carbonate / iron sulfide).

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