



Maximizing Earths Original Resources, L.L.C.

4610 S. 33rd Place • Phoenix, AZ 85040 • Phone: (480) 929-9194 • Fax: (480) 219-6875 • www.meor.net

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THREE TYPES OF CORROSION

I. General Corrosion

Corrosion can be defined as the destruction of a metal by chemical or electrochemical reaction with its environment. In down-hole treatment, corrosion causes two basic problems: failure of tubing with the resultant cost of replacement and oil production downtime.

Corrosion occurs at the anode, where metal dissolves. Often, this is separated by a physical distance from the cathode, where a reduction reaction can occur. An electrical potential difference exists between these sites and current flows through solution from the anode to the cathode. This is accompanied by a flow of electrons from the anode to the cathode through the metal:



The ferrous hydroxide $[\text{Fe}(\text{OH})_2]$ then combines with oxygen and water to produce ferric hydroxide, which becomes rust when dehydrated to Fe_2O_3 .

The Cathodic Reaction: $\frac{1}{2} \text{O}_2 + \text{H}_2\text{O} + 2\text{e}^{-} = 2\text{OH}^{-}$

The production of OH^{-} ions creates a localized high pH at the cathode about 1 to 2 pH units higher than the bulk solution pH. Dissolved oxygen reaches the surface by diffusion. The oxygen reduction reaction can control the rate of corrosion in down-hole systems.

Another Cathodic reaction: $2\text{H}^{+} + 2\text{e}^{-} = \text{H}_2$

At a neutral or higher pH, the concentration of H^{+} ions is too low for this reaction to occur at any great rate. This is the mechanism by which most down-hole general corrosion occurs.

II. Localized Corrosion (Pitting)

Pitting is one of the most destructive forms of corrosion and also one of the most difficult to predict in laboratory tests. Pitting occurs when anodic and cathodic sites become stationary, (under a scale or paraffin deposit) due to large differences in surface conditions of the metal. It is generally promoted by low velocity or stagnant conditions and by the presence of chloride ions. Once a pit is formed, the solution inside the pit, under the deposit, is isolated from the bulk solution and becomes increasingly corrosive with time. The *high corrosion rates* in the pit(s) produce an excess of positively charged metal **caution**, which attract the chloride anions ($\text{Fe}_{+2} + \text{Cl}^{-} \rightarrow \text{FeCl}_2$). In addition, hydrolysis produces H^{+} ions, resulting in HCl (Hydrochloric Acid) formation inside the pit itself further increasing its rate of corrosion. The process then becomes self-sustaining until a rupture finally occurs.



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Inhibitors can be used to control pitting; but they must be applied correctly and scale/paraffin formation must be removed and prevented.

III. Erosion Corrosion

Erosion Corrosion is the rate increase of metal deterioration from abrasive effects. It can be identified by grooves and rounded holes, which are usually smooth and have a directional pattern. Erosion Corrosion increases by high water velocities and increased suspended solid content. It is often localized at areas where water changes directions or bends in piping. This type of corrosion is difficult to protect against; unless a protective coating can be put on the piping and bends are minimized.