THE CO2 CORROSION MECHANISM

CO2 is naturally present in the ground, but it is also injected into wells as a method to increase oil recovery. The CO2 reacts with ground water (H2O), to produce carbonic acid (H2CO3):

\[
\text{CO}_2(g) \leftrightarrow \text{CO}_2(aq)
\]

\[
\text{CO}_2(aq) + \text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{CO}_3(aq)
\]

For the production of Carbonic Acid, the rate constant is \(K=1.70\times10^{-3}\) (at 25°C, 1atm), so the reactants are favoured and only a small amount of CO2 is converted into H2CO3.

Carbonic Acid (H2CO3), which is diprotic dissociates into Bicarbonate (HCO3-) and then can dissociate into Carbonate (CO32-).

\[
\text{H}_2\text{CO}_3(aq) + \text{e}^- \rightarrow \text{H}^+(aq) + \text{HCO}_3^-(aq) \quad (K=2.5\times10^{-4}, E^\circ=-0.21V), \text{ at } 25\text{C}, 1\text{atm}
\]

\[
\text{HCO}_3^-(aq) + \text{e}^- \rightarrow \text{H}^+(aq) + \text{CO}_3^{2-}(aq) \quad (K=5.61\times10^{-11}, E^\circ=-0.61V), \text{ at } 25\text{C}, 1\text{atm}
\]

The third cathodic reaction also includes the reduction of hydrogen ions that are present in the ground water.

\[
2\text{H}^+(aq) + 2\text{e}^- \rightarrow \text{H}_2(g) \quad (E^\circ=0.00V), \text{ at } 25\text{C}, 1\text{atm}
\]

The selectivity of the cathode reaction is determined by certain environmental factors.
The anode reaction is the dissolution of iron metal at the pipe surface into iron ions.

\[ \text{Fe(s)} \rightarrow \text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \quad (E^\circ=0.44V), \text{ at 25C, 1atm} \]

The overall electrochemical reaction of CO2 corrosion is given by,

\[ \text{Fe(s)} + \text{CO}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{FeCO}_3(\text{aq}) + \text{H}_2(\text{g}) \]

Where FeCO3 can further react to form a precipitate.

\[ \text{FeCO}_3(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \rightarrow \text{Fe(CO}_3)_2(\text{s}) \]

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**Figure 1: Overall Corrosion Reaction**

Source : [http://co2corrosionchem409.wikispaces.com/Corrosion+Mechanism](http://co2corrosionchem409.wikispaces.com/Corrosion+Mechanism)