

A new look at top of the line corrosion. A special case of flow induced corrosion which is due to electrochemical reactions in the hydrodynamic diffusion layer.

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Top of the line corrosion is a phenomenon encountered in the oil and gas industry due to the flow of wet gas or oil in stratified flow regime (Flow Induced Corrosion). The problems of corrosion appear at the surface of a pipe due to condensation of water containing dissolved corrosive gases (carbon dioxide and traces of hydrogen sulfide) and organic acids. Corrosion will occur in the hydrodynamic diffusion layer (of thickness  $\delta$ ) at the surface of the pipe where dissolved organic acids (e.g. acetic acids) will cause hydrogen evolution. Not only the pH will increase in the diffusion sublayer due to hydrogen evolution but also mixing will increase the dissolution of hydrogen sulfide and carbon dioxide. The pH of the hydrodynamic diffusion layer will determine whether intensive corrosion or formation of a physical protective layer may occur. This is because bicarbonate or carbonate ions will form upon dissolution of  $\text{CO}_2$  and bisulfide and sulfide ions will form upon dissolution of Hydrogen sulfide. Furthermore it is well known that Fe-carbonate and Fe-sulfide are not soluble in water. Thus the protective property will depend on the pH value of the hydrodynamic diffusion layer.

Figure 1: Enlarged section of a pipe where in the diffusion layer hydrogen evolution can increase pH and mixing can increase dissolution flux of  $\text{H}_2\text{S}$  and  $\text{CO}_2$ .

