# Effect of Anaerobic Microbial Corrosion on the Surface Film Formed on Steel

Dharshini D. Bala and Dev Chidambaram*

Materials Science and Engineering Department,
University of Nevada Reno,
1664 N. Virginia St., Reno, NV 89557-0338.
*dcc@unr.edu

## Introduction

Very few studies have been conducted on the influence of secreted molecules and metabolic by-products of obligate anaerobes on corrosion of steel (1,2). Although several anaerobes may be associated with corrosion, most studies have focused on sulfate reducing bacteria such as *Desulfovibrio* species and their innate role in anaerobic corrosion (3). While the phenomenon of occurrence of direct electron transfer between hydrogenases and electrode materials has also been widely demonstrated in the field of bioelectrochemistry, either for the electrochemical oxidation of hydrogen, or for the electrochemical reduction of proton (4). Such studies for corrosion are limited. Anaerobic corrosion caused by members of obligate anaerobe genus *Clostridium* species is reported in this study.

## Experimental

Clostridium was grown in a growth medium under strict anaerobic conditions. Corrosion rates were measured against controls. The extent of corrosion was also examined in the presence of either an artificial electron shuttle viz. AQDS (anthraquinone-2,6-disulfonate). Samples were exposed to microbial culture and iron concentration was monitored using UV-Vis spectroscopy/Ferrozine method and surface analysis was conducted. FTIR absorption spectrometry and Raman spectroscopy revealed the nature of chemical bonds of the oxides formed on the surface of the corroded metal; electrochemical methods such as cyclic voltammetry were carried out to confirm redox behavior of the protein. XPS studies were conducted to determine the chemistry of the surface film formed on steel.

## Results

Results demonstrate that anaerobic bacteria i.e. *Clostridium pasteurianum* can cause corrosion. Addition of AQDS accelerated the corrosion by 20%. Also, the effect of hydrogen on corrosion of steel was found to be minimal. Metabolic products influence corrosion more than the growth medium. The redox behavior of the protein was confirmed and the nature of the corrosion products was analyzed. It was determined that the metal sample experiences a higher corrosion rate than could be due to free $H_2$ or other metabolic products.

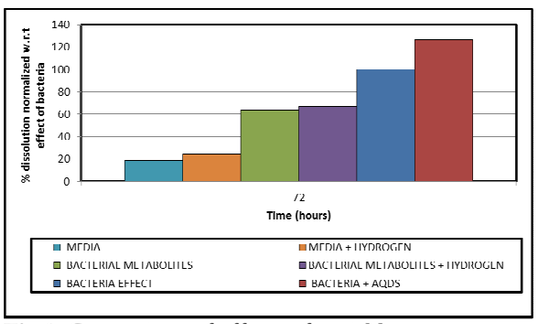


**Fig 1**. Comparison of effects of variable parameters on the dissolution of the steel.

## References

1. Y. Z. Congmin Xu, Guangxu Cheng, Wensheng Zhu, *Materials Science and Engineering: C*, **443**, 235 (2007).
2. R. Melchers and R. Jeffrey, *Electrochimica Acta*, **54**, 80 (2008).
3. W. P. Iverson, *International Biodeterioration & Biodegradation*, **47**, 63 (2001).
4. D. D. Schlereth, V. M. Fernández, M. Sánchez-Cruz and V. O. Popov, *Bioelectrochemistry and Bioenergetics*, **28**, 473 (1992).