LABORATORY STUDIES OF BIOCORROSION CONTROL USING TRADITIONAL AND ENVIRONMENTALLY FRIENDLY BIOCIDES: AN OVERVIEW.

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Abstract- **Metal surfaces immersed in natural or industrial waters undergo a sequence of biological and inorganic changes that may result in biocorrosion due to the formation of a biofilm. Microbial adherence to metallic surfaces affects different industrial systems, such us cooling water systems, off shore oil industry, thermal power stations, hydroelectric, chemical and process industry, etc. The chemical agents generally used to prevent or protect metallic structures from biocorrosion are highly toxic and, after use, can have a negative impact on the environment. Environmental concerns have led to legislation which encourages the replacement of toxic biocides, widely used in the past (e.g. chlorine) with more readily degradable antimicrobial chemicals that are compatible with system operation and less toxic to the environment. One innovative attempt to accomplish this goal is the use of naturally-produced compounds, such as plant extract that are environmentally acceptable. The aim of this paper is to give an overview of different laboratory studies which used both traditional and environmentally friendly biocides against planktonic bacteria and sessile bacteria on different metal surfaces.**

Keywords. **Biocorrosion, Environment, Glutaraldehyde, Natural biocides, Traditional biocides, Ozone.**

I. INTRODUCTION

Biocorrosion is directly related to the presence of microorganisms that by adhering to different industrial surfaces can damage the metal. Bacterial cells can encase themselves in a hydrated matrix of polysaccharides and protein, and form a slimy layer known as a biofilm. The later can be considered as a gel containing c.a. 95% or more water, microbial metabolic products including enzymes, extracellular polymeric substances (EPS), organic and inorganic acids, as well as volatile compounds such as ammonia or hydrogen sulphide and inorganic detritus (Geesey, 1982, Beech and Gaylarde, 1999). The capacity of EPS to bind metal ions is important to biocorrosion (Kinzler *et al.*, 2003; Rohwerder *et al.*, 2003; Sand, 2003) and depends both on bacterial species and on the type of metal ion (Beech and Coutinho, 2003). Biocorrosion occurs in aquatic and terrestrial habitats that differ in nutrient content, temperature, pressure and pH. It results from the presence and physiological activities of microbial consortia on the metallic surface. Such biofilms promote interfacial physiochemical reactions, not normally favoured under abiotic conditions (Beech and Sunner, 2004).

Therefore, prevention and treatment of biocorrosion should be mainly based on avoiding or minimizing the development of biofilms. Chemical treatments applied to control biofilms involve the use of biocides and other products such as penetrating or dispersive agents (which enhance the efficacy of the treatment). The mechanisms of resistance in biofilms are different from the now familiar plasmids, transposons, and mutations that confer innate resistance to individual bacterial cells. In biofilms, resistance seems to depend on multicellular strategies (Stewart and Costerton, 2001). The lack of efficacy of biocides against sessile organisms, well documented in the past few years, is probably due to the inability of the chemical to penetrate the biofilm, in addition to physiological differences between sessile and planktonic cells (Brown and Gillbert, 1993). A number of workers have shown that biocides sensitivity can be altered up to 1000-fold by changes in nutrients and growth rates (Gillbert and Brown, 1978).

The classical criteria governing the selection of an effective biocide have been generally summarised as follows: i) proven efficacy against a broad spectrum of microorganisms; ii) ability to penetrate and disperse microbial slime; iii) chemical and physical compatibility with other products (e.g. corrosion inhibitors) and the environment (e.g. pH effects); iv) safe storage and easy use and storage; v) appropriate biodegradability; vi) cost effectiveness (Gaylarde and Videla, 1992).

Unfortunately, biocides are inherently toxic and frequently are difficult to degrade being persistent in the natural environment or able to accumulate in a variety of matrixes and often causing contamination of areas distant from the site of treatment. Thus, biocides may have a very negative impact on the environment if they are applied without a proper environmental risk assessment. Environmental concern has led to legislation which encourages the replacement of toxic biocides, widely used in the past (e.g. chlorine) with more readily degradable antimicrobial chemicals that