Modeling of Micro-Scale Cathodic Protection

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ABSTRACT

Corrosion reactions proceed with different rates depending on many parameters and variables such as the corroding metal, environmental conditions and the electrolyte. It is almost impossible to totally prevent the corrosion process, however, it is common practice to reduce the corrosion rate of an existing structure via different methods and concepts. Some of these important methods are, addition of corrosion inhibitors, removal of aggressive oxidants, and cathodic protection. In the later method, cathodic protection, the electrochemical potential of the metal to be protected from corrosion is biased negatively from the open circuit potential or corrosion potential. The bias can be done by either a power source or by an active metal, e.g. Mg. The process of cathodic protection is governed by several variables. Most important variables are, the cathodic and anodic reactions, electrolyte resistance, potential offset (or potential difference) and geometry of the system. Cathodic protections of large systems, e.g. pipelines, storage tanks and concrete structures have been under active investigation on fundamental and applied levels [1,2].

For small-scale systems, e.g. the giant magneto resistive (GMR) element in the reader part of the hard disk drive, corrosion reactions can be detrimental and yield device failure either during manufacturing or in service. In such systems, even very small corrosion rates cannot be tolerated and selected manufacturing processes have to be applied. In the present study, a cathodic protection system is suggested to reduce the corrosion current of small scale structure via implanting or deposition an active anode next to the metal structure to be protected as shown in Figure 1. Also, in the present study, a model was built to simulate cathodic protection of small-scale systems. The model was solved using finite element method for current and potential distribution. Different parameters were tested in the model. Potential difference, geometry, and kinetics were the most important parameters studied in the model.

A precise description of corrosion kinetics of the protected metal was found to be essential to provide accurate model results of the actual protection system. Measurements of corrosion rate were carried to verify the model results.

References

1. M. Fontana,“ Corrosion Engineering”, 3rd ed., McGraw Hill, 1986

2. J. Morgan,” Cathodic Protection”, 2nd ed., NACE, 1987.

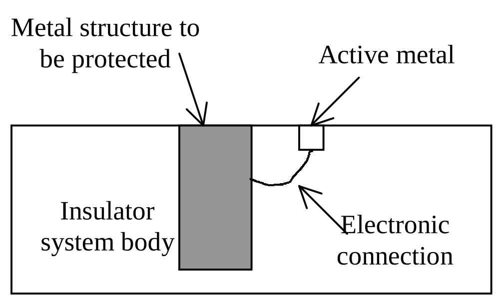

Figure 1. Schematic diagram showing catholically protected metal structure.