Modeling of the Galvanic Anode Cathodic Protection System with Dynamic Polarization Characteristics

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Abstract: - Cathodic protection systems are used for protection of underground or underwater metallic infrastructure against corrosion. Protection by cahtodic protection system is achieved by polarizing protected object i.e. by shifting equilibrium potential to more negative value. Value of the electric potential and current density on the surface of protected object are essential data for evaluation of efficiency of the cathodic protection system. Value of these parameters can be determined by using numerical techniques. This paper deals with the mathematical modeling of cathodic protection system when taking into account dynamic nonlinear polarization characteristics on the electrode surface. Firstly, mathematical model is described in detail. Numerical procedure presented in this paper is divided in the two parts. First part is the calculation of distribution of electric potential and current density in spatial domain using direct boundary element method, and calculation of the time changes of these parameters by finite difference time domain method. Finally, presented mathematical model was used for calculation of parameters of one geometrically simple cathodic protection system example.

Key-Words: - Cathodic Protection System, Galvanic Anode, Dynamic Nonlinear Polarization Chracteristics, Boundary Element Method, Finite Difference Time Domain Method, Newton-Raphson Technique.

1 Introduction

Cathodic protection is most widely used technique for protection of the underground and underwater metallic structures from corrosion [1]. This technique is based on the shifting the equilibrium potential of protected structure to more negative value. This can be done by connecting the protected object with additional electrode(s) placed in same electrolyte (ground or water), which equilibrium potential is more negative than equilibrium potential of the protected object [2]. After installation of the cathodic protection system, electric potential value on the entire surface of protected structure must be lower than minimum protection potential value defined by standards [3]. Also, current density distribution on the surface of protected structure should be uniform as possible [4]. Therefore, for evaluation of efficiency of the cathodic protection system, electric potential and protection current density distribution on the protected metallic structure surface need to be known [5]. These parameters can be determined by solving Laplace