Environmental Engineering and Management Journal

December 2016, Vol.15, No. 12, 2587-2594
http://omicron.ch.tuiasi.ro/EEMJ/

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XFEM BASED ALGORITHM FOR NUMERICAL OPTIMIZATION OF CURRENT DENSITY IN ELECTROCHEMICAL APPLICATIONS

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Abstract

This paper presents an advanced numerical algorithm for the optimization of the current density distribution in electrochemical applications. The optimization principle consists in the distortion of the electric field by an insulating shield properly positioned between the electrodes. Such a distortion influences the distribution of current density at the electrodes under consideration. The electrochemical problem is approached by a Laplace equation which is numerically solved using a mesh-free algorithm based on the eXtended Finite Element Method (XFEM) while the optimal position of the insulating shield is managed by a genetic algorithm (GA). In order to reduce the computational time, two integration techniques were implemented in the XFEM algorithm: Gauss quadrature for the elements intersected by the discontinuity and natural coordinates for the other elements. The computational environment based on XFEM and GA was implemented in MatLab software. It can solve two dimensional (2D) and three dimensional (3D) applications and it was demonstrated on a practical electrochemical application for the optimization of current density distribution at the neighborhood between a cathode electrode in line with an insulator. The standard current density deviation at the cathode electrode is considerably reduced for optimal shield position comparing to the initial shield position. The use of the combined integration technique in the XFEM framework leads to an overall 70% improvement of the computational time compared with the standard XFEM integration technique.

Key words: electrochemical process, moving interface, numerical optimization, XFEM

Received: August, 2015; Revised final: December, 2016; Accepted: December, 2016

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