

Development of low cost cathode material for electrochemical denitrification

M.K.D.C.S. Meegoda¹, S.T. Kariyawasam¹, A. Manipura² and K.G.N. Nanayakkara^{*}

¹Department of Civil Engineering, Faculty of Engineering, University of Peradeniya, Sri Lanka, ²Department of Chemical & Process Engineering, Faculty of Engineering, University of Peradeniya, Sri Lanka

^{*}nadee173@yahoo.com

Nitrate is a well-known water pollutant which is responsible for many diseases. Long term consumption of nitrate rich water could lead to cancers in the digestive system. Due to this risk on human health, World Health Organization has imposed a maximum permissible level of nitrates in drinking water. Therefore, nitrates should be treated so that the nitrate limits will be below the permissible limits. Among the available nitrate removal technologies, electrochemical denitrification has drawn attention as an efficient, cost effective method with many other benefits. In electrochemical denitrification, electrode material plays an important role on efficiency and durability. Hence, many studies have been carried out to develop electrode materials, but most of those studies were limited to very expensive materials.

In this study, attention was paid on the development of a cathode material with low cost materials using electroless deposition techniques to plate Cu on Al and mild steel substrates. The substrate materials were shaped, cleaned and etched in preparation for plating. A plating bath consisting of EDTA and Cu²⁺ was prepared to plate Cu on selected substrate materials using HCOH as the reducing agent. Plating conditions such as Cu²⁺, EDTA and HCOH concentrations, pH and the temperature of the plating solution varied during the plating process.

A successful coating of Cu was obtained only on Al substrate. The Al substrate was highly responsive for the changes of temperature and pH in the plating bath. The developed Al cathodes were characterized using cyclic voltammetry to compare the area which is actively participating in denitrification reaction. Then the surface morphology of developed cathodes were examined using Scanning Electron Microscope (SEM). SEM images showed that higher formaldehyde concentrations resulted in an increase of grain size of Cu deposit. The electroless plating rate observed to increase with the increase in HCOH concentration. The developed cathodes were used in denitrifying a synthetic solution, where almost all the cathodes succeeded in reducing the nitrate concentration from synthetic solution under controlled laboratory conditions than a pure Cu electrode. The highest nitrate removal rate which was 13.8% was observed in the plated electrode using 0.3M HCOH, where pure Cu electrode showed only a 1.8% removal rate. These results reflect that this setup could be further optimized to get better results.