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Removal of Nitrate from Water by the Electrocatalytic Denitrification on the Cu-Bi Electrode

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Abstract

The Cu-Bi cathode was a new type of electrode in the field of electrocatalytic denitrification. The Cu-Bi electrode prepared by electrodeposition at the current density of 6mA cm^{-2} was better. The Cu-Bi coating was compact and crystalline by the characterization of SEM, EDS and XRD. Reduction of nitrate was investigated on Cu-Bi cathodes and Ti/Ru-IrO_2 anodes. For 100mg L^{-1} NO_3^--N， the highest NO_3^--N removal rate of 87.5% was obtained at the current density of 6mA cm^{-2} and in neutral electrolyte at 4h. The removal of nitrate on Cu-Bi electrodes was better in neutral electrolyte, which didn't require additional acid or alkali to adjust pH. When the initial concentration of NO_3^--N was 50mg L^{-1}, the effluent concentration of NO_3^--N at 4 h was 7.175mg L^{-1} lower than the level of drinking water on the standard of the World Health Organization (WHO, 10mg L^{-1}). The kinetic investigation showed that the reduction of nitrate on Cu-Bi displayed pseudo first-order kinetic behavior. The results of Cyclic Voltammetric(CV) measurements indicated that nitrate was reduced on the Cu-Bi electrode with the occurrence of the hydrogen evolution.

Key words: electrocatalytic denitrification, nitrate, Cu-Bi electrode

1.Introduction

Nitrate is a common pollutant of groundwater and other water resources in the whole world[1], and the source is human activities such as overfertilization and combustion[2]. It threatens human seriously. Different techniques were applied to remove nitrate from water resources; i.e. biological removal[3, 4], ion exchange[5, 6], reverse osmosis[7], chemical reduction[8, 9]. Nevertheless, these usual techniques are difficult to meet the requirements of environmental protection because of their own disadvantages [10, 11]. The electrocatalytic denitrification will be a promising alternative to techniques above for the removal of nitrate from polluted water, provided that the selectivity of nitrogen that can be returned to the atmosphere is full enough. The key to electrocatalytic denitrification is the cathodic material. Depending on cathodic material, the product distribution of nitrate reduction varies from nitrite to ammonia. Many electrode materials such as Pt [11, 12], Pd[13], Ir[14], Rh[15], Cu[16-18], Ni[19], Zn[20] and Fe[21] have been investigated for their activity towards nitrate reduction and selectivity for nitrogen formation. Experimentally, it was found that among the above materials, Cu can produce more hydrogenated-products such as