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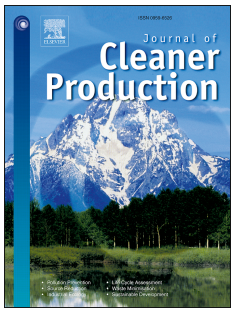

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Removal performances and mechanisms of action towards ethylenediaminetetraacetic acid nickel (II) salt by dithiocarbamate compounds having different carbon chain lengths

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ABSTRACT

Wastewater containing EDTA-Ni (ethylenediaminetetraacetic acid nickel salt) must be treated due to its high toxicity, accumulation of nickel and non-degradability. In the present study, effect of carbon chain length of dithiocarbamate on the removal efficiency of Ni^{2+} from an EDTA-Ni solution has been analyzed. Sodium dimethyl dithiocarbamate, sodium diethyl dithiocarbamate and sodium dibutyl dithiocarbamate were used to study their Ni^{2+} removal performances from various types of EDTA-Ni solutions. Mechanisms of reactions between different dithiocarbamates and Ni^{2+} were also studied. The results indicate that the rate of Ni^{2+} increased with an increase in the carbon chain length of dithiocarbamate. Infrared spectral analysis inferred that the three dithiocarbamates had similar removal mechanisms despite having different carbon chain lengths: all showing Ni^{2+} chelation. The thiol of dithiocarbamate captures Ni^{2+} and tends to produce an insoluble chelate. The results from scanning electron microscope show that for longer carbon chain, the chelate product is more closely packed. Therefore, removed efficiency by sodium dibutyl dithiocarbamate was higher. Meanwhile coexistence of Cr^{6+}, Cu^{2+} and Fe^{3+} inhibited the removal of Ni^{2+}, but Zn^{2+} promoted it. Metal ion impact became clearer as carbon chain length increased. The chelation capability of the three dithiocarbamates with metal ions was: $Cr^{6+}<Fe^{3+}<Ni^{2+}<Cu^{2+}$and $Cu^{2+}>Zn^{2+}$. Finally, these dithiocarbamates were tested in actual electroplating wastewater to validate our conclusions. After sodium dibutyl dithiocarbamate treatment, all residual metals'concentrations met the new tougher requirements announced by the Department of Environmental Protection of Guangdong province in Document No.25.

Keywords: Dithiocarbamate; Carbon chain; Metal ion; EDTA-Ni removal; Reaction mechanism[1]

1. Introduction

A number of methods have been proposed to remove nickel, which is discharged mainly by electroplating industry. Some of these methods include chemical precipitation(Tanaka *et al.*,2008; Mauchauffee and Meux,2007), adsorption(Martin-Lara *et al.*,2014; Salem and Awwad,2014), electro dialysis(Benvenuti *et al.*,2014; Lu *et al.*,2015) and biological methods(Akhtar *et al.*,2014; Chen *et al.*,2008). Currently, precipitation with dithiocarbamates is one of the preferred methods for wastewater treatment containing heavy metals, thanks to its strong removal ability, low energy consumption, low dissolved solids and simple operation (Dingman *et al.*, 1974). Chemical structure of the dithiocarbamate is given in **Fig.1**.

There have been a number of studies exploring the possibilities to increase the number of key functional groups of dithiocarbamate precipitants(Zhen *et al.*,2012; Fu *et al.*,2007) and synthesizing novel

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