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CN and heavy metal removal through formation of layered double hydroxides from mixed CN-containing electroplating wastewaters and pickle acid liquor

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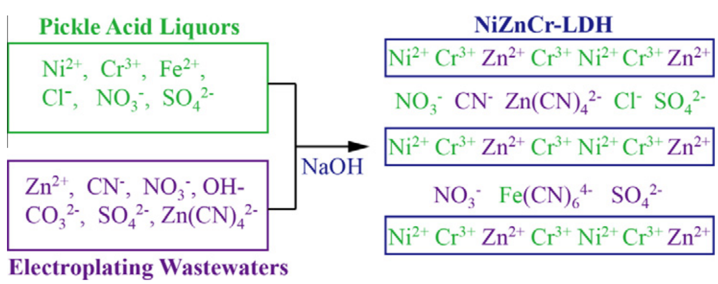
HIGHLIGHTS

- CN-containing electroplating wastewaters and pickle acid liquor were co-treated.
- The main removal mechanism was formation of layered double hydroxide (LDH).
- Heavy metals were mainly removed by forming hydroxyl layers of LDH.
- CN^- was primarily eliminated via intercalating into interlayer of LDH.

GRAPHICAL ABSTRACT



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ABSTRACT

The common ligand CN^- has been widely used in some core industries, such as electroplating and mining, as it significantly enhances process efficiency and product quality. The use of CN^- however generates a vast amount of CN-containing heavy-metal wastewaters, harming both environmental and human health. In this research paper, we present a co-precipitation strategy to treat CN-containing heavy-metal wastewaters (Ni, Zn, Cr and Fe) and pickle acid liquor (Fe) via formation of layered double hydroxide (LDH). Our experimental data demonstrate that Zn, Cr and Fe were completely removed and Ni was reduced from 100–400 to 3.0 mg/L, and about 60% CN^- was simultaneously removed (from 6–8 to 2.5–4 mg/L). This efficiency was constantly achieved under varied experimental conditions, including a wide range of heavy metal concentrations and their ratio with pH in 7–11 at 25–60 °C.

1. Introduction

Heavy-metal containing wastewaters have become a significant contributor to the environmental pollution. Vast quantities are generated every year as by-products of various core industries, including mining, metallurgy, electroplating, and chemical engineering [1,2]. In some cases, these heavy metals are necessarily complicated with cyanide (CN^-) either to enhance the efficiency of industrial processes (e.g. Au and Ag extraction) or assure the high quality of industrial products (e.g. Zn–CN and Cu–CN electroplating). However, the co-existence of cyanide (CN^-) in these wastewaters leads toxicity to animals and humans [3], thus very strict regulations apply for discharge of these wastewaters, for example the Chinese Standard GB8978-1996 stipulated by China Environmental Organization [4] and maximum contaminant levels (MCLs) stipulated by the US Environment Protection Agency [5].

CN-containing electroplating wastewaters (CEWs) and pickle acid liquors (PALs) are two typical examples, of which million tons are generated in each year in China with one or more heavy metals (Ni, Zn, Cr, Fe and Cu). Especially for CEWs, it also contains a certain amount of cyanide (CN^-). CN-free electroplating wastewaters (EWs) and PALs are currently treated in various ways, including precipitation, ion exchange, adsorption, electrolysis, membrane separation and bacteria adsorption [6–8]. Although the removal of heavy metals from EWs using these methods is very efficient in some cases, high treatment costs and secondary pollution often

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