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Development of an integrated electro-coagulation–flotation for semiconductor wastewater treatment

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ABSTRACT

In this study, an electro-coagulation–flotation process was used as a polishing treatment of semiconductor wastewater after precipitation. Batch mode experiments were undertaken using aluminium sheets as anode and stainless steel as cathode. Experiments on a synthetic solution showed that coupling electro-coagulation with electro-flotation in the same cell is efficient for simultaneous defluoridation and clarification. This combination was carried out by proper electrode arrangement and material choice. The performance is ascribed to the combined effect of anodically created coagulants and hydrogen micro-bubbles evolving on the cathode. The effects of the main parameters: electrode nature and arrangement, treatment time, current intensity, initial pH, initial concentration, type and concentration of supporting electrolytes were studied. Defluoridation efficiency may reach 90% corresponding to residual fluoride of 4.61 mg/L, while, turbidity removal efficiency may reach about 85% which corresponds to a residual turbidity of 3.09 NTU. The obtained final concentrations comply with national hazardous waste regulations.

Keywords: Semiconductor wastewater; Fluoride; Turbidity; Electro-coagulation–flotation; Integrated process

1. Introduction

In semiconductor-manufacturing plants, a large quantity of hydrofluoric acid (HF) is currently used for wafer etching and quartz-cleaning operations [1]. It has been found that acid fluoride-containing wastewater contributes to 40% of hazardous waste produced from the semiconductor manufacturer [2]. Fluoride concentrations, up to 3,500 mg/L, are found in this type of wastewater [1]. Fluoride ions originated from two sources; spent HF baths and waste rinse water. The direct discharge of such solutions may represent a huge threat for the environment. Environmental authorities limit fluoride discharge levels to 15 mg/L [3,4]. Most commonly, fluoride ions are removed by forming calcium fluoride (CaF_2) after adding lime [1]. Neutralization can be described according to the following reaction:

$$Ca(OH)_2 + 2\ HF \leftrightarrow CaF_2 + 2\ H_2O \quad (1)$$

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