Thesis Title	Copper and Nickel Removal from Wastewater by Precipitation and Coagulation Processes with Selected Coagulants
Author	Mr. Chaiwat Banyutsrisakool
M.Eng.	Environmental Engineering

Examining Committee :	Assistant Prof. Vililuck Kijjanapanich	Chairman
	Asisstant Prof. Dr. Seni Karnchanawong	Member
	Dr. Prapon Kemdumrong	Member

Abstract

The study was caried out to determine the efficiency of copper and nickel removal from wastewater by precipitation process. The possibility of using coagulation process for the efficiency improvement and suitable coagulant were also investigated. Four types of synthetic wastewater which are, wastewater contained 10-200 mg/l of copper, wastewater contained 10-200 mg/l of nickel, wastewater contained 10 mg/l of copper and 10-200 mg/l of nickel and wastewater contained 10 mg/l of nickel and 10-200 mg/l of copper, were used as raw wastewater. When the treatment efficiencies of the precipitation process were evaluated, sodium hydroxide was applied to the raw wastewater to form hydroxide precipitated at the pH of 7.5-11.0. The addition of sodium hydroxide was done at the time of rapid mixing which followed by sedimentation process. When the improvement of the treatment efficiencies by coagulation process was studied, slow mixing was introduced after rapid mixing and before sedimentation. As for the investigation of suitable coagulants, four different chemicals, ie., ACCLOFLOC A95, A110, A120 and OXYFLOC 106 were applied to the wastewater at the optimum pH illustrated by the precipitation process and at the time

of rapid mixing which followed by the sedimentation. The apparatus used in this study is Jar Testing Machine (Miyamoto Riken, Model JMD-6)

From this study, it was found that optimum pH for copper removal from wastewater which contained 10-200 mg/l of copper by precipitation process was 11.0. At this pH, the remaining copper in the wastewater were in the range of 1.10-2.19 mg/l. Slow mixing proved to increase the treatment efficiencies and optimum pH was the same as that of precipitation process. The remaining copper concentrations decreased from that of the precipitation process about 80.4-82.7 % and were in the range of 0.19-0.43 mg/l. At the optimum pH, ACCLOFLOC A95 was found to be the most suitable coagulant for copper treatment. Its optimum doses were about 0.4-1.2 mg/l which could decrease copper in the wastewater better than both precipitation and precipitation with slow mixing processes decreased from those of the precipitation process about 86.4-87.2 %. The remaining copper after applying this coagulant were in the range of 0.15-0.28 mg/l.

Optimum pH for nickel removal from wastewater which contained 10-200 mg/l of nickel by precipitation process was 11.0. At this pH, the remaining nickel in the wastewater were in the range of 3.19-5.12 mg/l. Slow mixing proved to increase the treatment efficiencies and optimum pH was 10.5. The remaining nickel concentrations decreased from that of the precipitation process about 68.4-86.5 % and were in the range of 0.43-1.62 mg/l. At the optimum pH, ACCLOFLOC A95 was found to be the most suitable coagulant for nickel treatment. Its optimum doses were about 0.4-2.0 mg/l which could decrease nickel in the wastewater better than both precipitation and precipitation with slow mixing processes decreased from those of the precipitation process about 96.9-98.0 %. The remaining nickel after applying this coagulant were in the range of 0.063-0.16 mg/l.

Optimum pH for nickel removal from combined copper and nickel wastewater which contained 10 mg/l of copper and 10-200 mg/l of nickel by precipitation process was 11.0. At this pH, the remaining nickel in the wastewater were in the range of 2.15-2.66 mg/l. Slow mixing proved to increase the treatment efficiencies and optimum pH was 11.0 at the ratio of copper and nickel are 10 : 10 and 10 : 50 and 10.5 at the ratio of copper

and nickel are 10 : 10 and 10 : 200. The remaining nickel concentrations decreased from that of the precipitation process about 78.2-80.5 % and were in the range of 0.42-0.58 mg/l. At the optimum pH, ACCLOFLOC A95 and ACCLOFLOC A110 were found to be the most suitable coagulant for nickel treatment. Its optimum doses were about 0.4-1.6 mg/l and 0.4-1.2 mg/l respectively which could decrease nickel in the wastewater better than both precipitation and precipitation with slow mixing processes decreased from those of the precipitation process about 95.5-98.5 %. The remaining nickel after applying this coagulant were in the range of 0.032-0.12 mg/l.

Optimum pH for copper removal from combined nickel and copper wastewater which contained 10 mg/l of nickel and 10-200 mg/l of copper by precipitation process was 10.5. At this pH, the remaining copper in the wastewater were in the range of 1.10-1.13 mg/l. Slow mixing proved to increase the treatment efficiencies and optimum pH was the same as that of precipitation process. The remaining copper concentrations decreased from that of the precipitation process about 56.6-80.0 % and were in the range of 0.22-0.49 mg/l. At the optimum pH, ACCLOFLOC A110 was found to be the most suitable coagulant for copper treatment. Its optimum doses was about 0.4 mg/l which could decrease nickel in the wastewater better than both precipitation and precipitation with slow mixing processes decreased from those of the precipitation process about 76.1-97.1 %. The remaining nickel after applying this coagulant were in the range of 0.032-0.27 mg/l.

Furthermore, it can be concluded that precipitation process alone can not decrease only copper concentration to meet the industrial effluent standard level issued by the Ministry of Industrial of Thailand. Slow mixing and applying of suitable coagulant can decrease both copper and nickel to meet the standard levels.