Purification of Copper-Containing Wastewater in Inner-Cooling Oil Channel of Piston with Magnesium Hydroxide

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Abstract. The treating fluid in the piston of inner-cooling oil channel is acid wastewater containing copper ion, it would adversely affect the aquatic ecosystem when emission directly. This paper use magnesium hydroxide as a wastewater treatment agent, to study the effect of magnesium hydroxide dose, stirring time, temperature on the results of treating fluid treatment, and get the best treatment conditions. The results indicate that magnesium hydroxide has an excellent performance including easy operation, super removing rate, supernatant can meet emission standards: c(Cu^2+)<2mg/L.

Keywords: Magnesium Hydroxide, Piston, Inner-cooling Oil Channel, Copper-containing Treating Fluid, Copper Ion.

1. Introduction

Heavy metal pollution in industrial wastewater has become one of the many environmental pollution problems in modern society with the acceleration of urbanization and industrialization. The pollution effect lasts for a long time after heavy metal wastewater is discharged into the water body. It can enter the human body through the food chain and become rich and it is not easy to degraded, thus causing harm to human health. Copper-containing wastewater comes from copper processing, smelting and electroplating industries mainly [1]. During the 13th Five-Year Plan period, the focus of China's heavy metal pollution prevention and control plan was to strengthen the quality monitoring of heavy metal environment. The maximum allowed discharge concentration of copper in wastewater discharged directly into natural water bodies is 2mg/L, according to Standard GB/T 31962-2015 Wastewater Quality Standards for Discharge to Municipal Sewers.

The common treatment methods of copper waste liquid are chemical precipitation, adsorption, electrolyte, ion exchange, etc. [2-4]. The treatment facilities are large and the processing cost is high, the processing process is complex and prone to secondary contamination, these are the disadvantages of the above approaches. Magnesium hydroxide is known as an ‘environmentally friendly wastewater treatment agent’, due to good buffering performance, large activity, strong adsorption capacity, small corrosion, and non-toxic. The maximum pH of the treated solution is not more than 9, and then the water is easy to meet the national emission standards after using sodium hydroxide to treat acidic
wastewater. Magnesium hydroxide has been used in the field of environmental protection widely [5]. The pH of terated water may be high when other alkalis are used, such as Lime and soda; liquids need further treatment before they can be discharged. Lots of researches on the treatment of wastewater containing lead, chromium, nickel, arsenic, cadmium, copper and zinc have done by Scholars at home and abroad [6-13]. Other scholars applied magnesium hydroxide to Phosphorus-containing wastewater, and the treatment effect was remarkable [14].

The prefab of inner-cooling oil channel in the piston produces a large amount of copper-containing acidic wastewater during the prochannelion process. The concentration of copper ions is much higher than the maximum allowable emission concentration in China. If copper-containing acidic wastewater is discharged directly, it will affect the water ecosystem seriously. At present, there are no relevant research reports on the treatment technology of copper-containing acidic in inner-cooling oil channel of piston at home and abroad. Therefore, magnesium hydroxide is used as a treatment agent to discuss the effect of magnesium hydroxide dosage, stirring time and reaction temperature on the treatment results of cleaning fluid.

2. Experiment

2.1. Instrument and Reagent
Thermostat; pH-600 pH meter; electric agitator; ICAP7400 Inductively coupled plasma emission spectrometer (ICP-AES). Magnesium hydroxide (AR).

2.2. Experimental Water Samples
The liquid cleaning fluid of the cold oil channel prefab in the piston is dark blue. There is a strong irritating smell. The pH of the cleaning fluid is 1.5 and the concentration of copper ions is about 2.5g/L.

2.3. Experimental Method
Take 800 mL copper-containing acidic in inner-cooling oil channel of piston and add different amounts of magnesium hydroxide. Stir for some time, change the reaction temperature, sit separate to be measured.

3. Results and Discussion

3.1. Effect of Magnesium Hydroxide Dosage on the Treatment Effect of Copper-containing Treating Fluid
Take 800 mL copper-containing acidic in inner-cooling oil channel of piston and add different amounts of magnesium hydroxide at Room temperature. The amount of Magnesium hydroxide added is: 1.00g, 1.50g, 2.00g, 2.50g, 3.00g, 3.50g, 4.00g, 5.00 g, 6.00g, 7.00g, 8.00g, 9.00g, 10.00g, with stirring rate was 600r/min, the stirring time was 2h, and then supernatant was taken after static separation. The pH value was measured by pH meter, and the concentration of copper ion in supernatant was measured by ICAP7400, the removal rate of copper ion in cleaning solution was calculated finally.

Concentration, removal rate and pH of Cu2+ by different magnesium hydroxide addition See Table 1. Figure 1 shows the effect of different Magnesium hydroxide on the concentration and removal rate of Cu2+. 
Table 1. Concentration, removal rate and pH of Cu²⁺ by different magnesium hydroxide addition

| No. | Mg(OH)₂ addition/g | pH value after treatment | Concentration of Cu²⁺ in supernatant /mg/L | Removal rate of Cu²⁺/% |
|-----|--------------------|--------------------------|-------------------------------------------|------------------------|
| 1   | 1.00               | 2.1                      | 2444                                      | 2.24                   |
| 2   | 1.50               | 4.6                      | 2225                                      | 11.00                  |
| 3   | 2.00               | 5.1                      | 1902                                      | 23.92                  |
| 4   | 2.50               | 5.2                      | 1506                                      | 39.76                  |
| 5   | 3.00               | 5.4                      | 876.5                                     | 64.94                  |
| 6   | 3.50               | 5.7                      | 336.6                                     | 86.54                  |
| 7   | 4.00               | 5.9                      | 178.25                                    | 92.87                  |
| 8   | 5.00               | 6.2                      | 124.25                                    | 95.03                  |
| 9   | 6.00               | 6.5                      | 1.721                                     | 99.93                  |
| 10  | 7.00               | 7.2                      | 1.519                                     | 99.94                  |
| 11  | 8.00               | 7.6                      | 0.219                                     | 99.99                  |
| 12  | 9.00               | 8.0                      | 0.1120                                    | 100.00                 |
| 13  | 10.00              | 8.1                      | 0.1039                                    | 100.00                 |

Copper Ions can be removed from copper containing waste liquid by adding Magnesium hydroxide, at the same time, the acid in copper-containing treating fluid can be neutralized. The effects of Mg(OH)₂ addition on the experimental results were divided into four stages according to Figure 1 and Table 1.

Figure 1. Effect of different magnesium hydroxide additions on Cu²⁺ concentration and removal rate

The first stage: when Mg(OH)₂ was added 1 g-1.5 g, the removal rate of copper ion increased slowly, the pH of supernatant increased from 1.5 to 4.6. The results show that the Magnesium hydroxide in first stage neutralizes the acidity of the cleaning solution mainly, and the removal effect of copper ion is not obviously. The second stage: when the addition of Mg(OH)₂ was between 1.5 g-3.5 g, the removal rate of copper ion increased rapidly, the pH value of supernatant increased from 4.6 to 5.7, which grew less than the first stage. The results show that the increase of Mg(OH)₂ in this phase is used for the removal of copper ions mainly. The third stage: when the addition of Mg(OH)₂ was between 3.5 g-6 g, the removal rate of copper ion increased slowly. The fourth stage: when the addition of Mg(OH)₂ is 6 g-10 g, the removal rate of copper ion in the cleaning solution has no obvious change, are greater than 99%, as shown in table 1.
Figure 2. Effect of different magnesium hydroxide additions on supernatant pH value

Fig. 2 shows the pH value of the supernatant at different Magnesium hydroxide addition, the pH value of copper-containing treating fluid increases gradually and the concentration of copper ion decreases gradually due to increase in Magnesium hydroxide. When the addition amount is 8.00 g, the pH value of the copper-containing treating fluid is 7.6 and the concentration of copper ion is 0.219 mg/L. The concentration of copper ion is less than 2 mg/L. At this time, the removal rate of copper ions, cleaning solution pH value and copper ion emission concentration is up to requirements, so the Optimum dosage of Magnesium hydroxide is 10 g/L.

3.2. Effect of Temperature on the Treatment Effect of Copper-containing Treating Fluid

The optimum addition of Magnesium hydroxide was 10 g/L, stirring rate was 600 r/min and stirring time was 2 hours, under these conditions, Change the reaction temperature by using a water bath. Set at room temperature 25℃, 35℃, 45℃, 55℃, and 65℃ Separately, Stationary separation, take supernatant, then to be tested. The concentration of copper ion in supernatant was detected by ICAP7400, and the removal rate of copper ion in cleaning solution was calculated.

Table 2. The removal rate of copper ions in the cleaning fluid at different temperatures

| Temperature /℃ | treating fluid before treatment | treating fluid after treatment | removal rate of Cu²⁺/% |
|-----------------|---------------------------------|------------------------------|-----------------------|
|                 | pH | Cu²⁺ Concentration/g/L | pH | Cu²⁺ Concentration/mg/L |                           |
| 25              | 1.5 | 2.5 | 7.6 | 0.22 | 99.99 |
| 35              | 1.5 | 2.5 | 7.2 | 0.34 | 99.99 |
| 45              | 1.5 | 2.5 | 7.1 | 0.37 | 99.99 |
| 55              | 1.5 | 2.5 | 7.0 | 0.40 | 99.98 |
| 65              | 1.5 | 2.5 | 7.0 | 0.49 | 99.98 |

Table 2 shows the effect of temperature on copper ions in the Magnesium hydroxide cleaning solution. Temperature has no significant effect on the removal rate of Cu²⁺ in cleaning solution can be seen from table 1, the pH of the treated solution was higher than 7. Therefore, the cleaning solution can be treated at room temperature.

3.3. Effect of Stirring Time on the Treatment Effect of Copper-containing Treating Fluid

At Room temperature, we add 8.00 g Magnesium hydroxide per 0.8 L cleaning solution, and then set stirring time to 30 min, 50 mi, 70 min, 90 min, 110 min and 130 min, with stirring rate is 600r/min.
Next step was taken supernatant after static separation. The concentration of copper ion in supernatant was detected by ICAP7400, and the removal rate of copper ion in cleaning solution was calculated.

![Figure 3](image)

**Figure 3.** The Cu²⁺ removal rate and the Cu²⁺ concentration in the upper liquid with different stirring times

Fig.3 is the influence curve of stirring time on Cu²⁺ removal rate and Cu²⁺ concentration in supernatant. The concentration of copper ion in supernatant was 0.431 mg/L when the stirring time was 30 minutes, which reached the discharge standard. The removal rate of copper ion in copper-containing treating fluid was 99%. The results showed that the increase of stirring time had little effect on the removal rate, so the stirring time was setted to 30 minutes.

4. Conclusion
The optimum treatment conditions of the copper-containing treating fluid in inner-cooling oil channel are as follows: when the pH value of the copper-containing treating fluid is 1.5, the concentration of copper ion is about 2.5 g/L, and the stirring rate is 600 r/min, then the addition of Magnesium hydroxide is 10 g/L, the treatment temperature is room temperature, the mixing time is 30 minutes.

The copper-containing treating fluid in inner-cooling oil channel is treated under the above optimum conditions, then the removal rate of Cu²⁺ was above 99%, and the concentration of Cu²⁺ in the supernatant was less than 2 mg/L, which reached the discharge standard.

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