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# STUDIES ON THE REMOVAL OF ZINC WITH THE COMPLEXING AGENTS FROM THE INDUSTRIAL EFFLUENTS

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**Abstract:**

*Human activities and consequent developments have brought about the spectre of an overwhelming degradation of all facets of the natural environment-physical, chemical, biological and social. Environmental pollution, especially by chemicals, is one of the most significant factors in the degradation of the biosphere components. Among all chemical contaminants, heavy metals are believed to be of special ecological, biological and health significance. Unlike organic pollutants, the majority of which are susceptible to biological degradation, metal ions do not degrade into harmless end products. Chemical precipitation is a simple and economical method, and hence, has been widely used. Among the chemical precipitation methods, hydroxide precipitation is the conventional method of removing heavy metals form wastewater, but it suffers from a few shortcomings such as high solubilities, amphoteric properties of metal hydroxides and their ineffectiveness in the presence of chelating agents. Sulphide precipitation is an extremely effective process for the removal of heavy metals. A comparative study of the removal of heavy metals by hydroxide and sulphide precipitation was carried out. The precipitation was carried out in the presence and absence of complexing agents such as ammonium chloride, tartrate and citrate.*

**Key Words:** Heavy Metals, Hydroxide Precipitation, Sulphide Precipitation & Complexing Agents

**Introduction:**

Water pollution due to heavy metals has been a major cause of concern since long. In olden days people are fascinated by the brightness, ductility and long lasting nature of heavy metals. The continuous use of heavy metals for centuries has resulted in increased heavy metals contamination of the globe, beyond tolerable limits causing various hazardous effects on mankind. The environment is getting polluted in many ways. Discharge of effluents from various industries causes the introduction of heavy metals into the aquatic environment. Heavy metal causes various health hazards to both human and other living organisms. Therefore, continuous efforts are being made to avoid the discharge of toxic chemicals into water bodies as well as the removal of the toxic metals from the aquatic environment. Today's humanity cannot do without heavy meals; therefore the best option to treat the effluent before discharge and maintain metal concentration within the permissible limit. The presence of heavy metals in water affects its potability and palatability. Heavy metals are widely used in a variety of industrial activities and the waste from these industries constitutes a major cause of heavy metal pollution in the environment.

Chemical treatment of industrial wastewater is preferable since industrial wastewaters are frequently complex, high in pollutant load and often containing materials toxic or resistant to the organisms on the biological processes. Chemical treatment systems are more predictable and inherently more subject to control by simple technique and chemicals are usually relatively tolerant to temperature changes. Sulphide precipitation is an extremely effective process for the removal of heavy metals. It has advantages like high solubility and high stability of metal sulphides. This implies

that metals can be precipitated as sulphides even in the presence of chelating agents. In addition, metal sulphide sludge exhibits better dewatering characteristics than metal hydroxides. The concentration of heavy metals from a large volume of effluent to a smaller volume can be achieved with sulphide precipitation method.

**Materials and Methods:**

All chemicals used were of Analytical Reagent (AR) grade. Double distilled water from an all glass still was used for preparing reagents. The instruments used for the study were pH meter (LI 120 ELICO make), high speed stirrer (model RW 16 B IKA Labortechnik), magnetic stirrer (model RH IKA Labortechnik) and Atomic Absorption Spectrophotometer (AAS) (Analytic Jena (AJ) Vario 6).

For hydroxide precipitation, pH of 200 mL of heavy metals solution (500 ppm) was raised from 7 to 11 using 1N NaOH. The contents were allowed to settle for 30 minutes. The supernatant was filtered through a Whatman No.42 filter paper and analyzed using atomic absorption spectrophotometer for the presence of chromium. The precipitation was carried out in the presence and absence of complexing agents such as ammonium chloride, tartrate and citrate.

For sulphide precipitation, variation of pH, sulphide dose and reaction time were done on 200 mL of heavy metalssolution (500 ppm). Initially, pH was optimized using 1N sodium hydroxide or 1N suphuric acid with heavy metals solution by the addition of sulphide under rapid mixing conditions. The contents were allowed to settle for 30 minutes. The supernatant was filtered through a Whatman No.42 filter paper and analyzed using atomic absorption spectrophotometer for the presence of chromium. Similarly, the sulphide dose was also optimized. The precipitation was carried out in the presence and absence of complexing agents such as ammonium chloride, tartrate and citrate.

**Results and Discussion:**

Experiments carried out for the removal of heavy metals using hydroxide and sulphide precipitation at the optimum conditions at a reaction time of 5-60 minutes did not show any variation in the efficiency of zinc removal. Hence, 10 minutes was considered as the optimum reaction time.

**Hydroxide Precipitation Technique:**

**Effect of pH:**

The effect of pH on the removal efficiency of zinc was studied in the pH range 7-11. The effect of pH on the removal efficiency of zinc in the absence and presence of complexing agents are illustrated in Figure 1.1. It is observed that the removal of efficiency increases with pH. The removal efficiency followed the order: absence of complexing agents>presence of ammonium chloride>tartrate>citrate. The effect of complexation is felt at all pH values.

The maximum and minimum removal efficiencies of zinc in the absence of any complexing agent were found to be 88% and 77%, respectively. The presence of ammonium chloride has reduced the maximum and minimum removal efficiencies to 85% and 74%, respectively. Tartrate being a stronger complexing agent has further reduced theses values to 66% and 49%, respectively. Citrate being more powerful ligand has reduced the values drastically to 57% and 45%, respectively.

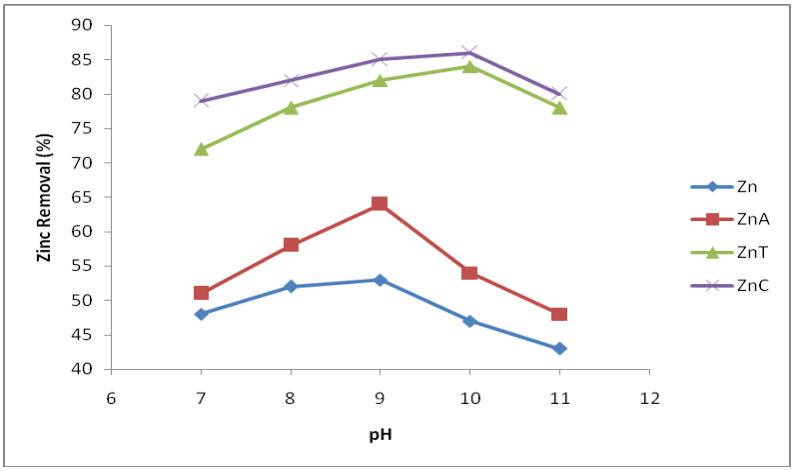


Figure 1.1: Effect of pH on zinc removal by hydroxide precipitation

**Sulphide Precipitation Technique:**

**Effect of pH:**

The effect of pH on the removal efficiency of zinc was studied in the pH range 1-11. The effect of pH on the removal efficiency of zinc in the absence and presence of complexing agents are illustrated in Figure 1.2. It is observed that the removal of efficiency increases with pH. Howerver, after pH 8 the efficieny remains almost a constant. Hence, pH 8 was considered optimum for the removal of zinc by the sulphide precipitation method. The removal efficiency followed the order: absence of complexing agents>presence of ammonium chloride>tartrate>citrate.

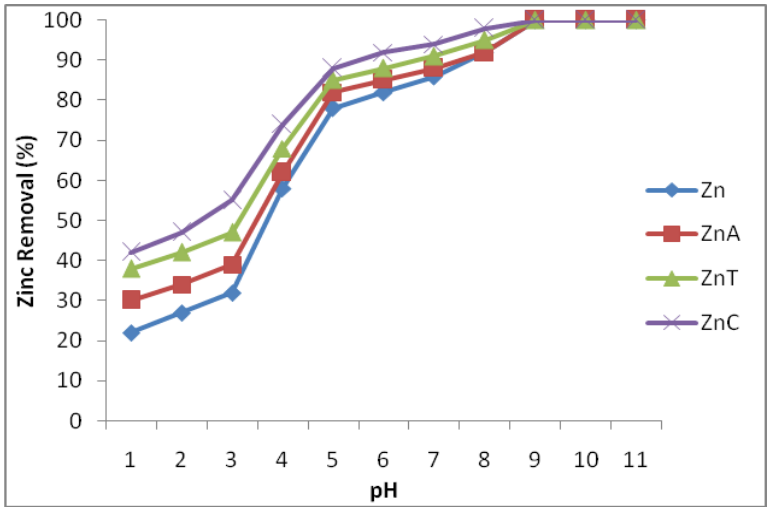


**Figure 1.2: Effect of pH on zinc removal by sulphide precipitation**

The effect of complexing agent on the removal efficiency decreases as the pH in increased and it almost vanishes at pH 8. Thus, at pH 8 the removal efficiencies with solutions containing no complexing agent, ammonium chloride, tartrate, citrate were 99.9%, 99.87%, 99.7%, 99.57%, respectively. However, these values were appreciable lower at lower pH values.

**Effect of Sulphide Dose:**

The effect of sulphide dose on the removal of zinc was studied by varying the dose from 40 mg/L to 615 mg/L and keeping the pH at the optimum value of 8. The results were shown in figure 1.3. The removal efficiency increased with increase in sulphide dose and leveled it off after a critical doser of 205 mg/L. The removal efficiency

followed the order: absence of complexing agents>presence of ammonium chloride>tartrate>citrate.

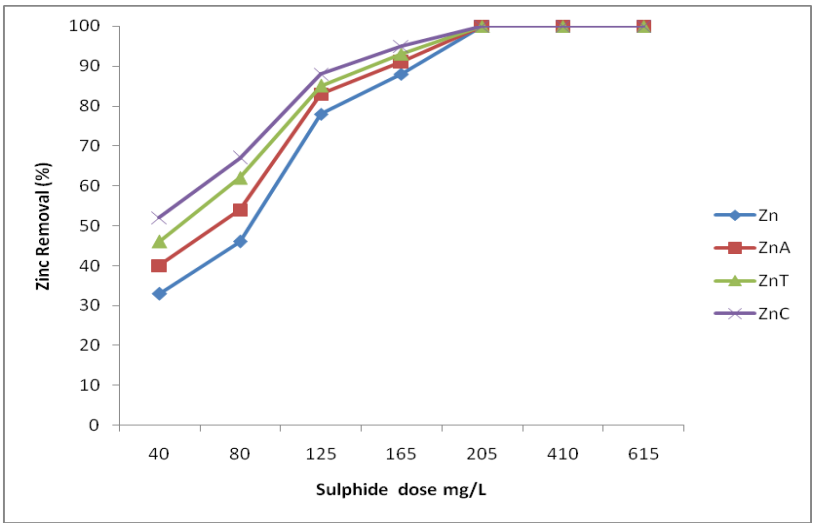


Figure 1.3: Effect of sulphide dose on zinc removal by sulphide precipitation

Thus, at a sulphide dose of 205 mg/L the removal efficiencies with solution containing no complexing agent, ammonium chloride, tartrate, citrate were 99.9%, 99.87%, 99.7% and 99.57%, respectively. However, these values were appreciably lower sulphide doses. At 40 mg/L sulphide dose corresponding values were 53%, 45%, 40% and 34%, respectively.

**Conclusion:**

Chemical precipitation method is used to achieve the superior metal removal required by the discharge limits. It removes the dissolved metal contaminants to the lowest levels possible while using the least amount of treatment chemicals and generating the least amount of sludge. It is a viable technology to remove complexed metals from wastewater. The hydroxide precipitation was not suitable for the removal of zinc in the presence of complexing agents. The zinc was removed effectively removed using sulphide precipitation technique. The removal efficiency was above 99%. The maximum removal efficiency of zinc was observed at alkaline pH and at the sulphide dose of 205 mg/L. The removal efficiency followed the order: absence of complexing agents>presence of ammonium chloride>tartrate>citrate.

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