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METAL SEPERATION FROM WASTEWATER BY  
ELECTROKINETIC METHOD- A REVIEW

DHEKANE PALLAVI S,

*KIT's COLLEGE OF ENGINEERING*

PROF.MR.AMAR KATKAR

*ASSISTANT PROFESSOR, ENVIRONMENTAL ENGINEERING DEPT,  
KIT's COLLEGE OF ENGINEERING, KOLHAPUR, INDIA.*

**Absrtact**

Electrokinetics is a rapid & simple method applied for separation of metal ions from wastewater. Basically based on electrical potential along with anode and cathode. In the previous papers presented they have separated heavy metals like cobalt, gold, nickel, lead, iron, zinc etc (1). In Electrophoresis process metals are separated by using high voltage as 10 kV (kilo volts) to 30 KV. In the studies the metal extraction is done in acidic condition. Much literature is not available on the Electro-kinetics technique for reference. All the metals separation from wastewater which is in ion form is separated by using chemicals and reagents (2, 3, 5). In the paper of Electro-coagulation the research is based on coagulation process and ampere based not voltage based. And other is based on high voltage separation called Electrophoresis. By Electrophoresis technique metal extraction is possible up to 95%, but this method is known as the Capillary Zone Electrophoresis. Various combinations of the time and voltage are applied in the available literature. Electrodes used for this study is having higher conductivity as silver and granite & so on.

## INTRODUCTION

In the separation process of metals the rods are used are of graphite because graphite is a inert material which cannot take part in any chemical reaction in another papers both aluminum and iron rods are introduced (10). In this method of separation metal is separated which is in ion form. Capillary electrophoresis technique is also gives best results for metal separation but needs to use capillary and voltage applied is too high (3, 5, 7). Their separation time is too short like 5 min or 6 min but voltage variation is from 10 kV to 30 kV. Most of the study is done on the capillary electrophoresis technique which is not introduced in environmental field till now. This method is now used in biotechnology for DNA separation. All the research is conducted on the electroplating wastewater. Only paper is studied on municipal sewage sludge by electro-kinetics.

## MATERIALS AND METHODOLOGY

The presence of heavy metals is one of the major problem for agricultural use of million tonnes of dewatered sewage sludge produced in wastewater treatment plants. Electrokinetic treatment can be applied to remove heavy metals from sludge. The research has been worked for the increasing treatment efficiency of Elctro-kinetics method of the sludge. In the paper of the sludge treatment the pH is adjusted to 4.4 and the cathode is immersed with acidification chamber. Ni, Zn, Cu, As, Cr, Pb. Removal efficiencies of heavy metals in the experiment with acidified sewage sludge and pH adjustment at cathode chamber at 2.0 were: 95% for Zn, 96% for Cu, 90% for Ni, 68% for Cr, 31% for As and 19% for Pb. The sludge used for this study was anaerobically digested dewatered sludge from STP. The sludge was checked for pH value and then oven dried at 60<sup>0</sup>c for 48 h. The liquid sample after digestion was diluted to 100 ml and filtered using 0.45micrometer nitrocellulose membrane filters. The content of heavy metals was determined by inductively coupled plasma-optical emission spectrometry using an Optima 2000DV spectrometer. Oven dried sample get powdered form and feed in bottle and agitated at 35 rpm and centrifuged. Supernatants were separated in volumetric flask. The metal were analyzed using

Inductivity coupled plasma optical emission spectrometer. Acidification of sludge was done (1)

In the another literature the method used for the separation was Capillary Electrophoresis in which the voltage used was up to 20 kV for the separation of 6 metals. Separated metals are potassium, copper, zinc, manganese, cadmium within 5 minutes duration. pH was adjusted to 4.4. Voltage applied was 20kV at 25<sup>0</sup>C. This method can be used for environmental treatment process (2). In this method various reagents and solutions are added. Most inorganic anions and cations have no strong absorption in UV-visible spectral region. For improving the sensitivity, complex reactions are commonly used, that is, adding some complexing

agent (such as  $\alpha$ -hydroxyisobutyric acid (HIBA), citrate, EDTA and acetic acid) into the electrolytic solution. If so, some factors in operation, e.g., the composition and concentration of buffer, pH adjustment as well as voltage and temperature, should be optimized in advance.

In some papers explained that Separation of metal ions is done by capillary electrophoresis provided with a weak complex reagent incorporated into the electrolyte to alter the effective mobility of the sample ions. Separations are described using sphthalate, tartrate, lactate or hydroxyisobutyrate as the complex reagent (3). Capillary electrophoresis has become a powerful separation technique because of its speed, resolving power, minimal reagent consumption. Proved that Factors affecting the separation selectivity and electro-osmotic flow for the separation of alkali, alkaline earth cations, ammonium ion are evaluated. The nature of electrolyte anion and solvent has important factors on the EOF (Electro-osmotic flow) in acidic conditions. Unique separation selectivity was achieved for alkali and alkaline conditions (4). Studied that Electrophoresis technique is used to found sorption possibility of toxic metal ions. Heavy metals as cobalt, nickel, lead, cadmium can be separated out. The adsorption isotherm and pH effect indicate the sorption of metal. The sorption study indicated that the heavy and toxic metals Pb (II), Ni (II), Co (VI) and Cd (II) could be adsorbed and thus removed significantly (5).

Electrophoresis has recently attracted attention as a promising analytical technique for metal ion separations. Showed that advantage of capillary electrophoresis in the analysis of metal species have occurred based on exploiting various auxiliary Separation principles. He has used selected complexes and time variation for electrophoresis technique. A variety of electrolyte additives have been studied to change the electrophoretic mobility of metal. Many studies are focused on the use of pre- electrophoresis derivatisation methodology. In this paper approaches are suitable for including metal cations, metal complexes, metal oxyanions and organometallic compounds (6). Experimented that Capillary zone electrophoresis technique is used for cyanide complexes of Au, Pt, Fe, Pd, Cu, Ag, Cr, Ni separation. Capillary zone electrophoresis is growing in significance as an analytical method for separation of low molecular mass ionic species. A phosphate- tri ethanolamine buffer at pH 8.5 was selected. Carrier electrolyte was trimellitate of 254nm. The separation selectivity can be optimized for different applications by using ion interaction reagent. UV detection is used (7). Another paper showed that Capillary electrophoresis has been applied to metal ion analysis during last 10 years. To improve sensitivity, different methods of detection have been adopted. This paper compares currently available and recently developed detection methods for CE (Capillary Electrophoresis) as applied to the analysis of metal ions. He has stated the advantages disadvantages and drawback of detection method of capillary electrophoresis (8). Testing of sequential sludge washing in triplicate using typical biosurfactant saponin was conducted to remove heavy metals. The aim of the study was efficiency and reduce mobility of

heavy metals. Different washing conditions such as concentration, contact time, liquid/solid ratio and pH were optimized. After three washings Cr extraction efficiency was 65% and Pb extraction efficiency was highest which is 85%. The study was conducted on the municipal wastewater and dewatered by 80 %. This work has shown that saponin provided an effective results to enhance heavy metals extraction from sludge, and the results indicated that the saponin obtained good extraction efficiency (9). In the paper 'Efficient Removal of Heavy Metals from Electroplating Wastewater using Electrocoagulation' experimented with electroplating wastewater using Fe and Al electrode as material at pH variation of 3.0, 5.0, 7.0 and 9.0 for 30 minutes of retention time. The influence of electrode material, pH and retention time was explored during experimentation also corresponding with electrode and energy consumption. Maximum removal efficiency on optimization was observed during pH 9.0 at 0.1 ampere current using electrode combination of Fe-Fe and Fe-Al 100.0% of nickel and chromium removal within 20 minutes at cost of INR 90.0/m<sup>3</sup> compared to Al-Al and Al-Fe removal efficiency and consumption cost.

## RESULT

The the referred papers shows that maximum separation is achieved by capillary electrophoresis technique. Without chemicals and reagents separation metal separation is not possible. High voltage is necessary for electrophoresis method. With lower voltage application no one has studied for metal ions separation. Maximum time for this method is applied is 20 min. rods of various metal is not tried for electro-kinetics. It is necessary to check or compare efficiency of this method using various combinations of verity of rods, voltage application, time variation and pH change to give maximum results.

## DISCUSSION

In the studied papers it is shown that the metal separation is only possible with the use of reagents and with chemicals. In another method of Electrophoresis the metals were separated with very high voltage and with only specified conditions like majorly alkaline. Papers are searched for the metal separation but there is nothing mentioned that which type of wastewater is used for the separation of metals.

## CONCLUSION

By referring the literature we observed some points like

- Research has not been carried out with alkaline waste water for metal separation. As we have referred papers from Electro-kinetics methods for metal separation the author used only acidic

conditions for the research (2) and there is no specification for neutral and alkaline conditions, so we have decided to try all pH conditions as neutral, acidic and alkaline.

- In present literature time is kept constant and no research has been done with variation in time and voltage (2). We are changing time from 5 minutes to 30 minutes in this project work. Variation in the extraction of metal with respect to time is not described in the literature.
- In present literature every research is based on using reagents or chemicals for metal separation (3, 6, 7). In most of the literature the method is performed with using reagents or complexing agents. In this project work we have tried for without any chemical separation can be done. Only for adjusting the pH we have used chemicals.
- Research has not been carried out with lower voltage for metal separation. Research work is done on the Electrophoresis process in which the very high voltage is applies which is in kilo volts. Work is done with lower voltage in one paper (10) but it is based on the ampere variation and also electrode variation. No work is done on voltage variation basis.

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