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METAL SEPARATION FROM SYNTHETIC WASTEWATER BY ELECTROKINETICS METHOD

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Abstract

The industrial growth is the major source of heavy metals introducing such pollutants into different segments of the environment including air, water, soil, and biosphere. Heavy metals are easily absorbed by fishes and vegetables due to their high solubility in the aquatic environments. Hence, they may accumulate in the human body by means of the food chain. Various methods have been developed and used for water and wastewater treatment to decrease heavy metal concentrations. Heavy metals like arsenic, copper, cadmium, chromium, nickel, zinc, lead, and mercury are major pollutants. This paper is focused on the recently developed and newly applicable treatment process for the removal of heavy metals from industrial wastewater is called Electro kinetics. Industrial wastewater needs effective treatment before disposal as they may mostly contain heavy metals in dissolved form, advance treatments are required for efficient, economical with low operational and maintenance systems for commercial utilization. Electro-kinetics was experimented with synthetic wastewater using graphite electrode as material at pH variation and time up to 30 minutes of retention time.

KEY WORDS- ELECTROKINETICS, AUTOMIC ABSORBTION SPECTROMETER.

INTRODUCTION

Heavy metals in effluent are serious problem of concern during treatment process to be efficient. Electroplating wastewater contains heavy metals such as nickel, chromium, zinc and iron after discharged from treatment unit. Heavy metal ions can naturally be found in the environment, but these days their concentration is getting high because of increased industrial wastes. The toxic ions enter the food chain and then the human body. Once they accumulate in an organ to more than standard limits, they may cause serious health-related diseases. High concentration of Ni bring cancer of lungs and kidney (1). These heavy metals above limits can cause adverse effect on the humans and environment. Heavy metals are generally considered those whose density exceeds 5 g per cubic centimeter (3). Heavy metals are produced from different industries. Heavy metals such as cadmium, zinc, lead, chromium, nickel, copper, vanadium, platinum, silver, and titanium are generated in electroplating, electrolysis depositions, conversion-coating, and anodizing-cleaning, milling, and etching industries(3). Chromium is carcinogenic. Nickel can cause decreases in body weight, heart liver damage, and to cause cancer. Zinc above 5mg/l gives astringent taste and opalescence in water, also health problems such as stomach cramps, skin irritations, vomiting, nausea and anemia (1,2), while chronic exposure could lead to copper deficiency in man. Iron above 3 mg/l can affect appearance affecting domestic water supplies, promotes iron bacteria, and staining of laundry cloths (1). The ingestion of large quantities of iron salts may lead to severe necrotizing gastritis with vomiting, hemorrhage and diarrhea followed by circulatory shock, also diseases of aging such as Alzeihermer’s disease, other neurodegenerative disease, arteriosclerosis, diabetes mellitus may all be contributed to by excess iron and copper. Hence heavy metal treatment is important before disposal of effluent on land or in water bodies, with possibility of metals getting dissolved or formation of complex. Various treatments are employed to treat wastewater containing small or large concentration of heavy metals. Methods such as adsorptions, bio-sorption, ion exchange, zeolite, phytoremediation, nanomaterial and chemical coagulation are used for the efficient removal of heavy metals, still these methods have their own barriers during treatment. Electro kinetics is considered as the effective treatment technique over methods listed above. The merits of the treatment which are considered over other techniques are less sludge generation, no chemicals used, less retention time, no problem on selectivity of contaminants and easy in operation, only disadvantage is changing sacrificial electrodes of the system. Electrocoagulation has shown effective results on electroplating wastewater. The aim of this study was to investigate electro kinetics process efficiency to remove heavy metals using graphite electrodes determining pH and optimal voltage.

2. Materials and methodology

2.1. Characterization of wastewater:

The synthetic wastewater used in this study was prepared in the laboratory, using standard methods.

2.1.1. CONCENTRATION OF SYNTHETIC WASTEWATER

Sr. No	**Characteristics**	**Value**
1	Zinc	16ppm
2	Chromium	16ppm
3	Iron	16ppm
4	Copper	16ppm

2.2. Electro kinetics procedure

The present study was performed in laboratory on prepared samples of synthetic wastewater.

- Set-up includes DC power supply graphite electrodes (120 mm height × 5 mm width × 5mm thickness), spacing of 5 mm between electrodes, glass jar (200 ml capacity), electrode connection.
- Wastewater parameters like pH , and heavy metal concentrations were analyses using atomic absorption spectrophotometer (AAS).
- Parameters of the sample was analysed at various pH as acidic, normal and in alkaline conditions and at optimum voltage range for the duration of 30 minutes using graphite electrodes.
- pH of the sample was adjusted using sulphuric acid and normal sodium hydroxide.
- Finally sample was analysis for heavy metal concentration for pH, electrode combination and reaction time.

2.3. Efficiency of Treatment

$$n\,\% = \frac{C - Cx}{C} \times 100$$

After finding out efficiencies as described above are mentioned bellow. We have done no of experiments on the synthetic wastewater and optimum results are found out. That results are applied on the actual industrial wastewater and final results of this method are calculated.

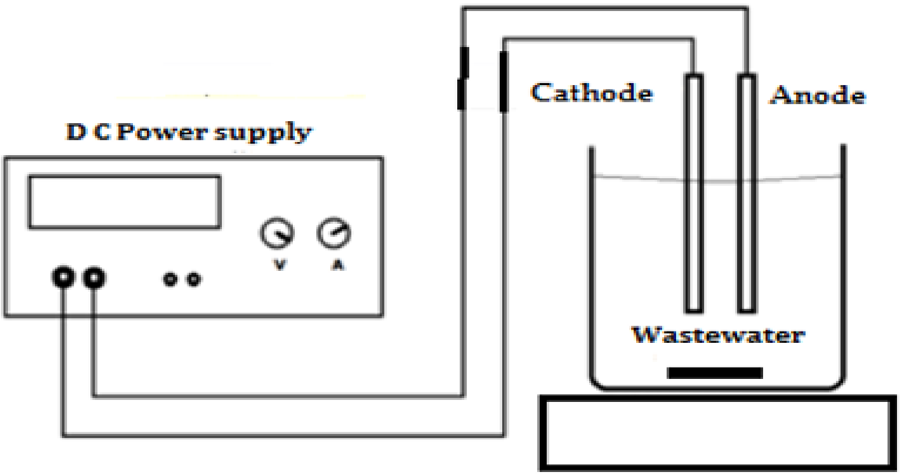


FIG NO.1 EXPERIMRNTAL SETUP

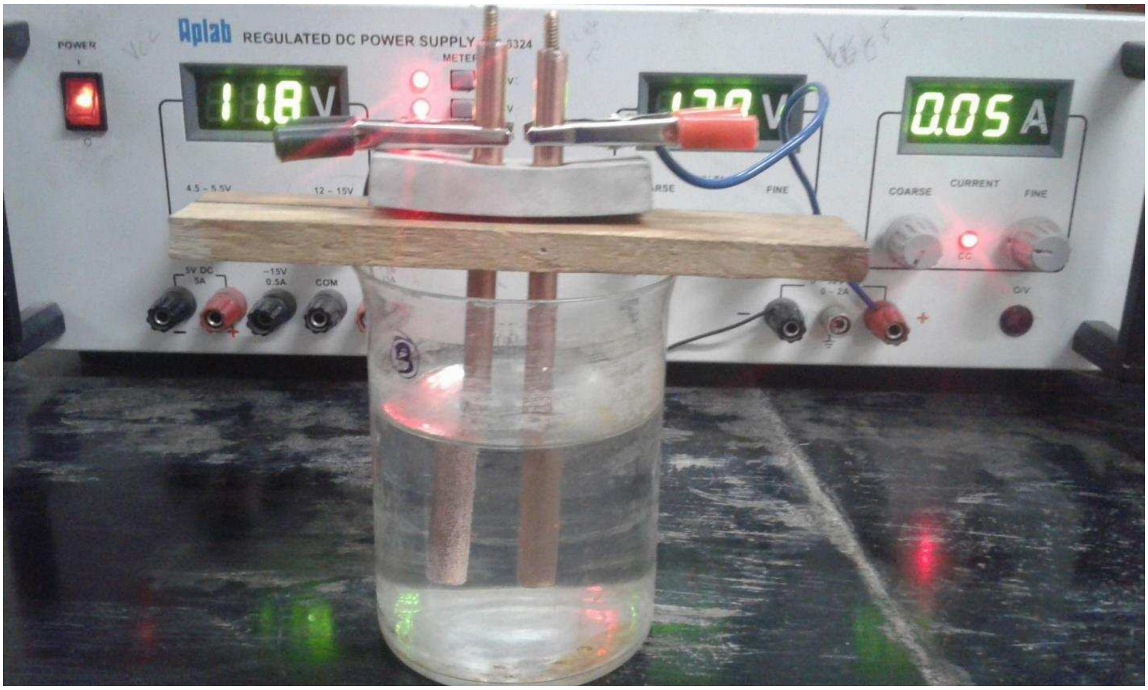
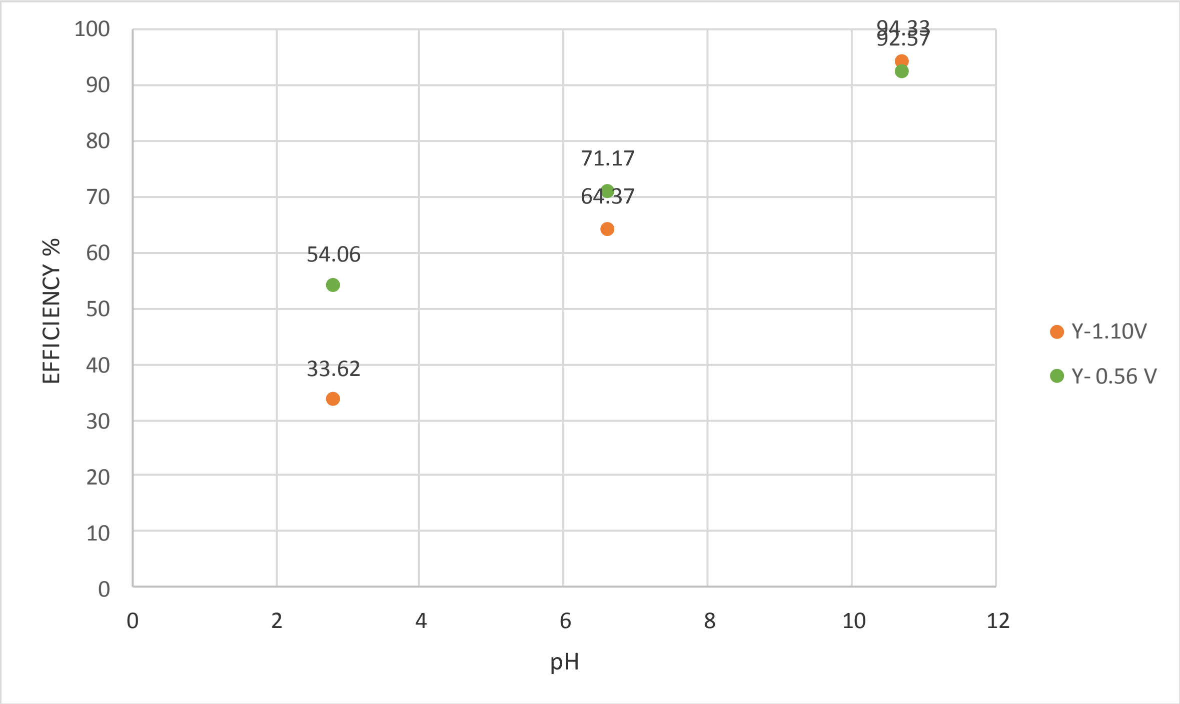


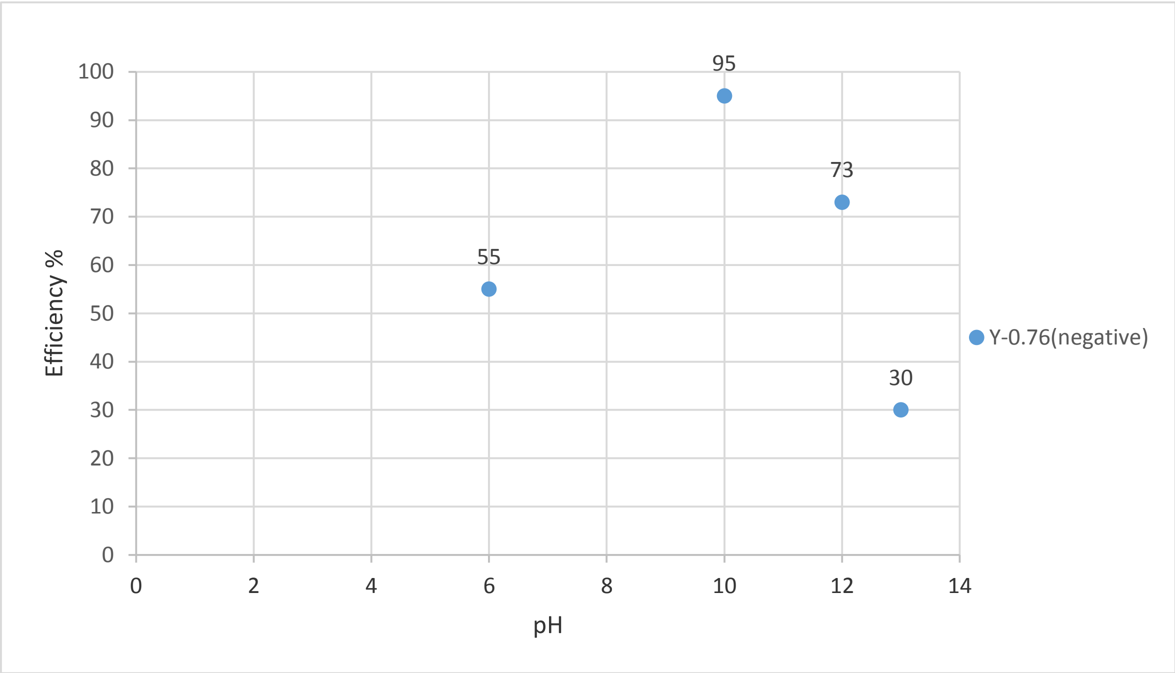
FIG NO.2 EXPERIMRNTAL SETUP

2.4. Result

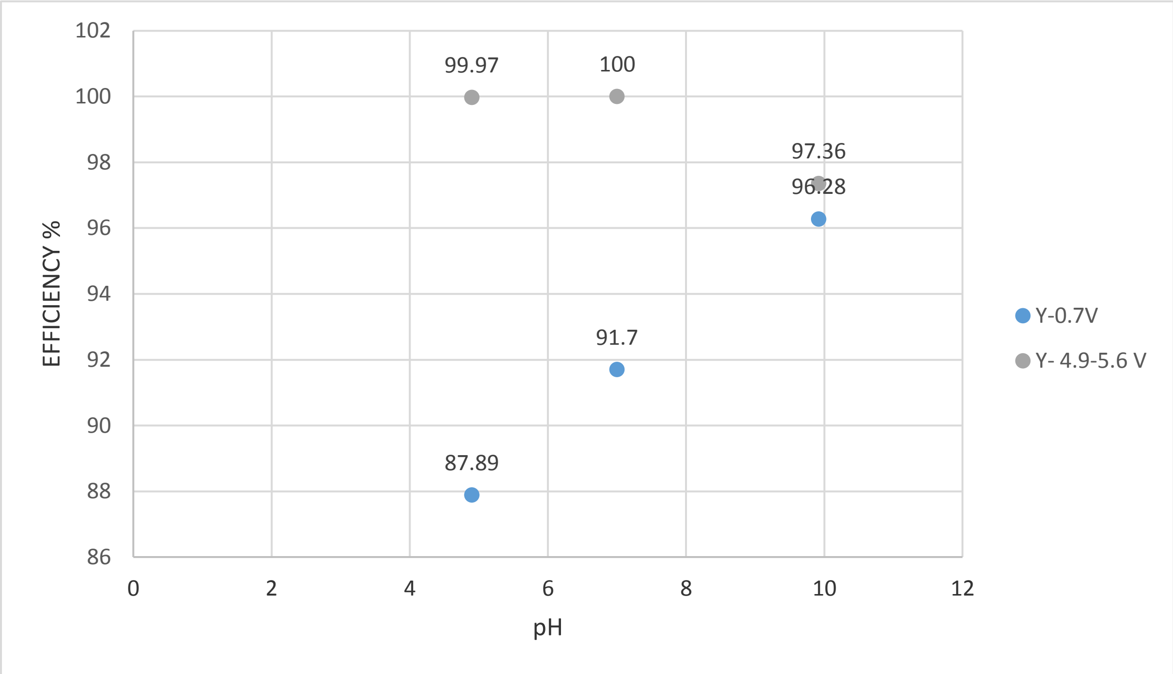
2.4.1. COPPER RECOVERY



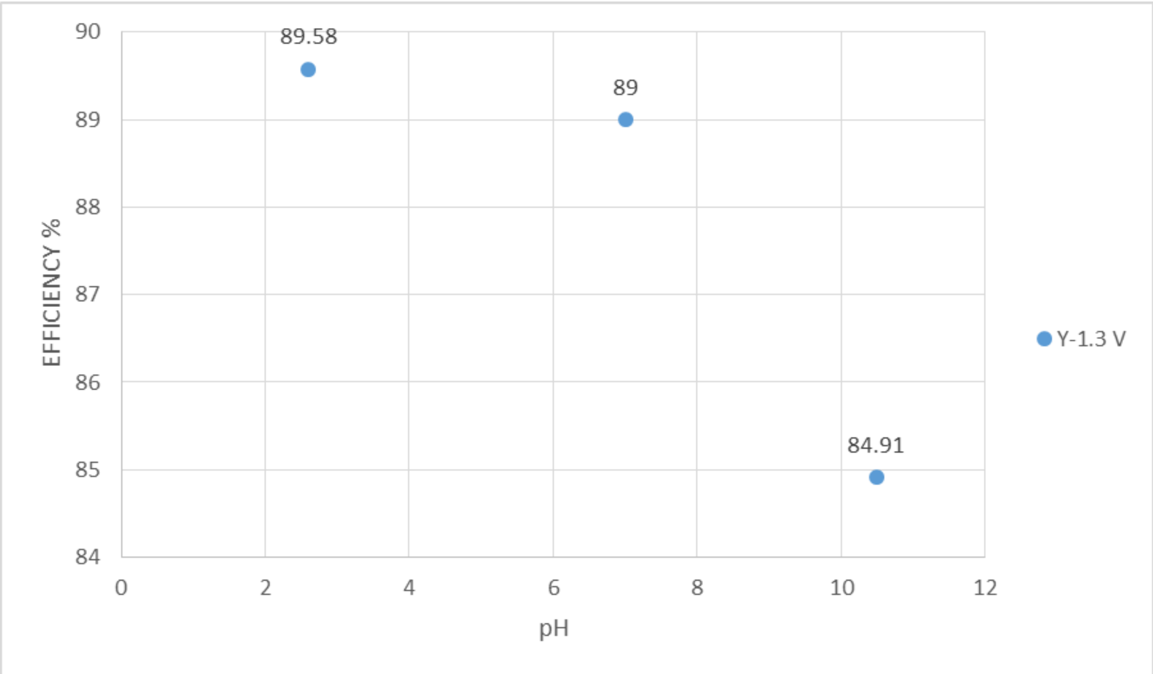
2.4.2. ZINC RECOVERY



2.4.3. IRON RECOVERY



2.4.4. CROMIUM RECOVERY-



3. Discussion

3.1. Final results on the industrial wastewater

METAL	INDUSTRIAL WASTEWATER	COMBINATION OF SYNTHETIC WASTEWATER
COPPER	36.16%	100%
IRON	33.27%	100%
ZINC	90.22%	100%
CHROMIUM	97.46%	100%

These are results of the electrokinetics analysis. When combined synthetic wastewater analysis is carried out results we get are 100%. In the industrial analysis we get less efficiency as compared to synthetic sample because of industrial wastewater contains various type of metals and chemicals. This combination of chemical and metal affects the efficiency of electrokinetic. We get good results in industrial wastewater for zinc is about 90% and for chromium is 97%. And results for copper and iron are 36% and 33% respectively**.**

4. Conclusion

The problem of heavy metal pollution is worsening day by day due to human activities. Therefore the removal of metals from the environment becomes a subject of great importance. With the latest technologies, reduction of electricity requirements, and miniaturization of the needed power supplies, Electrokinetic systems have now become affordable for water treatment plants and industrial processes worldwide.

According to the above study, Graphite electrodes at alkaline pH conditions are observed to be more efficient in the treatment of synthetic and industrial waste water. The optimum reaction time is observed to be 30min.the voltage for various metals at the specific point is found out as

METAL	VOLTAGE	pH
Zinc	0.7 (negative)	10 (Alkaline)
Iron	0.7	7.5 and 9.9 (Neutral and Alkaline)
Copper	1.10 and 0.5	10.7 (Alkaline)
Chromium	1.3	6.90 and 2.60 (Neutral and Acidic)

By observing the above results obtained from synthetic and industrial wastewater samples, it can be concluded that these conditions for metal removal can be applied practically in industries for heavy metal removal.

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