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Performance Evaluation of Electrocoagulation Process for Removing Hardness from Bore Well Water

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Abstract: Water is the basic & essential need of human beings. In recent times the quality of potable water has deteriorated due to pollution which has led to ill effects on the health of human beings. Hence there was a need to undertake suitable method of purification of water. One of the most effective methods of water purification is electrocoagulation. Electrocoagulation consists of a tank in which plates of aluminum are alternately placed which acts as anode and cathode. A D.C. source is required to supply the power to the elctrocoagulation model. Thus we carry out electrolysis by preparing a electric cell. This process has great efficiency for the purification of water and removal of hardness.
Keywords- Groundwater treatment, Hardness removal, Electrocoagulation, Continuous process.

I. INTRODUCTION

Throughout history people around the world have used groundwater as a source of drinking water and even today, more than half of the world's population depends on it for survival. Ground water quality may be impaired by many natural constituents such as fluoride, arsenic, iron, nitrate and salinity of which fluoride stands as a pollutant of geogenic origin in many countries. Calcium, magnesium concentration in groundwater is reported from as many as 40 countries including India. Drinking water is one of the basic needs of life and essential for survival. Still more than one billion people all over the world do not have ready access to an adequate and safe water supply and more than 800 million of those unsaved live in rural areas. In India, ground water is being used as raw water for 85% public water supply. (According to world health report 1998) water supply varies widely in terms of region and country. In 1970s, of the approximately 2.5 billion people in developing world, only 38% has safe drinking water. At the beginning of the 1980s, water supply coverage was 75% in urban areas and 46% in rural areas. Suitable and available water for human consumption is highly limited and likewise, available drinking water has been reduced because of the pollution created naturally and artificially. Among water quality parameters, hardness has always been investigated as an important factor. Moreover, water hardness is an essential parameter in industrial water consumption in manufacturing of high-quality products. Water hardness originates from existence of cations such as calcium, magnesium; and in lower traces; aluminium, iron and other bivalent and trivalent cations. Among hardness causes, ions, calcium and magnesium are identified as main factors of hardness.

A. Title & Objective

Performance Evaluation of Electrocoagulation Process for Removing Hardness from Bore Well Water
Specific objectives are as follows:

1) To study and understand the fundamentals of electrocoagulation process
2) To design and construct batch mode electrocoagulation reactor for hardness removal
3) To study the effect of operating parameters such as: effects of pH, effects of current density, effects of voltage, effects of electrolysis duration.
4) To characterize the sludge generated after electrolysis by SEM analysis.

II. METHODOLOGY

A. Materials and methodology

1) Bore Well Water.
2) The experimental set-up of EC box was made up of plastic material. It comprised of eight electrode plates, and two outlet knobs. One inlet knob was provided for controlling discharge.

3) Electrode plate.
4) Elevated storage container
5) Collection container
6) Direct Current supply

B. Electrocoagulation Process

Electro coagulation (EC) is process whereby metallic hydroxide flocs are created within the water/wastewater due to the action of soluble anodes (iron or aluminum). The anode material undergoes oxidation and hence various monomeric and polymeric metal hydrolyzed species are formed. These metal hydroxides remove organics from water by sweep coagulation and/or by aggregating with the colloidal particles present in the water to form bigger size flocs and ultimately get removed by settling. An electrocoagulation reactor consists of anode and cathode like a battery cell; metal plates of specific dimensions are used as electrodes and supplied with adequate direct current using power supply as shown in Fig-1.

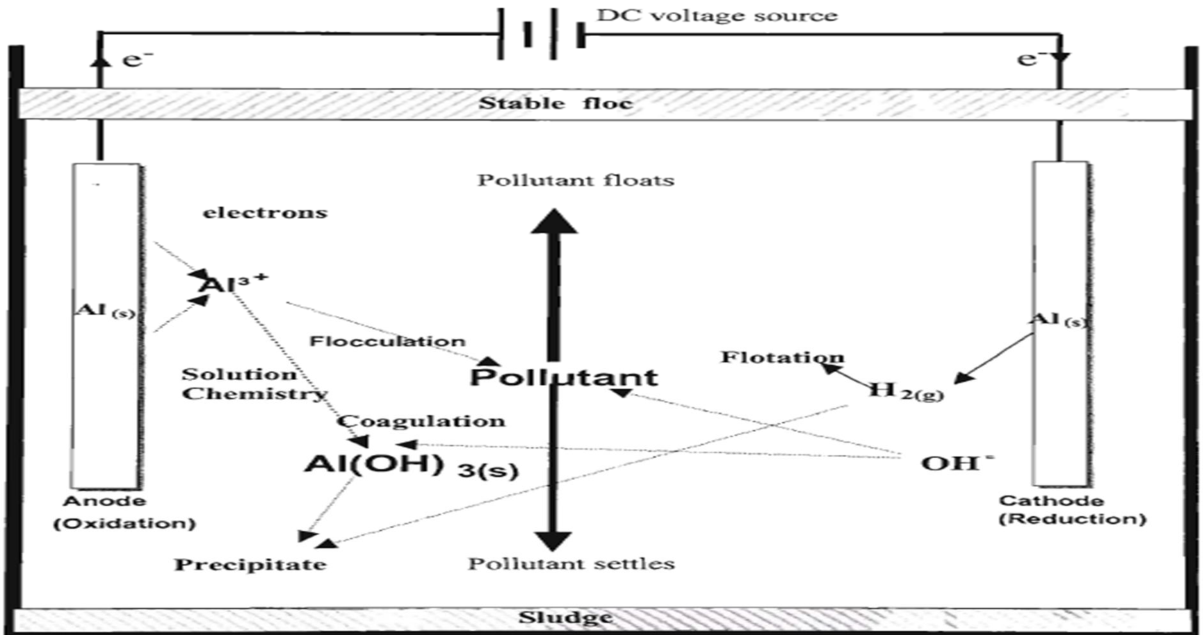


Fig-1 Processes occurring in an EC reactor

The EC technique combines three main interdependent processes, electrochemistry, coagulation and hydrodynamics. In an EC process, the coagulating ions are produced in situ and it involves three successive stages:

1) Formation of coagulants due to electrical oxidation of anode.
2) Destabilization of pollutants and emulsion breaking. Destabilization mechanisms in this process include electrical double layer compression, adsorption and charge neutralization, and enmeshment in a precipitate and inter-particle bridging.
3) Combining of instable particles to form flocs.

If M is considered as anode, the following reactions will occur:

$$M^{n+}{}_{(aq)} + ne^- \rightarrow M_{(S)}$$

$$2H_2O_{(l)} + 2e^- \rightarrow H_{2\,(g)} + 2OH^-$$

Freshly formed amorphous $M(OH)_3$ has large surface areas that are beneficial for rapid adsorption of soluble organic compounds and trapping of colloidal particles. If iron or aluminium electrodes are used, the generated $Fe_{(aq)}{}^{3+}$ or $Al_{(aq)}{}^{3+}$ ions will immediately undergo further spontaneous reactions to produce corresponding hydroxides and/or polyhydroxides. For example, ferric ions generated by electrochemical oxidation of iron electrode may form monomeric ions, $Fe(OH)_3$ and polymeric hydroxyl complexes, namely: $Fe(H_2O)_6{}^{3+}$, $Fe(H_2O)_5(OH)^{2+}$, $Fe(H_2O)_4(OH)^{2+}$, $Fe_2(H_2O)_8(OH)_2{}^{4+}$ and $Fe_2(H_2O)_6(OH)_4{}^{4+}$. Al^{3+} ions on hydrolysis may generate $Al(H_2O)_6{}^{3+}$,$Al(H_2O)_5\,OH^{2+}$, $Al(H_2O)_4\,OH^{2+}$ and the hydrolysis products may form many monomeric and polymeric species such as, $Al(OH)^{2+}$, $Al_2(OH)_2^{4+}$, $Al(OH)^{4-}$, $Al_6(OH)_{15}^{3+}$, $Al_8(OH)_{20}^{4+}$, $Al_{13}O_4(OH)_{24}^{7+}$, $Al_{13}(OH)_{34}^{5+}$ over a wide pH range. These hydroxides/polyhydroxides/polyhydroxy metallic compounds have strong affinity for dispersed particles as well as counter ions to cause coagulation. The gases evolved at the electrodes may impinge on and cause flotation of the coagulated materials. The hydroxides/polyhydroxides/polyhydroxy metallic compounds increase the elimination efficiency.

C. *Monopolar electrodes in series connections*

An arrangement of EC cell with a pair of anode and cathodes in series connection is shown in Fig 2. It can be seen from the figure that, each pair of sacrificial electrodes are internally connected with each other, and has no interconnections with outer electrodes. Because of the interconnections between the inner electrodes in this connection, the cell voltages sum up and a higher potential difference is required for a given current. This arrangement of monopolar electrodes with cells in series is electrically similar to a single cell with many electrodes and interconnections.

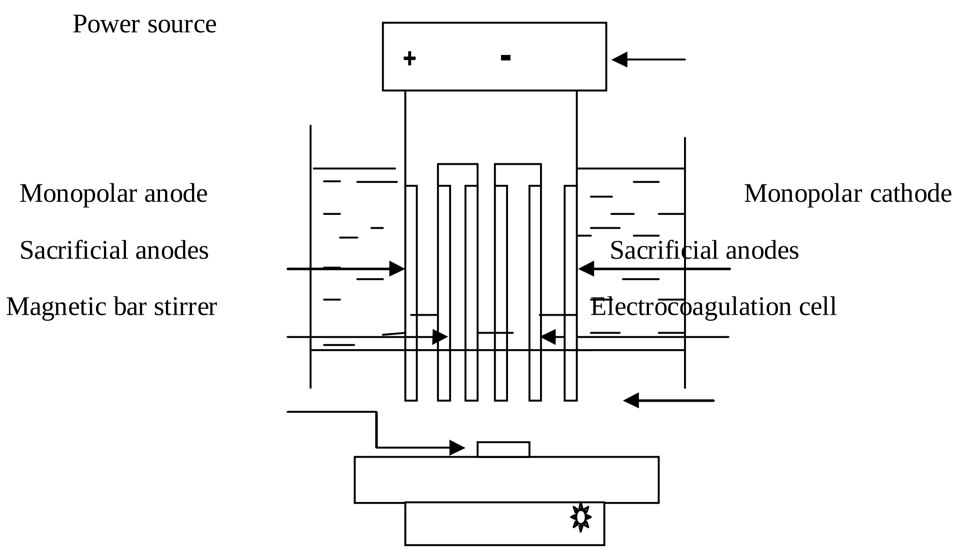


Fig-2 EC reactor with monopolar electrodes in series connection

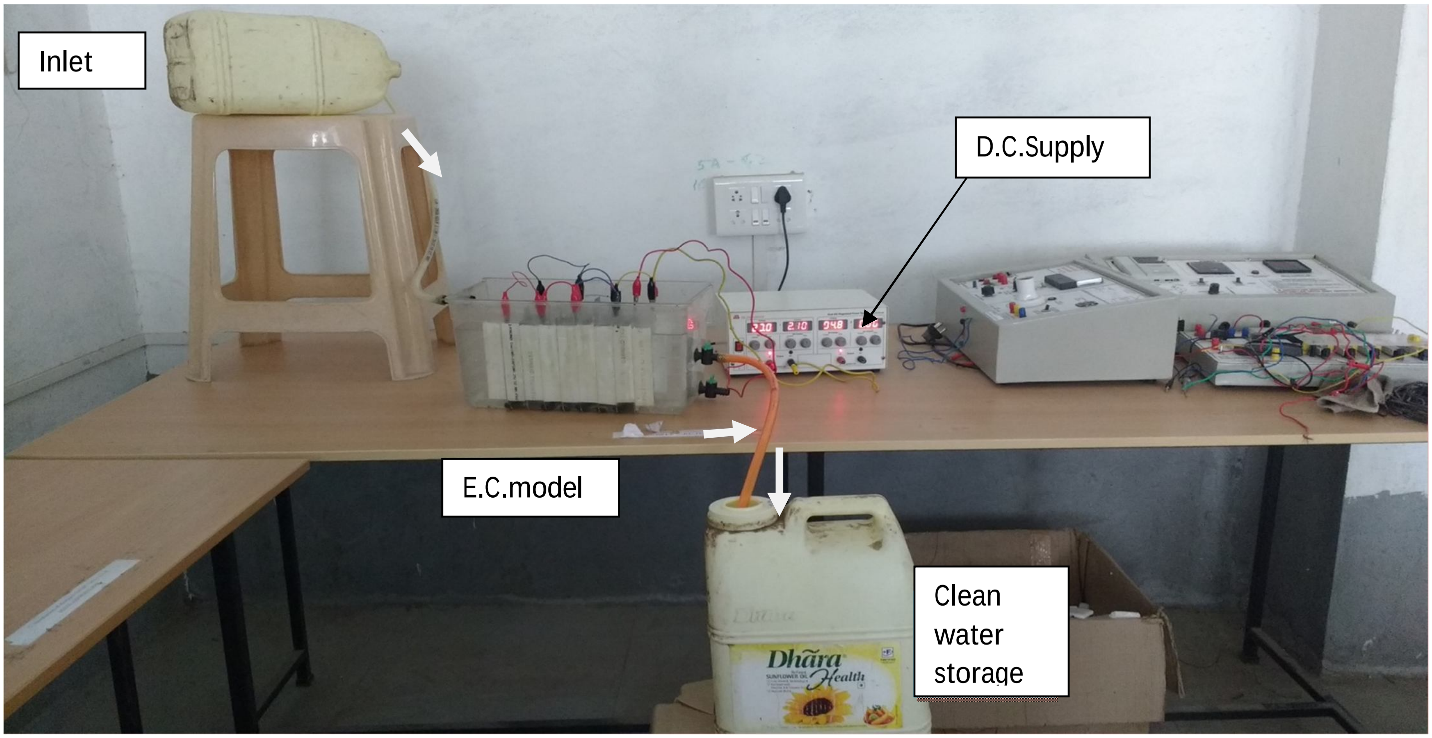
D. *Application of electrocoagulation process*

1) No need to add chemicals, thus preventing secondary pollution and reduction of amount of generated sludge needing disposal.
2) Low reaction time and thus small size of reactor.
3) Simple operation and maintenance.
4) Flocs formed settle easily and are readily dewaterable.
5) The salt content of the treated water does not increase appreciably as in case of chemical treatment.
6) The EC technique can be conveniently used in rural areas where electricity is not available, since a solar panel attached to the unit may be sufficient to carry out the process.

E. *Experimental Procedure*

1) Initially, the bore well water is taken in beaker and initial pH is tested then bore well water is fed to elevated storage tank.
2) The bore well water is discharged into EC unit. Discharge is controlled with the help of valve which is present in between elevated storage tank and EC unit. Discharge is made to pass through the EC unit and effluent is collected in collection container. This continuous wastewater flow run through EC unit is checked 2 to 3 times in the duration of 10 min so as to check whether the required discharge is achieved.
3) Switch on the DC supply so that designed current would pass through the running water in the EC unit for designed electrocoagulation period.
4) The 100ml effluent is collected in a beaker of 250ml in every desired time interval, in between detention period and two times in second detention period after completion of detention period.
5) All supernatants in all 250ml beakers are taken for TH, Ca^{2+}, Mg^{2+}, TDS and alkalinity determination.

6) We get continuous discharge of soft and purified water at the outlet



III. RESULTS AND DISCUSSION

In this study, bore well water (BWW) collected from a local bore-well (i.e. at – Vishrambag, Sangli; Maharashtra) in residential area was treated by continuous mode EC. The sampling was done twice in a month by grab sampling method. The characterization of bore well water was done for different parameter such as pH, total hardness, alkalinity and TDS throughout the study.

A. Water before treated

Table-1: Characteristics of Bore Well Water

Parameter		Value
pH		6.9 ± 0.5
Total hardness (TH)		380 ± 100 mg/L
Total dissolve solid (TDS)		680 ± 100 mg/L
Alkalinity		200 /l

B. Water after treated

Table 2: Effects of Voltage, Current and Removal of TH, pH and TDS Removal

Voltage(V)	*Current(A)*	*Efficiency %*			
25	*3.2*	*TH*	*pH*	*Alkalinity*	*TDS*
25	*3.2*	*89.45*	*83.45*	*83.43*	*74.07*
22	*2.6*	*83.27*	*81.51*	*78.74*	*69.43*
20	*2.1*	*79.93*	*78.47*	*75.43*	*65.69*

III. CONCLUSION

A. Based on experimental findings following conclusions were drawn:

1) Electrolysis time [ET] to reach acceptable Hardness removal limit increases.
2) At higher current density and voltage removal time was shorter due to due to faster release of coagulant.
3) Results indicated that water softening process is more efficient when pH is kept constant in the range 6-8 and also pH shift post treatment occurs towards alkaline conditions.
4) Groundwater sample collected from Vishrambag, Miraj Taluka, and Sangli District was successfully treated by EC with an hardness removal efficiency of 75%.
5) Thus based on the results obtained for treatment of groundwater by EC it was clear that EC is a viable method for hardness removal and holds the potential to be implemented as a reliable community water softening system as considerable improvement in water quality.

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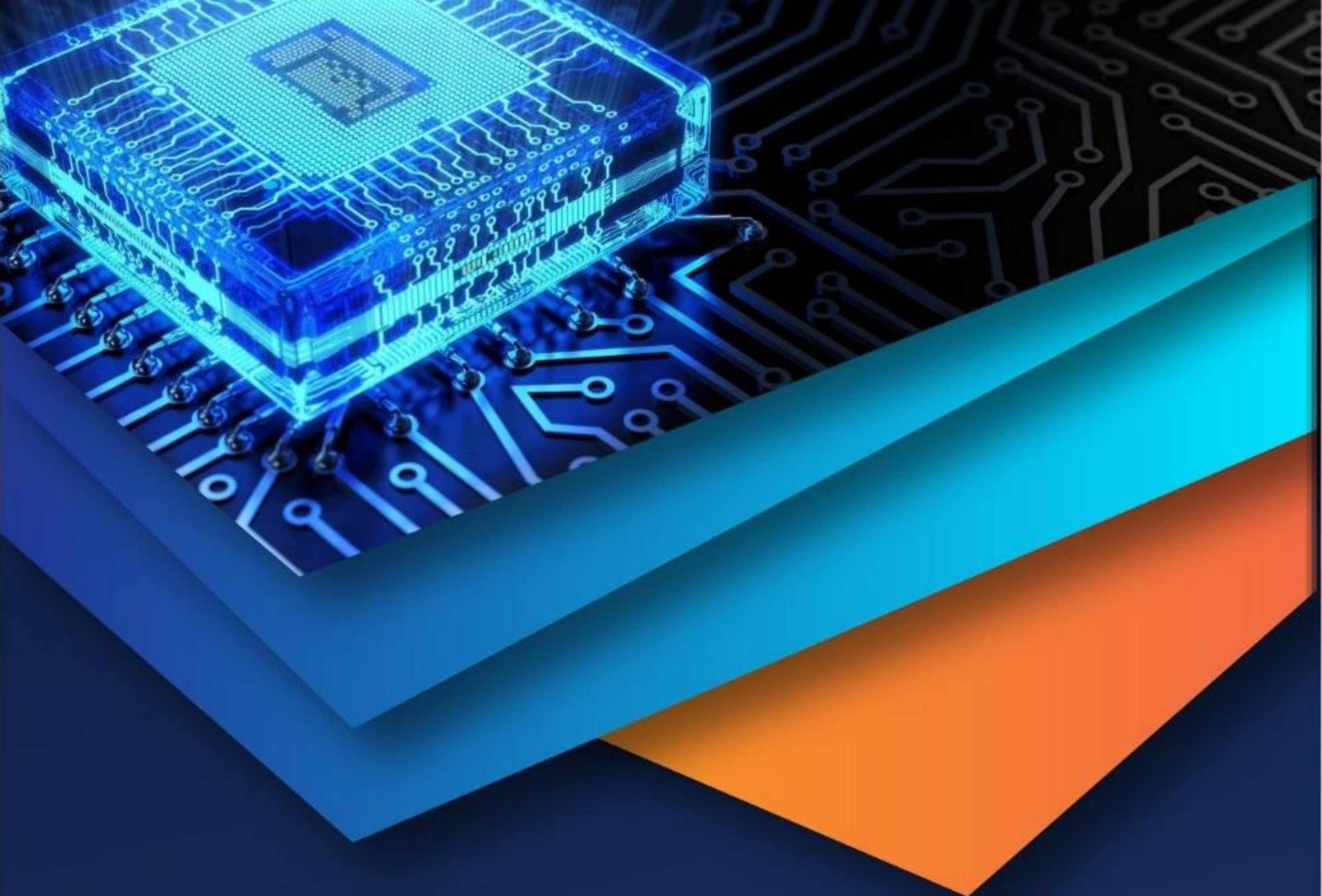
REFERENCES

[1] APHA /AWWA /WEF and A.p.h.a.p., 2340, Standard method for examination of water and wastewater,20 The Ed, Washington DC. 1999.
[2] A. Tabatabai, et al., Economic feasibility study of polyelectrolyte-enhanced ultrafiltration (PEUF) for water softening, Journal of Membrane Science 100 (1995) 193–207.
[3] A. Mika, et al., Ultra-low pressure water softening:a new approach to membrane construction, Desalination 121 (1999) 149–158.
[4] D. Nanda, et al., Effect of solution chemistry on water softening using charged nanofiltration membranes, Desalination 234 (2008) 344–353.
[5] Groundwater contamination: An overview, Report by Environmental Protection Agency (EPA), 2010.
[6] J. Suk Park, et al., Removal of hardness ions from tap water usingelectromembrane processes, Desalination 202 (2007) 1–8.
[7] J. Schaep, et al., Removal of hardness from groundwater by nanofiltration, Desalination 119 (1998) 295–302.
[8] K. Rajeshwar, J.G. Ibanez, G.M. Swain, J. Appl. Electrochem. 24 (1994) 1077. Mukul Bishnoi and Shalu Arora, "Potable groundwater quality in some villages of Haryana, India: Focus on Fluoride", Journal of environmental biology, pp. 291-294, April 2007.
[9] M. Bodzek, S. Koterb, K. Wesolowsk, Application of membrane techniques in a water softening process, Desalination 145 (2002) 321–327.
[10] N. Kabay, et al., Removal of calcium and magnesium hardness by electrodialysis, Desalination 149 (2002) 343–349.
[11] P. Stamberger, J. Colloid Interface M.Yousuf A. Mollah et al. / Journal of Hazardous Materials B84 (2001) pp-29–41 41.
[12] Brahmi K., Bouguerra W., Hamza B., Zied T. and Mouna L., (2015), "Use of Electrocoagulation with Aluminum Electrodes to Hardness in Tunisian Phosphate Mining Process Water." Indian Journal of Environmental Protection, 34(7), 529-533.
[13] Khairi K., Ghazi N. and Mohammed A., (2014), "Hardness Removal from Drinking Water Using Electrochemical Cell." Egg. & Tech. Journal, 33 (1), 78-88.
[14] Malakootian M. and Yousefi N., (2009), "Efficiency of Electrocoagulation Process Using Aluminum Electrode in Removal of Hardness from Water." Desalination, 6, 131-136.
[15] Mansoorian H., Malakootian M. and Moosazadeh M., (2010), "Performance Evaluation of Electrocoagulation Process Using Iron Electrode for Removing Hardness from Drinking Water." Desalination, 255, 67-71.



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