

# Wastewater Treatment by Electrocoagulation

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## Abstract

Water shortage is very important issue in the world; especially at the current rates it is being used. Drinking water and water for industrial use demand for freshwater is at an all-time high. Using electrocoagulation method, industrial companies can treat wastewater to a point that it can be reused within their plant, discharged without environmental restriction or for use in irrigation. A review of recent research identifies future opportunities to use the application of electrochemical water treatment systems for many different industrial wastewaters.

## Introduction

Water is one of the world's most spirited resources. It is critical to the survival of every living individual on the world. Health experts stress drinking fluids all over the day the day to remain properly hydrated. However, in many parts of the world, water is hard to obtain. Either there are no sources adjacent to, or there is an incomputable management system that makes it hard for people to obtain water. Water and wastewater treatment have become very important standard in all over the world. Wastewater effluents from homes, buildings, and factories in many countries are also treated via wastewater treatment systems before being discharged back into surface waters. Without environmental damage However, there are two main significances of wastewater treatment, one is defending the environment and the other one is sustaining freshwater resources [1]. With the ever-increasing population and the stringent environmental regulations regarding the wastewater discharge, electrochemical technologies have retrieved their importance worldwide for treatment waste waters.

## Conventional Wastewater Treatment

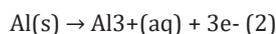
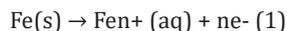
Chemical coagulation, biological methods and advanced oxidation processes, such as ozonation and UV/  $H_2O_2$  that cannot treat the effluent. All of earlier methods have some boundaries and problems. Biological treatment by activated sludge is very high efficiencies in COD removal but does not effective in decolorization of the wastewater and have problems such as bulking appear. Chemical oxidation by ozone, or a combination of UV-radiation and ozone and  $H_2O_2$ , has great interest, but the costs are still very high due to the high doses required [2-4]. Coagulation-flocculation process has been found to be cost effective, easy to operate and energy saving treatment alternatives, but the coagulation process does not work well for soluble dyes. Electrocoagulation treatment technology method that used electrons only employed agents in ECF being responsible for facilitating wastewater treatment.

## Electrocoagulation Process

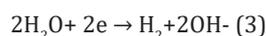
The (EC) technology includes coagulation and precipitation of contaminants by a direct current electrolytic process followed by the separation of flocculent (settling or flotation) with or without the addition of coagulation-inducing chemicals. A direct electric current is applied to the electrodes to induce the electrochemical reactions needed to achieve the coagulation. In an EC process the coagulated ions a produced in "in situ" and it involves three successive stages [5,6].

- Formation of coagulants by electrolytic oxidation of the sacrificial electrodes.
- Weakening of the contaminants, particulates suspension and breaking of emulsions.
- Collection of the destabilized phase to form flocculent.

iron or aluminum are Electrodes which produce coagulants into water. Iron and aluminum cations dissolve from the anodes according to Equations 1 and 2.



And at cathode according to Eq. 3

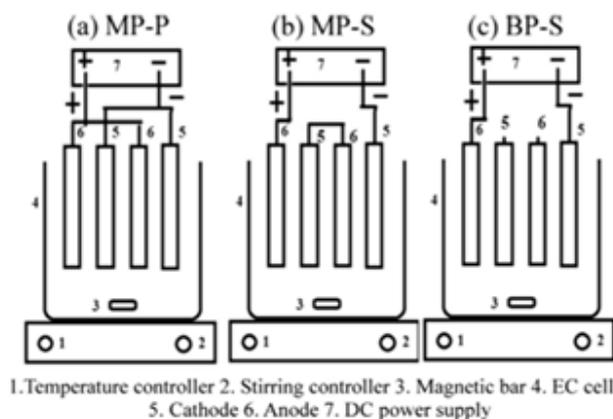


In solution the positively charged ions are attracted with the negatively charged hydroxides to produce ionic hydroxides that have a strong attraction towards dispersed particles as well as counter ions to cause coagulation (Table 1).

**Table 1:** Examples in recent applications of electrocoagulation in treatment of water and wastewater [1].

Reference	Type of Wastewater	Anode-Cathode	Removal Efficiency
Warren R et al. (2018)	Metals	Fe-Fe	Fe (99.17%), Mn (99.97%),
Naraghi et al. (2018)	Reactive dyes	Fe-Fe	96% (Colour)
Mahammedrafi P et al (2018)	Fluoride ions	Fe-Fe	91 % fluoride ions
Francisco P et al. (2017)	Whey acids	Al - Fe, graphite and Ti/ RuO <sub>2</sub>	79%-49% contaminants
LiR et al. (2017)	Landfill Leachate	Al-Al	99 %-91%
Bejjany B et al. (2017)	Internal loop airlift	Al-Al	70%-87%energy consumption
Hariraj S et al. (2017)	Removal of suspended solids and metals from synthetic water	Al-Al	76.6%, and reduced rates of 99%, 59.2%, and 82.1%, for Cu, Cr, and Zn
Shobhan M et al. (2017)	Textile mill	(SS-Ti)- (Al-Ti)	90 %-78% (Colour)
Seyed Ali et al. (2017)	Remazol Black B Dye	Al-Al, Fe-Fe	99%-91% (Colour)
Maghanga J et al. (2017)	Reactive Black 5	SS- SS	99.4%(Colour)
Jorge V et al. (2017)	Palm Oil Mill, Paint Wastewater	Fe-Fe	65% and 76% Total Suspended and Dissolved Solids
Alimohammadi M et al. (2017)	Natural organic matter	Al-Al, Fe-Fe	100% (Colour)
Abubaker T et al. (2017)	Tannery	aluminum nanoparticles	98.98%, 90.6%,70.40%,99.9% and 88.3% of Turbidity, COD, TDS, Chromium and Sulphide
Joseph T et al. (2017)	Abattoir	Fe-Fe	93%(Colour)
Nasser G et al. (2017)	Herbicide oxyfluorfen, COD	Fe-Fe., S.S- S.S, Fe-Fe	(98.5-90, 99.2-85, 96.1- 70.5% (Colour, COD)
Manoel É et al. (2016)	Dye yellow Sirius	Al-Al	95%(Colour)
Murat Eyvaz (2016)	Brewing industry	Al-Al, Fe-Fe	
Vidal J et al. (2016)	Acid Black 194	Fe-Fe	100% (Colour)
Anmoldeep S et al. (2016)	Brilliant Green, Bromo blue and Brilliant blue	Fe-Fe	100% (Colour)

**Different Modes of Electrode Connections [7]**



**Figure 1:**

Monopolar electrodes in serial connections (MP-S): In the monopolar electrodes in serial connection, each pair of sacrificial electrodes is internally connected with each other. The addition of the cell voltages leads to a higher potential difference for a given current. Bipolar electrode in serial connections (BP-S): In this connection mode, the outer electrodes are connected to the power supply and there is the no electrical connection between the inner electrodes. reported that MP-P mode is the most cost effective for both aluminum and iron electrodes (Figure 1).

### Conclusion

Finally, according to findings of this Article, it can be concluded that electrocoagulation process can obtain the highest favorable color removal which can make a recycle for wastewater, but in case of COD removal, I recommend adding a help method to complete treatment which agrees with restricted environment. The author and their colleagues recently proved that treated textile wastewater of activated sludge biomass was investigated and the results indicated that both dye and minerals content have negative effect therefore it is recommended to recycle treated effluent in industrial processes or consider total dissolved solids in the effluent as clearance limits [8].

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