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Soap Industry Waste Water Treatment by Electro-Coagulation

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***Abstract*: Water is a critical resource in the lives of people who both benefit from its use and who are harmed by its misuse. Industry is a huge source of water pollution, it produces pollutants that are extremely harmful to people and the environment. Many industrial facilities use freshwater to carry away waste from the plant and into rivers, lakes and oceans. Nowadays, water is being purified by various methods but research is being conducted to look for more reliable and cheaper methods that can purify water at an affordable cost. The objective of this paper is to find the optimal operating conditions for the removal of various physical and chemical parameters of wastewater from soap industries by electro-coagulation techniques. In this process without using any chemicals and the chemicals which are present in the sample can be removed, it does not leave any additional chemicals in the sample. In the Present study the analysis is done by varying voltage for different period of time. The voltages are 10V, 20V, and 30V for the duration of 30min, 60min, 90min, and 120min. The electro-coagulation process is more effective, quick and Feasible method for treatment than chemical coagulation the effect On color, turbidity, pH, fluoride, iron, residual chlorine, oil and grease DO, BOD etc., and duration of treatment, on the percent removal of parameters were investigated. Under the optimal operational conditions (initial pH =8, t = 30 min and J=60 A/m2), the treatment of wastewater from soap industries by electro-coagulation alone has led to a removal of color 46.15%, nitrate 27.27%, fluoride 50%, oil and grease 65.21%, COD 77.56% and BOD 63.84%, Total Dissolved solids 19.72%, Chromium 56.81%, Electrical conductivity 27.38%, Total Suspended solids 71.15%. respectively at particular voltage and for the particular period of treatment.**

***Keywords*: Wastewater from soap industries; Electro coagulation (EC); physical and chemical parameters; Electrode.**

1. Introduction

Natural soap was one of the earliest chemicals produced by man. Historically, its first use as a cleaning compound dates back to Ancient Egypt. In modern times, the soap and detergent industry, although a major one, produces relatively small volumes of liquid wastes directly. However, it causes great public concern when its products are discharged after use in homes, service establishments, and factories .Over the past 40 years, the total world production of synthetic detergents increased about 50-fold [Lawrence 2014], but this expansion in use has not been paralleled by a significant increase in the detectable amounts of surfactants in soils or natural water bodies to which waste surfactants have been discharged. This is due to the fact that the biological degradation of these compounds has primarily been taking place in the environment or in treatment plants. Water pollution resulting from the production or use of detergents represents a typical case of the problems that followed the very rapid evolution of industrialization. The continuing increase in consumption of detergents are the origin of a type of pollution whose most significant impact is the formation of toxic or nuisance foams in rivers, lakes, and treatment plants. Water is also used and required for steam generation and other general purposes. The waste water discharged is highly polluted in nature with highly variable characteristics such as temperature, color, total solids, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), anions, cat ions, surfactants. Due to highly polluting nature, it is not possible to discharge treated and untreated waste either into water course or on land without causing great damage. They pose great problem for environmental engineers.

Water pollution resulting from the production or use of detergents represents a typical case of the problems that followed the very rapid evolution of industrialization that contributed to the improvement of quality of life after World War II. Prior to that time, this problem did not exist. The continuing increase in consumption of detergents (in particular, their domestic use) and the tremendous increase in production of surfactants are the origin of a type of pollution whose most significant impact is the formation of toxic or nuisance foams in rivers, lakes, and treatment plants.

A. Electro coagulation

Coagulations one of the important physic-chemical operations used in water treatment. This is a process used to cause the destabilization and subsequent aggregation of smaller particles into larger complexes. Water contaminants such as ions (heavy metals) and colloids (organic and inorganic) are primarily held in solution by electrical charges. Colloidal systems could be destabilized by the addition of ions of the charge opposite to that of the colloid. The destabilized colloids can then aggregate and subsequently be separated from the wastewater.

Coagulation can be achieved by both the chemical or electrical means. Chemical coagulation has been used for decades to destabilise suspensions and to effect precipitation of soluble species and other pollutants from aqueous streams. Alum, lime and polymers are some of the chemical coagulants used. These processes, however, tend to generate large volumes of sludge with high bound water content which can be difficult to separate and dewater. The processes also tend to increase the total dissolved solids content of the effluent, making it unacceptable for reuse within industrial applications.

Electro coagulation is one of the commonly used processes for the treatment of wastewater, it involves the generation of coagulants in situ by dissolving the ions from the electrode [Krishna 2017]. Electro means applying an electrical charge to water and coagulation means the process of reducing the colloidal particle surface charge and allowing suspended matter to form agglomeration. The various electrodes such as copper and graphite are used in this technology.

There has been renewed interest in the use of Electro coagulation owing to the increase in environmental restrictions on wastewater. In the past decade, this technology has been increasingly used in developed countries for the treatment of industrial wastewaters, by allowing the particles to react with anion on having an opposite charge or floc of metallic hydroxides generated within the effluent. Electro coagulation method is not only applied for the treatment of slaughterhouse wastewater, wastewater containing heavy metals, pesticides and phenol compounds, drinking water for fluoride removal, but also for the treatment of industrial waste water. Electro coagulation process has been extensively and successfully used for the treatment of numerous wastewaters including municipal wastewater, dying wastewater, and wastewater containing organic species such as phenol. An Electro coagulation reactor is composed of an electrolytic cell with a pair of electrodes immersed in a liquid (wastewater) that serves as the electrolyte. The process of pollutant removal involves the application of an electric current to sacrificial electrodes which in turn leads to the dissolution of metal ions, such as iron or aluminium, from a sacrificial anode. Consequently, the metallic hydroxide, a coagulant formed by electrolytic oxidation in an aqueous phase, destabilizes colloidal suspension such as emulsified oil. Further, the destabilized colloids aggregate and form flocks.

B. Karnataka soaps and detergents limited (KSDL)

Mysore Sandal Soap is a brand of soap manufactured by the Karnataka Soaps and Detergents Limited (KSDL), a company owned by the government of Karnataka in India. This soap has been manufactured since 1916, when Krishna Raja Wodiyar IV, the king of Mysore, set up the Government Soap Factory in Bangalore. The main motivation for setting up the factory was the excessive sandalwood reserves that the Mysore Kingdom had, which could not be exported to Europe because of the First World War. In 1980, KSDL was incorporated as a company by merging the Government Soap Factory with the sandalwood oil factories at Shimoga and Mysore.

Mysore Sandal Soap is the only soap in the world made from 100% pure sandalwood oil. KSDL owns a proprietary geographical indication tag on the soap, which gives it intellectual property rights to use the brand name, to ensure quality, and to prevent piracy and unauthorised use by other manufacturers. In 2006, Mahindra Singh Dhoni, the Indian cricketer was selected as the first brand ambassador of the Mysore Sandal Soap.

2. Literature review

M. A. Aboulhassan, S. Souabi, A. Yaacoubi and M. Baudu, et.al., (2006): Removal of surfactant from soap industrial wastewaters by electro-coagulation flocculation process Surfactants are among the most widely disseminated xenobiotics that contribute significantly to the pollution profile of sewage and wastewaters of all kinds. Among the currently employed chemical unit processes in the treatment of waste waters, coagulation-flocculation has received considerable attention for yielding high pollutant removal efficiency. Jar-test experiments are employed in order to determine the optimum conditions for the removal of surfactants, COD and turbidity in terms of effective dosage, and pH control. Treatment with FeCl3 proved to be effective in a pH range between 7 and 9. The process is very effective in the reduction of surfactants and COD, the removals are 99 and 88 % respectively, and increased BOD5 /COD index from 0.17 to 0.41. In addition to precipitation coagulation process, adsorptive mi cellar flocculation mechanism seems contribute to the removal of surfactants and organic matters from this rejection. Removal of surfactant from industrial waste waters by coagulation flocculation process. Fluctuation range of the measured values for COD, BOD, NTK, surfactants, total phosphorus, etc., are given in Table 1. The wastewater is characterised by substantial organic matter and high surfactants contents. The company uses a liquid anionic surfactant on the manufacturing process; it is a mixture of ammonium nonyl phenol ether sulphate (60 %), ethanol (15 %), and water (25 %),

M. Zaied et.al., (2008): In this paper, the effect of operational variables, such as treatment time, current density, type of electrode material and initial pH, on the removal efficiency is explored to determine the optimum operational conditions. The removal efficiency of the treatment was determined by monitoring he decrease of total phenol, COD and color intensity. It. was shown that removal increase with time and current intensity for both electrodes but with increasing time the COD and total phenol removal were slightly high for alminium electrodes than iron electrodes. The color removal was also high for alminium electrodes. Energy consumption and electrode consumption were high for iron electrodes. The optimal conditions found were (initial pH 7, t = 50 min and $J=14mAcm^2$), under which the removal obtain 98% of COD, 92% of poly phenols and 99% of color by using Al electrode.

K. S. Parama Kalyani et.al., (2009): In this investigation, the influence of electrolysis time, applied charge density, pH and supporting electrolyte on electro-coagulation efficiency for the treatment of pulp and paper industrial effluent has been attempted. It was found out that COD removal decrease as the initial concentration of effluent increase. The percentage COD removal decreased from 91% to 53%when the initial effluent concentration was increased from 3200 mg/l to 6400 mg/l. It was also found out that percentage COD and color removal were high with mild steel electrode than aluminum electrode. The maximum percentage COD removal has been observed at the electrolyte pH of 7 for mild steel electrode. It was observed that % removal increase with increase in current density from 50A/m2 to 100 A/m^2 but after that no increase in % removal was found. It was mention that the increase in electrolyte concentration from 200 to 600ppm increases the removal from 85 to 95%. It was observed that the rate of removal follow first order mechanism and rate constant was calculated at different conditions. The effluent was treated with sequential batch reactor (SBR) after increasing its biodegradability by electro-coagulation. It was shown through figures that the COD removal was 35 % during 8 hr operation by single biological process and 90 % by integrated process. Thus improvement of biodegradability through electro coagulation increases the efficiency of SBR. It was also shown that COD removal was 80 % after the end of aeration phase and 90 % after anoxic phase. The various isotherm models were tested for COD removal and it had been observed from the present investigation that Langmuir and Radke-Prausnitz isotherm models match satisfactorily with the experimental observations.

MikkoVepsalainen et.al., (2011): In this paper, the synthetic wastewater was made by addition of polish wood resin and copper nitrate and the wastewater was treated with electro-coagulation to remove the resin acid and copper. Debarking effluent was also treated with EC. Experimental designs and partial least squares modelling were used to investigate the effect of initial pH, current density and treatment time on pollutant removal. The highest resin acid removal in synthetic water was obtained 97%when initial pH 5, intial concentration 125 mg/l and time 60 min were maintained. EC removed pimaric-type resin acids with higher efficiency than biotic-type acids. It was also shown that efficiency of electro-coagulation to remove copper was very high (72-97%). The highest concentration of iron was found at pH 5 because at acidic condition the solubility of iron electrodes is maximum. The debarking effluent was also treated with EC and removal of colour and toxicity were studied. High colour removal was obtained at high pH and high toxicity removal was obtained at low and high pH. The model predicts minimum toxicity; EC50at 43%solution in the tested factor ranges at 1.4A, 360 s and initial pH 8. Thus result shows that electro-coagulation removal.

Kamal Aldin Ownagh and Amir Hossein, et.al., (2012): Made study to investigate the applicability of an electro-coagulation method using iron and aluminium electrodes in the removal of fluoride from aqueous environments. The influence of various variables such as pH, reaction time, and conductivity of solution on the removal of fluoride was investigated. The results showed that electro coagulation process with iron and aluminium electrodes could successfully remove fluoride from the aqueous environments. The results obtained with synthetic solutions revealed that the increase of reaction time, in the range of 0-60 min, enhanced the treatment rate for both iron and aluminium electrodes. The maximum efficiency of fluoride removal for various initial concentration of fluoride was obtained in constant electrolysis voltage of 40 V and reaction time of 60 min. Finally, the results demonstrated the technical feasibility of electro coagulation as a reliable technique for removal of fluoride from aqueous environments.

Edris Bazrafshan and Hossain Moein, et. al., (2012): Performed the batch electro coagulation studies were to evaluate the influence of various experimental parameters such as applied voltage and electrolysis time on the removal of pollutants from dairy wastewater. Results of this study have shown the applicability of electro coagulation in the treatment of real dairy industry wastewater. Treatment rate was shown to increase upon increasing the applied voltage and reaction time. However, increasing the applied voltage caused the energy consumption to increase. Highest voltage produced the quickest treatment with an effective reduction of COD, BOD and bacterial indicators concentration. Consequently, it can be inferred that electro coagulation is a comparatively suitable process for removal of COD, BOD and other pollutants using aluminium electrodes to effectively treat dairy industry wastewater.

Riyanto and Afifah Hidayatillah, et.al., (2014): electro coagulation of detergent wastewater using aluminium wire netting electrode. Electro-coagulation of detergent wastewater using aluminium wire netting electrode has been carried out. The electro coagulation method was performed in a two electrodes system using aluminium wire netting as an anode and cathode electrode. Detergent wastewater is characterized by chemical oxygen demand (COD) concentrations and absorption spectra using spectrophotorometer UV-Visible. Electro coagulation is carried out in electrochemical cell containing 100 ml detergent wastewater, without supporting electrolyte. In this study electro coagulation of detergent using applied voltage 5, 10, 15 and 20 Volt with various electrolysis time. The result, of the study showed aluminium wire netting electrode has higher degradation of detergent wastewater. The detergent wastewater degradation results were analyzed using Spectrophotometer UV Visible Hitachi U-2010 at wavelength 200-400 nm. The chemical oxygen demand (COD) was determined by common photometric tests using Spectrophotometer UV-Visible Hitachi U-2010 according to Standard Methods (SNI 6989.2-2009). This paper reports a study of the electro coagulation of detergent wastewater. Electrochemical degradation of organic pollutants, presence in the wastewater needs specific electrodes (Aboulhasan et al. 2006). Electro coagulation experiments on detergent were carried out with aluminium wire netting electrode. Electro coagulation involves the in situ generation of coagulants by dissolving electrically either aluminium or iron ions from aluminium or iron electrodes, respectively. The metal ions generation takes place at the anode; hydrogen gas is released from the cathode. The hydrogen gas would also help to float the flocculated particles out of the water. This process sometimes is called electro flocculation (Songsak, 2006).

S. S. Mahmoud and M. M. Ahmed, et.al., (2014): Removal of surfactants in wastewater by electro-coagulation method using iron electrodes. The present work aims to study the removal of sodium dodecyl sulphate surfactant from wastewater by electro coagulation method using iron electrodes. Different series of experiments were carried out to study the effect of each of pH, current density, time of electrolysis, NaCl concentration and initial surfactant dose on removal of surfactant. The experimental results showed that the surfactant in the wastewater was effectively removed by the electro coagulation process. The obtained results revealed that the optimum operating conditions for the maximum removal of the surfactant were: current density of 1.0 mA/cm2, pH of 6 to 7, time of electrolysis of 10 min, NaCl concentration of 1.5 g/L and initial dose of surfactant of 0-150 mg/L. The energy consumption was 0.5 kWh/kg surfactant. Results indicated that the pseudo second order equation is the most suitable model for the system. Keywords: Electro coagulation, sodium dodecyl sulphate, iron electrode, wastewater.

Ahmed Samir Naje and Saad a Abbas et.al., (2015): Made review on the performance of an electro coagulation process by adding titanium plates (electro oxidation, EO) was studied for the treatment of textile wastewater using combined electrical connections in a single reactor. Aluminium (and iron) and Titanium (Ti) electrodes were fixed in a bipolar (Bp), and monopole structure in the same electrolytic cell. The performance of the reactor was characterized in terms of electrolysis time (RT), current intensity (I), pH, chemical support, inter-electrode distance (IED), and stirring speed (Mrpm). Furthermore, energy and electrode consumption, sludge compaction, operating expenses as well as comparison with the conventional electro coagulation process was also examined. The most suitable EO performance was achieved by using Ti-Bp Al plates. Preliminary results showed the following optimal operating conditions: I=0.6 A, pH=6, IED=1cm and Mrpm=500 rpm. The implementation of these parameters on textile wastewater revealed a relatively high removal efficiency of COD (93.5%), TSS (97%), colour (97.5%), BOD5 (90%), TDS (89%), turbidity (96%), and phosphate (97%). The overall operating cost for the process was 1.69 US$/m3. This value was calculated based on the electrode and energy consumption, chemicals, and sludge disposal.

Mohammad ali zazouli, jamshidyazdani charati, seyed mohsen alavinia, et.al., (2016): efficiency of electro coagulation process using iron electrode in hospital laundry wastewater pre-treatment. The aim of the present study was to assess the possibility of hospital laundry wastewater pre-treatment by electro coagulation process using iron electrodes. A total of 18 composite samples were taken from the effluent of a hospital laundry wastewater. After determining the quality of raw laundry wastewater, the wastewater was treated by electro coagulation process with iron electrodes in different circumstances of pH, voltage and times. Process efficiency concerning the removal of chemical oxygen demand (COD), color, phosphate and surfactant was examined by standard methods. The analysis revealed that COD, phosphate and surfactants in hospital laundry wastewater were 815.1 ± 113.1mgL1, 1.05 ± 0.07 mgL-1 and 5.03 ± 1.18 mgL-1, respectively and the mean concentration of color was 665.9 ± 122.5 TCU. The optimal condition, reaction time was 60 min; voltage was 40 V; pH was neutral. Under optimal conditions, this process could remove 89.1, 77.8, 81 and 78% of COD, color, phosphate and surfactant, respectively. This study indicated that the efficiency removal of all parameters increased as the voltage and the contact time increased. Also, removal efficiency was more in neutral pH. Finally, electro coagulation process with iron electrodes has a good efficiency for pre-treating of hospital laundry wastewater.

Abhinesh Kumar Prajapati, et.al., (2016): Have reported the electro coagulation treatment (ECT) of rice grain based distillery effluent in a batch reactor using copper electrodes. ECT with copper electrode is a better alternative as compared to aluminium/iron electrode to treat rice grain based bio digester effluent (BDE), due to less power consumption at acidic pH which is the main attraction of the present work. The ECT in batch mode is conducted in a 1.5 L cubical shape electro-coagulation reactor using four-plate configurations. A current density of 89.3 A/m^2 and pH 3.5 is found to be optimal, providing a maximum COD and color removal of 80% and 65%, respectively.

Afshin Takdastana, Majid Farhadib et.al., (2017): Electro coagulation Process for Treatment of Detergent and Phosphate. Detergent and phosphate are one of the main and vital threats (eutrophication phenomenon and production of synthetic foam) for the source of drinking water, agriculture and soap industrial uses in the Ahvaz, Iran that threaten human health. The aim of this study is the evaluation of the efficiency of the electro coagulation (EC) process in the removal of detergent and phosphate from car wash effluent. Materials & Methods: In this experimental study, we used a glass tank with a volume of 2-4 litters (effective volume of 2 litters) containing 4 electrode-plate iron and aluminium (AL-AL, AL Fe, Fe-Fe). Bipolar method was used to convert alternative electricity to direct; electrodes were connected to a power supply. Daily samples were collected from different car washes sewage. Initial PHs of samples was from 7 to 9. At first, different tests were performed on primary samples. Reaction times were set for 90, 60 and 30 minutes with middle intervals of 2 cm. Results: According to the result of this study, percentage of phosphate removal in the EC with Al-Fe electrode, with an optimum pH = 7, has been from 34 % (in the 10 Volt) to 78% (in the 30 Volt). Percentage of detergent removal in the EC with AL electrode, with an optimum pH = 7, has been from 68 % (in the 10 Volt) to 94%

(in the 30 Volt). Conclusions: Altogether, it was found that this method can be used as a confident and convenient method for treating car wash effluent and according to the highest removal efficiency of the process, effluent can be discharged safely into the environment

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3. Materials and methodology

A. Objectives

The present work objectives are as follows

- To treat the soap industry wastewater.
- To select the suitable operating parameters for electro-coagulation.
- To study the impact of voltage variation on treatment of soap industry wastewater.
- To study the impact of time variation on treating soap wastewater.

B. Batch study

Batch study was undertaken for the optimization of process parameters for treatment of Karnataka Government Soap Factory wastewater by electro-coagulation. The characteristics of Soap Factory wastewater (Black liquor) used for electro-coagulation treatment are shown in Table. Considering the requirement of sample for the analysis of, turbidity, pH, fluoride, iron, residual chlorine, oil and grease DO, BOD and colour for industrial sample, 1 litres of sample volume was taken for each experiment.

C. Study area

The raw waste water sample is obtained from Karnataka Government Soap Factory (KSDL), Yeshawanthapur was analysed as per standard methods. This is collected and currently treated by the method of electro-coagulation.

Fig. 1. Waste water collection at KSDL

Fig. 2. Waste water treatment at KSDL

Fig. 3. Waste water

D. Experimental set-up

For electro-coagulation treatment, the batch reactor was a 1litre reactor made of Acrylic fibre box. Electrodes were positioned vertically and parallel to each other with an inner gap of 1-3 cm. Electrodes were kept at 3 cm above the bottom surface of reactor for the proper mixing. Four electrodes of active area 79.8cm^2 each were used. The electrodes were connected through parallel arrangement. DC power supply was given to the electrodes in mono polar mode according to required current intensity and experiments were carried out at constant current condition.

Table 1
Electrode specifications

Material (anode and cathode)	Aluminium
Shape	**T**-shape
Size	9.6 cm×8.3 cm
Thickness	6 mm
Plate arrangement	Parallel
Surface area	79.68 cm^2

Table 2
Reactor characteristics

Material	Acrylic fibre glass
Dimensions	12 cm x12 cm x10 cm
Capacity	1Litres
Electrode gap	1-2.7cm
Power supply	DC power supply of 30volts

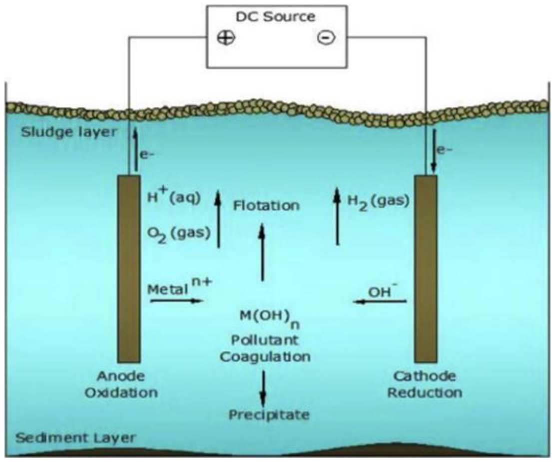
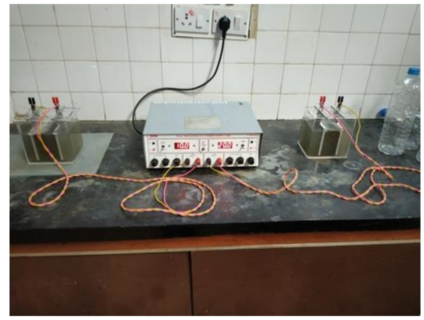


Fig. 4. Schematic experimental set up

E. Procedure

1) Pre-treatment of the electrodes

The electrodes plates were cleaned manually by abrasion with sand paper and they were treated with 15 % HCl for cleaning followed by washing with distilled water prior to their use. Then dried for half an hour and weighted. The same procedure was repeated before each run in both cases of synthetic and industrial wastewater. Experiments were carried out in a 1L reactor made up of glass Electro coagulation treatment of both anionic and cationic species is possible by using an aluminium plate of thickness 6mm as the sacrificial electrode. The plates, connected in series, have higher resistance. In a parallel arrangement, the electric current is divided between all the electrodes in relation to the resistance of the individual cell. Therefore, the electrode plates were arranged in parallel. There were four electrodes connected in a bipolar mode in the electrochemical reactor, each one with dimensions of 12cmx12cmx10cm. The total effective surface area of each electrode was 79.8cm^2. The electrode plates were cleaned manually by abrasion with sandpaper, and they were treated with 15% HCl for cleaning followed by washing with distilled water prior to their use. The electrodes were spaced 1-2.7 cm apart (because <10 mm spacing between electrodes prevented movement of liquid adsorbate in the interstitial spaces of the electrodes thus, hindering/affecting removal efficiency). The anode and the cathode leads were connected to the respective terminals of DC power supply. The thickness of the plates was 6.00mm. Magnetic stirrer was used to agitate the solution. At the end of the experiments, sample was filtered to remove sludge. The filtered liquid was used for color, BOD, turbidity, pH, Total Hardness, calcium, magnesium, chloride, TDS, sulphate, nitrate, fluoride, iron, chromium, zinc, copper, boron, residual chlorine, total alkalinity, oil and grease, dissolved oxygen, and COD analysis.


(a) Electro-coagulation set up adopted in the laboratory at different Volts and Time

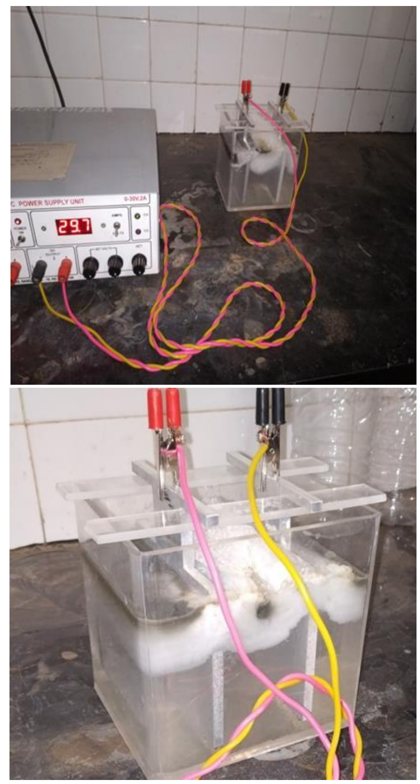


Fig. 5. Real experimental set up


Fig. 6. Weighing of electrode

4. Results

Table 3
Loss of electrodes weight with varying time and volt

10V						
Time (Min)	Initial		Without Wash		With Wash	
	Anode(g)	Cathode(g)	Anode(g)	Cathode(g)	Anode(g)	Cathode(g)
30	163.3	163.2	163.7	163.9	163.2	163.1
60	163.2	163.1	164.3	164.8	163.2	163.3
90	163.2	163.3	163.5	164.9	163.1	163.2
120	163.2	163.3	163.5	165.4	162.8	163.2
20V						
TIME (MIN)	Initial		Without Wash		With Wash	
	Anode(g)	Cathode(g)	Anode(g)	Cathode(g)	Anode(g)	Cathode(g)
30	163.3	163.3	164.0	163.6	163.1	163.2
60	163.1	163.2	163.6	164.3	163.1	163.3
90	163.0	163.2	163.0	163.9	162.8	163.2
120	162.7	163.2	163.2	164.4	162.3	163.0

30V						
Time (Min)	Initial		Without Wash		With Wash	
	Anode(g)	Cathode(g)	Anode(g)	Cathode(g)	Anode(g)	Cathode(g)
30	161.4	162.6	162.0	163.9	161.4	162.8
60	162.2	163.1	162.6	164.3	162.1	163.2
90	162.8	163.2	162.7	164.8	162.5	163.1
120	162.1	163.0	161.8	164.3	161.6	162.6

Table 4
Physical & chemical analysis report

Name	BATCH – B 12
Address	DR AIT COLLEGE , NAGARBHAVI 2ND STG , B/LORE
Sample Particulars	RAW WATER
Sample Received on	13.03.19
Date of testing	13.03.19

Table 5
The water sample submitted by the above party was analyzed by us with the following results

Tests		Results	Maximum Acceptable Limits (In mg/l)	Maximum Permissible Limits (In mg/l)	Protocol Is-3025
			(As per IS 10500:2012)		
1	Color, Hazen Units	13	5	25	IS-3025/Part-4
2	Odor	Disagreeable	agreeable	-	IS-3025/Part-5
3	Turbidity, NTU	26	1	5	IS-3025/Part-10
4	PH Value	6.35	6.5-8.5	No Relaxation	IS-3025/Part-11
5	Total Hardness as $CaCO_3$, mg/l	480	200	600	IS-3025/Part-21
6	Calcium as Ca , mg/l	120	75	200	IS-3025/Part-40
7	Magnesium as Mg , mg/l	44	30	100	IS-3025/Part-46
8	Chloride as Cl, mg/l	445.8	250	1000	IS-3025/Part-32
9	Total Dissolved solids, mg/l	1470	500	2000	IS-3025/Part-16
10	Sulphate as SO_4 , mg/l	195	200	400	IS-3025/Part-24
11	Nitrate as NO_3, mg/l	11	45	No Relaxation	IS-3025/Part-34
12	Fluoride as F , mg/l	2.6	1	1.5	IS-3025/Part-60
13	Iron as Fe , mg/l	0.38	0.3	1	IS-3025/Part-53
14	Chromium as Cr, mg/l	0.44	0.05	No Relaxation	IS-3025/Part-52
15	Zinc as Zn, mg/l	0.31	5	15	IS-3025/Part-49
16	Copper as Cu, mg/l	0.39	0.05	1.5	IS-3025/Part-42
17	Nickel as Ni, mg/l	0.24	0.02	No Relaxation	IS-3025/Part-54
18	Residual Free Chlorine , mg/l	0.55	0.2	-	IS-3025/Part-26
19	Total Alkalinity as $CaCO_3$,mg/l	275.8	200	600	IS-3025/Part-23
20	Sodium as Na, mg/l	70	-	-	IS-3025/Part-45
21	Phosphate as PO_4,mg/l	0.49	-	-	IS-3025
22	Dissolved Oxygen , mg/l	2.2	-	-	IS-3025/part-44
23	Chemical Oxygen Demand , mg/l	780	250	-	IS-3025/part-58
24	Bio -Chemical Oxygen Demand (3 days @ 27 °,mg/l)	88.5	10	-	IS-3025/part-44
25	Electrical conductivity, micro µ	5880	4000	6000	IS-3025
26	Total suspended solids, mg/l	260	-	500	IS-3025/Part-21
27	Oil & Grease , mg/l	4.6	1	-	IS-3025/part-49

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Table 6
Tabulated results

VOLT (V) TIME (MIN)		10 V				20 V				30 V			
		30	**60**	**90**	**120**	**30**	**60**	**90**	**120**	**30**	**60**	**90**	**120**
1	Color, Hazen Units	8.5	7.8	7	8	7	8	7.5	7	9	7.5	8	7
2	Turbidity, NTU	16	12	9	16	11	22	19	12	16	19	17	13
3	PH Value	6.55	6.43	6.38	6.1	6.42	6.9	6.34	6.38	6.25	6.05	6.16	6.6
4	Total Hardness as $CaCO_3$, mg/l	360	340	290	270	310	260	240	225	365	340	325	280
5	Calcium as Ca , mg/l	95	88	80	78	76	70	66	56	93	80	73	68
6	Magnesium as Mg , mg/l	41	37	34	31	31	28	27	24	39	34	31	29
7	Chloride as Cl, mg/l	418	386	353	340	360	280	265	241	296	308	285	264
8	Total Dissolved solids, mg/l	1360	1290	1270	1140	1320	1200	1170	1220	1430	1265	1220	1180
9	Sulphate as SO_4 , mg/l	85	60	40	40	60	78	55	90	160	135	110	80
10	Nitrate as NO_3, mg/l	9	8.8	8	9.	12	11.5	11	12.5	14.8	13	12.5	12
11	Fluoride as F , mg/l	2.2	1.9	1.6	1.4	2.35	2.2	2.1	1.98	3.7	3.3	3.1	2.95
12	Iron as Fe , mg/l	0.44	0.41	0.38	0.21	0.33	0.25	0.23	0.28	0.46	0.41	0.37	0.32
13	Chromium as Cr, mg/l	0.38	0.35	0.29	0.23	0.31	0.28	0.22	0.25	0.31	0.27	0.23	0.19
14	Zinc as Zn, mg/l	0.26	0.22	0.18	0.16	0.16	0.13	0.11	0.34	0.38	0.35	0.31	0.28
15	Copper as Cu, mg/I	0.35	0.3	0.27	0.28	0.24	0.22	0.17	0.41	0.49	0.46	0.44	0.42
16	Nickel as Ni, mg/l	0.37	0.35	0.31	0.33	0.33	0.3	0.28	0.34	0.36	0.33	0.28	0.25
17	Residual Free Chlorine , mg/l	0.43	0.38	0.33	0.3	0.4	0.39	0.34	0.31	0.32	0.3	0.27	0.24
18	Total Alkalinity as $CaCO_3$,mg/l	256	243	265	244	278	246	260	259	248	253	265	270
19	Sodium as Na, mg/l	65	56	48	39	40	53	47	37	58	45	39	36
20	Phosphate as PO_4,mg/l	0.38	0.35	0.31	0.41	0.26	0.21	0.19	0.3	0.39	0.34	0.28	0.24
21	Dissolved Oxygen , mg/l	4	4.6	4.9	4.2	5.2	5.8	5.95	4.6	3.8	3.1	2.7	2.4
22	Chemical Oxygen Demand , mg/l	340	310	280	245	260	220	190	240	225	210	190	175
23	Bio -Chemical Oxygen Demand(3 days @ 27 °, mg/l)	65.5	57	52	43.8	48	37	34	39	43	41	35	32
24	Electrical conductivity, micro µ	5440	5160	5080	4560	5280	4820	4680	4890	5720	5060	4880	4270
25	Total suspended solids, mg/l	170	140	120	110	100	230	180	155	130	108	90	75
26	Oil & Grease, mg/l	2.9	2.7	2.55	2.3	1.6	1.3	1.1	1.9	2.4	2.1	1.85	1.6

Table 7
Percentage removal of various parameters

S. No	Parameters	% Removal	At	
			Volts (V)	Time (min)
1	Color, Hazen Units	46.15	30	120
2	Turbidity, NTU	65.38	10	90
4	PH Value	4.72	30	90
5	Total Hardness as $CaCO_3$, mg/l	53.12	20	120
6	Calcium as Ca , mg/l	53.33	20	120
7	Magnesium as Mg , mg/l	45.45	20	120
8	Chloride as Cl, mg/l	45.93	20	120
9	Total Dissolved solids, mg/l	19.72	30	120
10	Sulphate as SO_4 , mg/l	79.48	10	120
11	Nitrate as NO_3, mg/l	27.27	10	90
12	Fluoride as F , mg/l	50.00	10	120
13	Iron as Fe , mg/l	44.73	10	20
14	Chromium as Cr, mg/l	56.81	30	120
15	Zinc as Zn, mg/l	64.51	20	90
16	Copper as Cu, mg/l	56.41	20	90
17	Nickel as Ni, mg/l	4.16	30	120
18	Residual Free Chlorine , mg/l	57.40	30	120
19	Total Alkalinity as $CaCO_3$,mg/l	11.53	10	120
20	Sodium as Na, mg/l	48.57	30	120
21	Phosphate as PO_4,mg/l	61.22	20	90
22	Dissolved Oxygen , mg/l	2.0	30	120
23	Chemical Oxygen Demand , mg/l	77.56	30	120
24	Bio -Chemical Oxygen Demand (3 days @ 27 °, mg/l)	63.84	30	120
25	Electrical conductivity, micro µ	27.38	30	120
26	Total suspended solids, mg/l	71.15	30	120
27	Oil & Grease , mg/l	65.21	30	120

5. Conclusion

From the present study, it was concluded that the treatment process had shown feasible activity in removing the impurities present in the wastewater. In this process without using any chemicals and the chemicals which are present in the sample can be removed, it does not leave any additional chemicals in the sample. If we treat the waste water for higher voltage and for longer duration waste water can be purified further .In this process, suspended solids formed after electro coagulation process removed by filtration and Maximum reduction of biological oxygen demand (BOD) removal is 63.84% at 120 minutes for 30V, Chemical oxygen demand (COD) removal is 77.56% at 120 minutes for 30V, color about 46.15% at 120 minutes for 30V, oil and grease removal is 65.21% at 120minutes for 30V, Total Dissolved solids removal is 19.72% at 120minutes for 30V , and Total suspended solids 71.15% at 120 minutes for 30V.a successful application of electro coagulation (EC) technique for the removal of various ions from wastewater. Would address the environmental needs of reduction in the operational costs and potential saving in processing unit. A host of very promising techniques based on electrochemical technology are being developed but are not yet to the commercial stage. Among different physical and chemical methods of water and waste water treatments, electro coagulation method offers a special attraction due to its ecologically friendly, safety, simplicity and lower operating costs. Based on the results, it was suggested that for successful industrial application of electro coagulation, quantitative parameters must be identified to ensure dimensional consistency between small and large scale processes. Development of advanced materials and application of different electrode types brings a new dimension to electro coagulation. Different electrode material can be used to assess different coagulant types for specific pollutants. For example, the use of aluminum will produce Al^{3+} ions that are readily used in the water industry. Electrodes operation, such as periodic polarity reversal, controls pasivation formation in situ. Development of sophisticated electrode arrangements and associated operation programs lead to significant developments for pasivation control. Further this technique will continue to make inroads into the water treatment area because of numerous advantages and the nature of the changing strategic water need in the world.

References

[1] M. A. Aboulhassan S. Souabi A. Yaacoubi and M.Baudu, Removal of surfactant from soap industrial wastewaters by electro-coagulation (2006).
[2] K.S. Parama Kalyani, in this investigation, the influence of electrolysis time, applied charge density, pH and supporting electrolyte on electro-coagulation (2009).
[3] MikkoVepsalainen, In this paper, the synthetic wastewater was made by copper nitrate and the wastewater was treated with electro-coagulation, (2011).
[4] Kamal Aldin Ownagh and Amir Hossein, et.al. (2012): Made study to investigate the applicability of an electro-coagulation method using iron and aluminium electrodes (2012).
[5] Riyanto and Afifah Hidayatillah, electro coagulation of detergent wastewater using aluminium wire netting electrode, (2014).
[6] S. S. Mahmoud and M. M. Ahmed, Removal of surfactants in wastewater by electro-coagulation method using iron electrodes, (2014).
[7] Ahmed Samir Naje and Saad an Abbas, A review on the performance of an electro coagulation process by adding titanium plates (2015).
[8] Mohammad Ali Zazouli, Jamshidyazdani Charati, Seyed Mohsen Alavinia, et.al., (2016): Efficiency of electro coagulation process using iron electrode in hospital laundry wastewater pre-treatment, (2016).
[9] Abhinesh Kumar Prajapati, et.al., (2016): Have reported the electro coagulation treatment (ECT) of rice grain based distillery effluent in a batch reactor using copper electrodes, (2016).
[10] Afshin Takdastana, Majid Farhadib et.al., (2017): Electro coagulation Process for Treatment of Detergent and Phosphate (2017).
[11] S. Mahesh, B. Prasad, I. D. Mall, I. M. Mishra, Electrochemical degradation of pulp and paper mill wastewater. Part1. COD and color removal, Ind. Eng. Chem. Res. 45, (2006), 2830–2839.
[12] O. T. Can, M. Kobya, E. Demirbas, M. Bayramoglu, Treatment of the textile wastewater by combined electro coagulation, Chemosphere, 62 (2006), 181–187.