Egypt. J. Chem. **Vol. 62**, No.11 pp. 2019 - 2032 (2019)

Egyptian Journal of Chemistry
http://ejchem.journals.ekb.eg/

Innovative Electrochemical Treatment of Textile Dye Wastewater

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APPLICATION of electrocoagulation (EC) for removal of Chemical Oxygen Demand (COD) and color from textile wastewater is the aim of this research. Batch wise experiments were carried out using iron electrodes to investigate effect of pH, current density and electrolysis time on percentage removals. Results show maximum removal efficiency of COD (65%) and color (97%) at 0.9 A and 0.4 A, respectively at 1.6 V and 120 minutes reaction time. Moreover, the results show that the COD removal is influenced by the pH with maximum removal at pH 8. The EC process improves wastewater biodegradability with increasing BOD/COD ratio from 29% to 34%. The results prove that the EC is effective in color and COD removal. Regarding electrical current, there was no significant difference between 0.5 A and 0.7A in color removal and so 0.5 A is selected as cost effective for the treatment process with estimated Electricity Consumption of 3.2 kWh/m^3. Impact of treated wastewater on oxygen uptake rate of activated sludge biomass was investigated and the results indicated that both dye and minerals content have negative impact and therefore it is recommended to reuse treated effluent in industrial processes or consider total dissolved solids in the effluent disposal limits.

Keywords: Color removal, Electrocoagulation, Iron electrode, Textile wastewater, Treatment.

Introduction

Textile industry is one of the most water-consuming industries with huge volume of high quality water demand. Textile wastewater is contaminated with wide range of potential organic and inorganic pollutants that adversely affect the aquatic environment (biodiversity). Most of annually produced dyes that are estimated at hundreds of thousands of tons are used in textile industry. Textile industry is considered as one of the most-dye consuming industries. There are various types of dyes involved in dying process; reactive dyes are one of them. As reported by Khandegar and his colleagues, reactive dyes are water soluble with estimated residual amounts of reactive dyes in the final effluent of dying basins range between 20 and 40% of the initial concentration [1]. These dyes are very toxic, mutagenic, carcinogenic and/or teratogenic to the aquatic organisms and effluent discharge without proper treatment damages aquatic ecosystems and makes this water resource unusable. Effluent from textile industries is potentially toxic to the ecosystem and at 20% ratio it was found to reduce the activity of sludge in activated sludge systems to 50% [2]. Others investigated the potential toxic effect of textile wastewater prior to any treatment and reported that a fraction of 3-6% of textile wastewater reduces the biological activity of luminescent bacteria by 50% [3].Using acute toxicity bioassay, Kaur and his colleagues proved high and lethal toxic effects of raw textile wastewater[4].

Accordingly, environmental researchers including engineers and scientists, stakeholders and decision makers are highly concerned with prominent needs for efficient treatment of textile wastewater. Effective removal of dye color and reduction of pollution loads to safe disposal limits without negative environmental impacts is the

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Received 13/3/2019; Accepted 14/5/2019
DOI:10.21608/ejchem.2019.10576.1683

ultimate goal and requirement of selected treatment technology. Latest innovative wastewater treatment technologies have been investigated for textile wastewater treatment. Application of advanced oxidation using conventional chemical and innovative electrochemical processes has been used for the treatment of textile wastewater [5, 6]. COD and color removal from real textile wastewater was performed in electro-catalytic treatment unit including Ti/RuO2 electrode [4] and in electrolysis cell containing Pt/Ti screen anode and graphite packed-bed cathode [5]. Kaur and his colleagues conclude that the electro-catalytic degradation of textile wastewater sufficiently reduces the toxicity effects and effluent can be safely disposed to the environment [4].

Electrochemical coagulation (electrocoagulation) has been investigated as alternative technology to the conventional chemical coagulation for water and wastewater treatment. The electrocoagulation is most widely used and explored as non conventional method for the removal of heavy metals from water and wastewater [7-12]. The process of electrochemical coagulation has been used for removal of organic and inorganic pollutants from municipal and domestic wastewater [13, 14]. Nawarkar and Salkar[14] reported a current density of 40 A/m^2 and reaction time of 20 min as optimal operating conditions for sewage treatment using electro-coagulation with estimated percentages removal of 92% and 94% for COD and turbidity, respectively while others concluded that initial pH of 7.8, 100 A/m^2, and 10 minutes reaction time are optimal conditions for COD (72%), turbidity (98%) and Phosphorus (98%) removal from domestic wastewater [13]. The electro-coagulation has been investigated for removal of organic matter from high strength industrial wastewaters [15-17]. Nasrullah and his colleagues [16] studied treatment of palm oil mill effluent using stainless steel electrodes and achieved 95%, 94% and 96% for the removal of COD, Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS), respectively. Electrolysis cell containing stainless steel cathode and aluminum anode was used to remove petroleum organics from drilling fluids wastewater [15]. The process is used as a pre-treatment step to remove oil and grease and heavy metals from oily wastewater at drilling site [17]. Use of electrochemical cell containing Al and Fe as two different electrodes for the treatment of wastewater (1600 mg COD/L) produced in pulp and paper recycling factory indicated lower COD removal rate in case of Al (87%) compared to Fe (92%) [18].

The electrocoagulation process was reported as innovative and simple method for color removal and treatment of textile wastewater [19-21]. The process is used to remove color and COD of textile dye [20], destruction and removal of Remazol Black B from synthetic dye wastewater [19] and treatment of real textile wastewater with 1280 mg/L initial COD concentration [21]. Different process operating parameters of the electro-coagulation like initial concentration [11, 19], electrolysis time[7, 16], initial pH [9, 12, 16, 18], current intensity [10],voltage [19], inter-electrode distance [7, 8, 22], material of the electrodes [8, 10, 22] and its configuration [21, 22] are investigated in various research works. Aim of the current research work is color and COD removal from dye wastewater using electrochemical coagulation cell containing iron electrodes.

Experimental

Source of wastewater and laboratory analyses

Textile wastewater used in this study was collected from dye basin of one of textile factories at 6 October industrial city and was stored in the fridge at 4°C for lab analyses and experimental works. Laboratory analyses of wastewater are carried out according to the Standard Methods for Examination of Water and Wastewater [23]. COD was measured using dichromate as oxidizing agent and measured colorimetrically using Nanocolor Linus spectrophotometer after acid digestion on Lovibond RD 125 digester. The pH was measured with a Thermo Electron Corporation pH Meter and Electric Conductivity was determined using Lovibond conductivity meter. The pH was adjusted to desirable values using NaOH and HCl. Different samples were taken at 20 min intervals time up to120min and analyzed to determine residual dye concentration. The residual dye concentration in the solutions was analyzed by using UV/VIS spectrophotometer (Jenway 6300) at 600 nm wavelength. During the runs, the reactor content was stirred at 150 rotations per minute using magnetic stirrer (VELP Scientifica) to allow complete mix of the reactor content. Dye removal efficiency was calculated as:

$$\text{Dye removal efficiency (\%)} = (Abs_i - Abs_f)/Abs_i \times 100 \quad (1)$$

Where Abs_i is the initial absorbance of dye solution (initial dye concentration) and Abs_f is the

final absorbance of the dye solution (final dye concentration). In this study, each treatment was repeated twice and the absorbance measurement of each sample was repeated three times and values in figures and tables represent average values of the results.

Experimental Set Up

The study consists of lab-scale batch system, composed of an electrolysis cell, a power supply system and a magnetic stirrer unit. The electrolysis cell is made of borosilicate glass beaker with an effective volume of 1L and with mono-polar electrodes, with four Iron electrodes connected in parallel. The Iron cathodes and Iron anode consist of pieces of Iron with size of 10cm × 5cm × 1mm separated by a space of 1 cm and dipped in the wastewater. The electrodes are connected to the positive and negative terminals of the DC power supply (Range 30V/3A) as shown in Fig. 1. In this study, effects of initial pH, current density and electrolysis time were studied. The experiments were carried out in batch process at room temperature. During the reaction, treated samples were taken at 20 minutes regular interval time for COD and color measurement. The various characteristics of real textile wastewater are shown in Table 1. Adjustment of the pH of wastewater to the desired value was carried out using dilute H_2SO_4 and dilute NaOH solution.

Consumption of electrical energy (Ec) in KWh/m^3 dye wastewater was estimated using equation reported by Ghanbari and his colleagues [21] as described below:

$$Ec\ (kWh/m^3) = [V \times I \times t]/[m^3\ wastewater \times 1000]$$

Where V is the voltage in V, I is the current density in A, t is the reaction time in hour and m^3 is the volume of the wastewater (reactor) in m^3.

Biological bioassay

Since activated sludge is the most widely used technology for municipal wastewater treatment and the ultimate end of industrial effluents including textile wastewater is the municipal wastewater treatment plants, inhibitory effects of electrocoagulated textile dye wastewater on activated sludge biomass was investigated. The impacts of the treated effluent on the Oxygen Uptake Rate (OUR) and Specific Oxygen Uptake Rate (SOUR) of activated sludge biomass were studied.

Three different solutions were used in this bioassay; namely pre-settled sewage, treated textile dye wastewater and synthetic solution similar to the treated dye wastewater. Primary treated sewage supplemented with sucrose was used as substrate solution. The sewage has average COD, Total Kjeldahl Nitrogen (TKN)

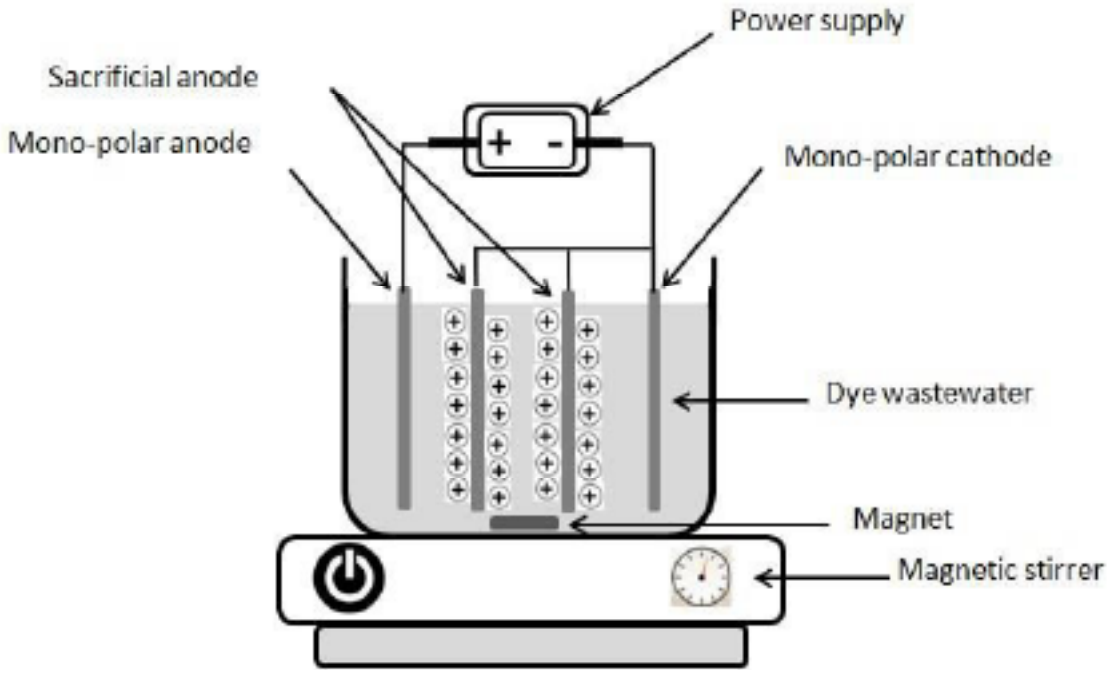

Fig. 1. Experimental setup and EC unit components

TABLE 1. Characteristics of real textile wastewater and treated effluent.

Analytical parameter	Unit	Raw wastewater	Treated wastewater	Percentage removal
pH	-	10.3	9.1	-
Color	-	1.22	0.05	96
Conductivity	mS/cm	72800	64900	-
Alkalinity	mg/L	2870	3000	-
Total dissolved solid	mg/L	41100	46130	-
BOD5	mg/L	350	187	47
COD	mg/L	1200	550	54
Chlorides	mg/L	18750	21500	-
Nitrate	mg/L	1.4	1.8	-
Sulphate	mg/L	4200	3800	-
Phosphate	mg/L	5.9	2.5	58

and Total Phosphorus (TP) of 240 mg/L, 38.5 mg/L and 6.2 mgP/L, respectively. On the other hand, the quality of electrochemically treated dye wastewater has average COD of 550 mg/L. Accordingly primary treated sewage has been supplemented with sucrose to increase the COD value to 550 mg/L.

Also, the characteristics of treated wastewater indicate average values of 3000 mg$CaCO_3$/L, 21500 mgCl/L, 3800 mg SO_4/L, 2.5 mgP/L, 15 mg N/L for total alkalinity, chloride, sulfate, total phosphorus and total nitrogen, respectively. The pH of the treated wastewater is 9.3 and has been neutralized to 7.5 using phosphoric acid 85% before bioassay.

Synthetic wastewater with similar characteristics to the electrochemically treated dye wastewater was prepared. Calcium carbonate, sodium chloride, magnesium sulfate, sucrose, urea and phosphoric acid 85% were used as sources of alkalinity, chloride, sulfate, COD, nitrogen and phosphorus, respectively.

Source of activated sludge biomass and procedure

Activated sludge biomass was collected from municipal wastewater and transferred to the lab within less than 1 hour. The sludge biomass was settled for 1 hour and settled sludge was taken and mixed with sucrose-supplemented sewage at 50% and subjected for continuous aeration overnight. Representative sample was taken from the mixed sample under aeration and analyzed for TSS and Volatile Suspended Solids (VSS).

The bioassay was carried out in 300-ml bottles in duplicates. There are two sets; one for the settled sewage with different fraction of electrochemically treated dye wastewater and the second set for the settled sewage with different fraction of the synthetic wastewater similar in composition to the real treated wastewater. The fractions of treated and synthetic wastewater are 0, 5. 10, 15, 20, 40, 60, 80 and 87%. First the sludge biomass with 2.99 g TSS/L and 2.23 g VSS/L (lab analysis) was added to the bottles at 0.43 gTSS/L (43 ml/bottle). The bottles were completed with the sucrose-supplemented sewage at different fractions of wastewaters (real treated wastewater and synthetic wastewater). The bottles were subjected to continuous diffused aeration for 5 minutes then let stand for around 1 hour on shaker. During shacking, dissolved oxygen was measured online at 5 minutes interval time using OHAUS DO meter (STARTER 300).

Results and Discussion

Effect of pH

Initial pH of wastewater is a significant operational parameter in the electrochemical coagulation process [24, 25, 26]. The electro-coagulation and removal process is maximum at an optimal pH and the removal rate decrease**s** above and below the optimum pH value. Results presented in Fig. 2a and 2b show reduction in the residual COD concentration and percentage removal of COD in the treatment cell at different initial pH. The results clearly show minimum residual COD and maximum percentage removal at pH 8 with average values of 450 mg COD/L and 63% for both, respectively. The minimum percentage removal and highest residual COD value were 50% and 600 mg COD/L at pH 12. The Color behaves as COD (Fig. 3a and 3b) with recorded maximum percentage removal rate and

minimum residual value at pH 8 with exception that the color removal is better than COD removal. The color removal at pH 8 was 97% compared to 63% for COD at the same pH and 120 minutes reaction time (Fig. 2b and 3b). It is well known that the color removal in the electro-coagulation process is faster and better than the removal of COD. Ghanbari and his colleagues [21] obtained 98% color removal and 87% COD removal from real textile wastewater.

The effects of the initial pH on the treatment performance of the electro-coagulation is pollutant-dependent process. Some pollutants found to be more effectively removed at higher pH [13] while others reported maximum removal at acidic pH [16, 19]. It is reported that performance of sewage treatment improves by increasing the initial pH from 3 to 7.8 [13]. On the other hand, maximum removal of Remazol Black B color was reported to happen at pH 2 and

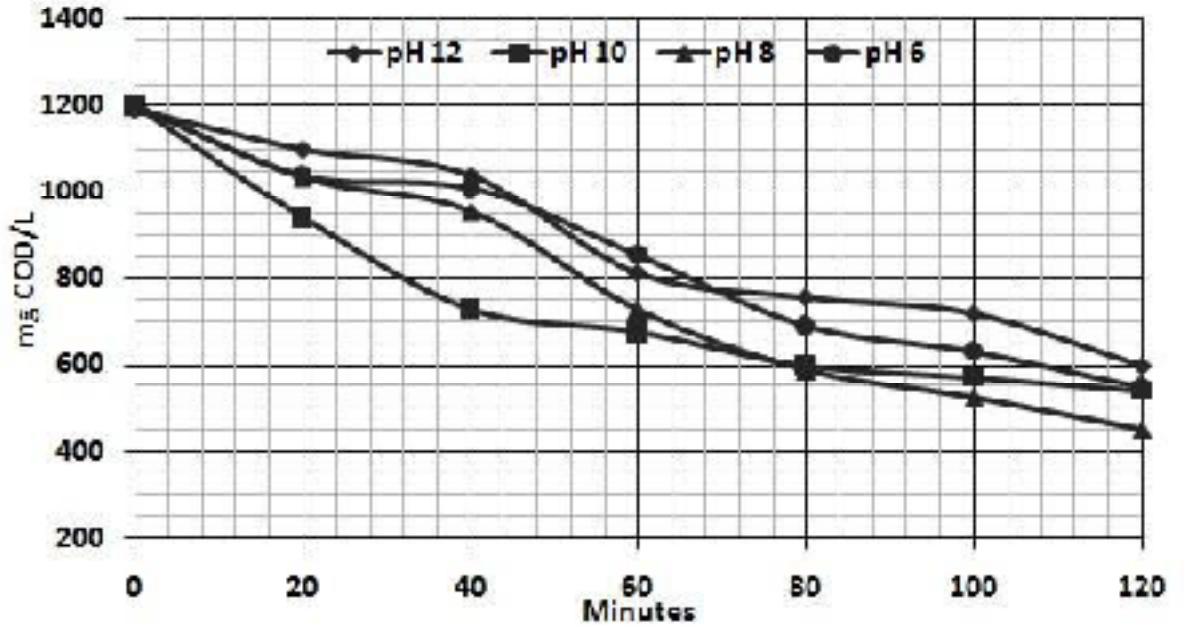

Fig. 2a. Effect of pH on the residual COD.

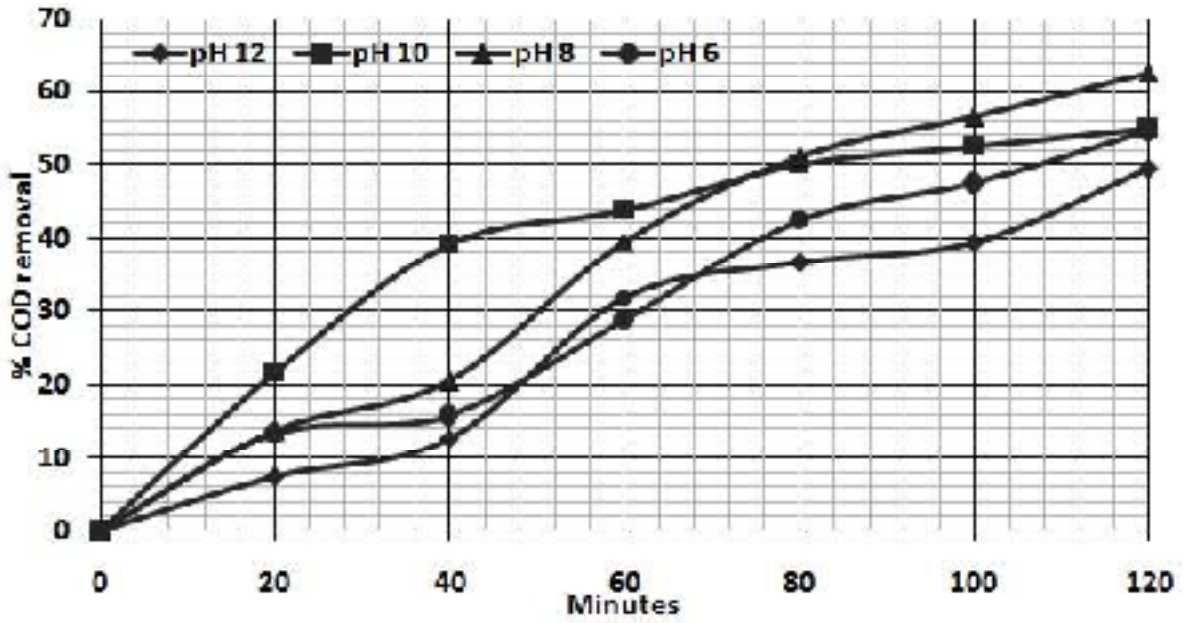

Fig. 2b. Effect of pH on COD percentage removal.

pH 4 with percentage removal of 99% and 91%, respectively [19]. Also, reported results of electro-coagulation of palm oil mill effluent [16] showed better treatment performance at slightly acidic pH rather than neutral or alkaline pH while Zazouli and his colleagues achieved better treatment performance for the electrochemical coagulation of pulp and paper recycled wastewater at neutral pH (7) comparing to acidic (5) and alkaline (9) pH [18]. Also, You and Han [9] reported faster and higehr arsenic removal rate from arsenic-contaminated ground water at neutral (7) pH. Similarly, the results obtained by Vasudevan and his colleagues [8] for electrochemical treatment of boron-contaminated water showed maximum removal at neutral pH (7). The data of the current study is similar to the outcome of Dolati and his colleagues who reported maximum rate of boron removal at pH 8, due to the formation of borates (appears at higher pH) and Al^{+3} ($Al(OH)_3$) which has tendency to appear at pH less than 9 [11]. In addition maximum removal of pollutants from sewage was performed at slightly alkaline pH of 7.8 [13]. Also Kobya and his colleagues [27] obtained

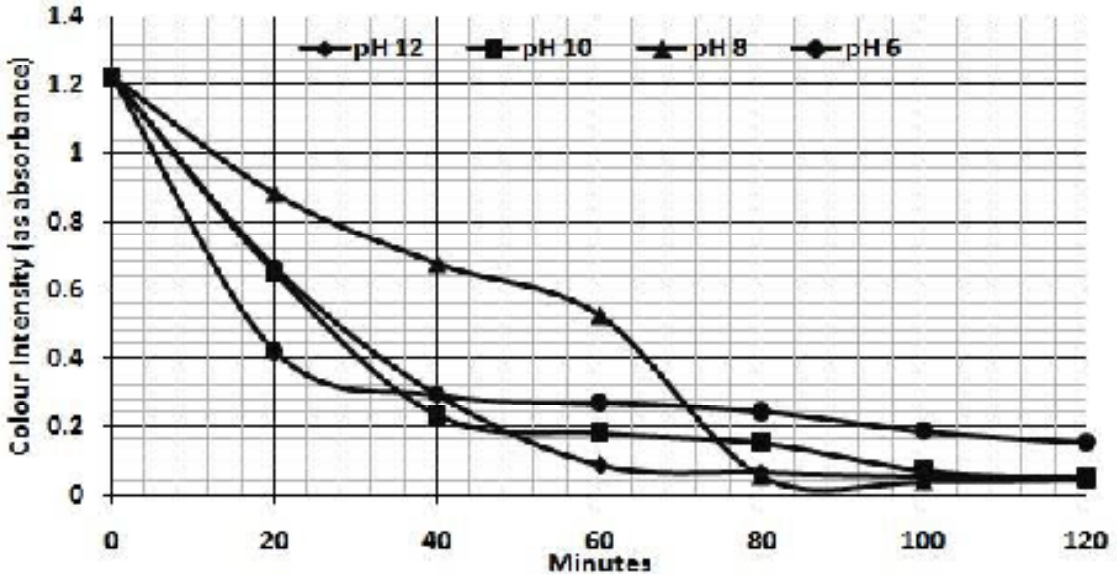

Fig. 3a. Effect of pH on the residual color.

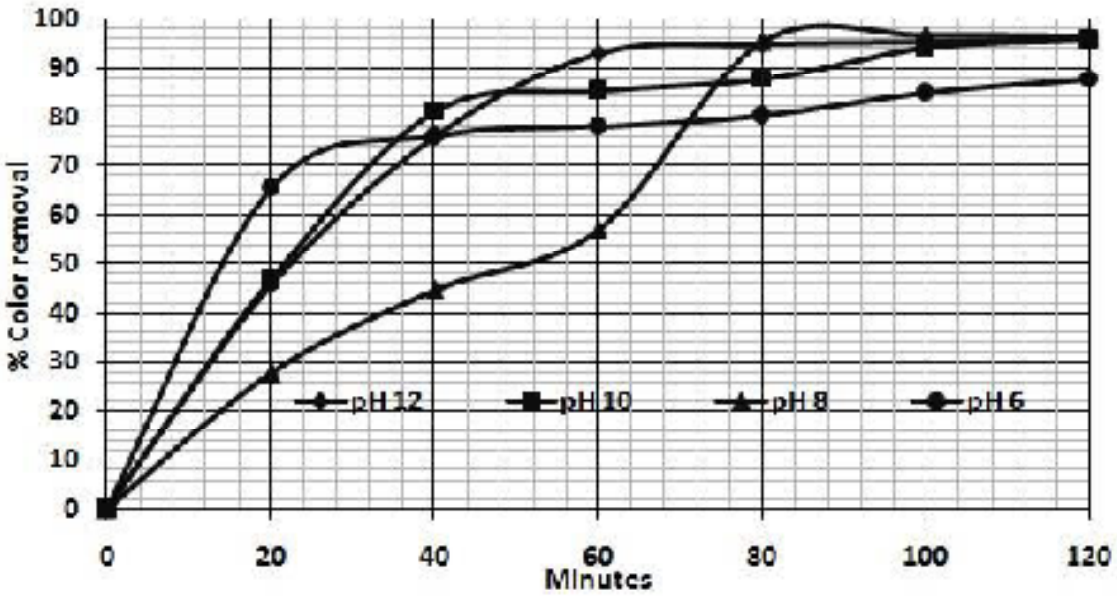

Fig.3b. Effect of pH on color percentage removal.

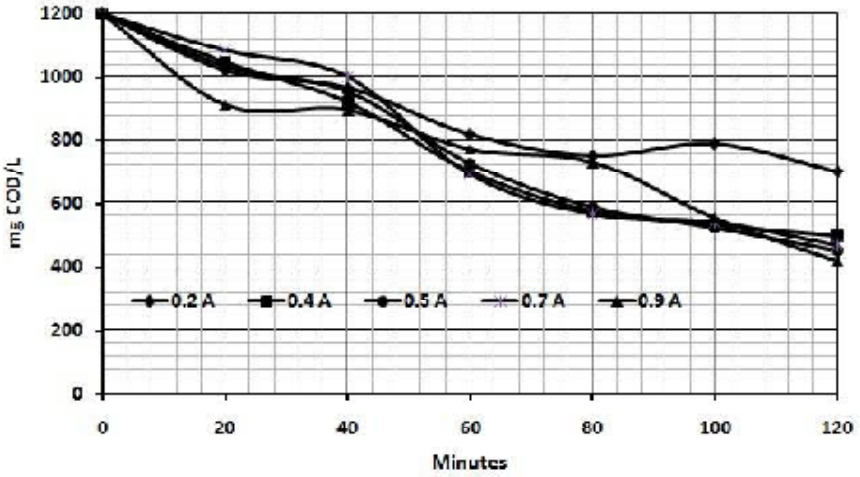

Fig. 4a. Effect of electrical current on the residual COD.

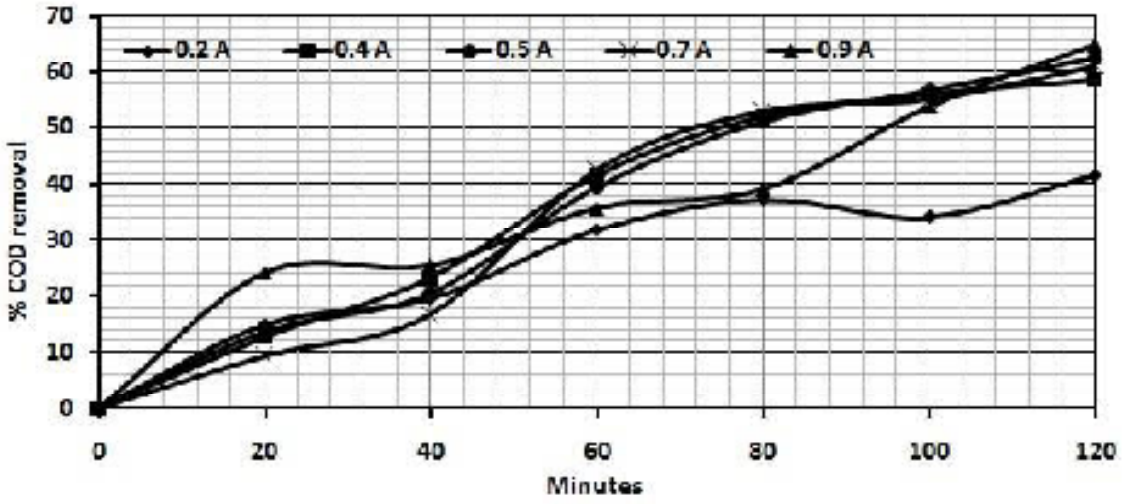

Fig. 4b. Effect of electrical current on COD percentage removal.

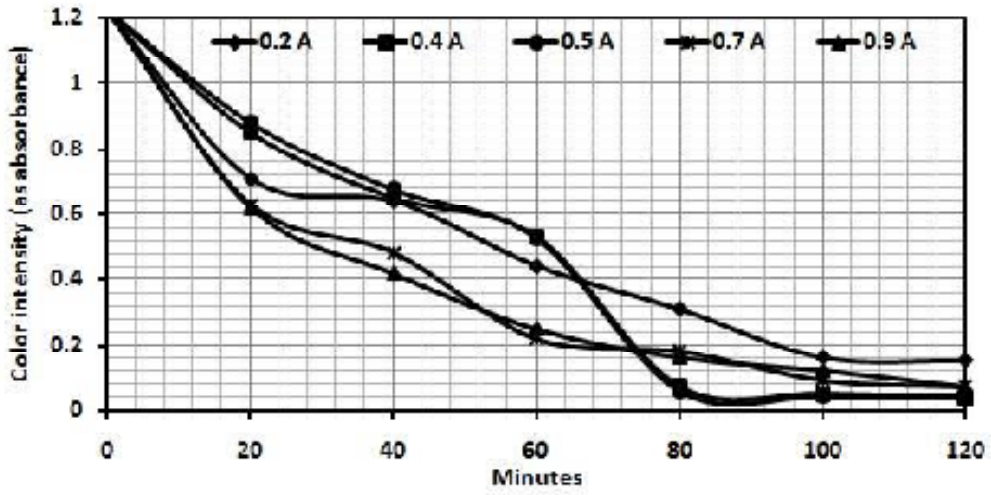

Fig. 5a. Effect of electrical current on the residual color

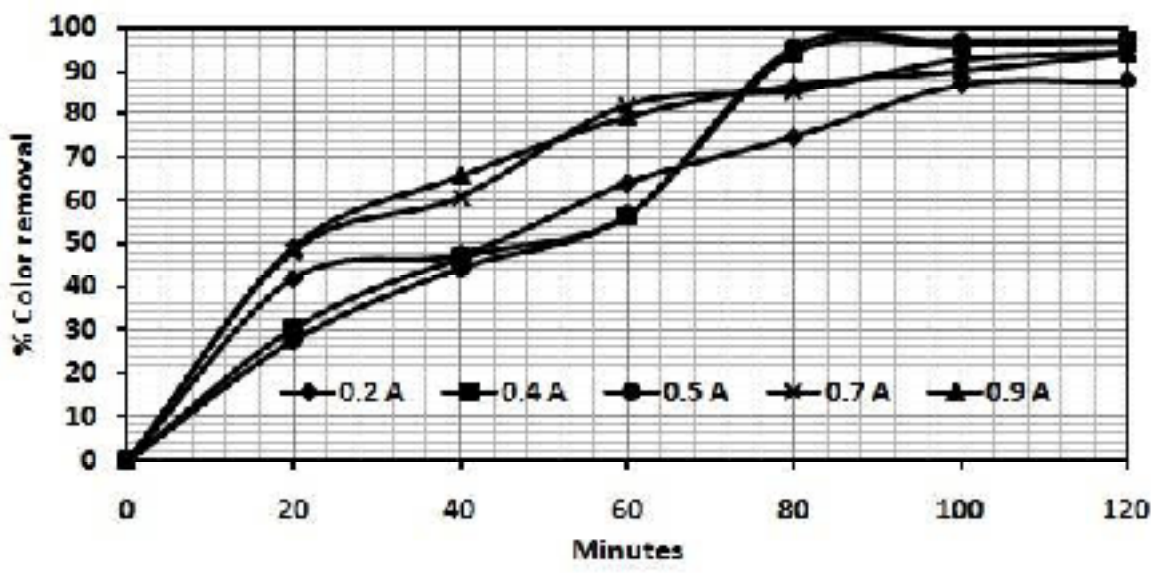

Fig. 5b. Effect of electrical current on color percentage removal.

highest color removal efficiencies at neutral and alkaline medium, especially between pH 6 and pH 9. Similar results have been obtained by Wang and his colleagues [5] during the electrochemical treatment of real textile wastewater. Their results indicated that increasing the initial pH of wastewater from 8 to 11 result in performance reduction of the COD. These results could be attributed to an amphoteric behavior of ferric hydroxide which forms soluble ferrous hydroxide ($Fe(OH)_2^+$) at acidic pH and to monomeric soluble anions ($Fe(OH)_4^-$ and $Fe(OH)_6^{3-}$) at alkaline pH and so oxidation of ferrous to ferric takes place only above pH5[26]. The dissolution rate falls at high pH, which is coherent with corrosion rate of iron at alkaline pH in the presence of oxygen due to the formation of inactive layer on the surface [28]. Also, iron hydroxides exhibit their minimum solubility within pH around 8 which is similar to the finding of this study [29, 30].

Effect of electrical current

The effects of electrical current on COD removal is depicted in Fig. 4a and 4b. The results of COD removal indicate improvement in the treatment performance by increasing the current density and provide 42% at 0.2A and maximum of 65% at 0.9 A (Fig. 4a) which correspond to residual COD of 700 mg/L and 420 mg O2/L, respectively (Fig. 4b). It is well documented that increase in the electrical current increases the anode dissolution and consequently increase the concentration of produced hydroxide [31, 32] which results in improvement and enhancement of pollutants removal. Also, increase in the electrical current increases released oxidants concentration such as hypochlorite and consequently causing more degradation and oxidation of organic pollutants [5, 28, 33]. At higher electrical current, production of extra electrons may contribute to unwanted side-reactions leading to the exhaustion of hypochlorite concentration. In the current study the maximum electrical current (0.9 A) is not high enough to have the previous phenomena. In the current study there was no significant differences in COD removal at electrical current of 0.5 A and 0.7 A and so, 0.5 A was selected as optimum current. As presented in Fig. 5a and 5b, the effect of electrical current on color removal indicates better removal of color in comparing with COD.

The results of COD and dye removal in the current study are less than the values reported by other researchers. Some authors reported percentages of dye removal exceeding 95% and COD removal rate exceeding 87% [19]. Sajjadi and his colleagues concluded increase of percentage removal of Remazol Black B dye with initial concentration of 1000 mg/L to reach 99% removal (residual dye is 10 mg/L) by increasing the voltage from 5 to 30 V while continuous increase in voltage to 60 V results in decline of percentage removal to 95% with residual dye concentration of 50 mg/L [19]. The removal of Reactive Red is significantly affected by variation in voltage with 79% and 96% removal at 6.75 V and 12 V, respectively [34]. Many authors reported increase in anode dissolution by voltage increase which in consequence enhances the process of pollutants removal [20]. Majumder and Rida [20] investigated treatment of textile mill effluent in electrocoagulation unit at various voltages from minimum of 8 V to maximum of 16

V. They got 90% removal of the initial COD (3500 mg/L and residual value was 315 mg/L) at 14 V and 60 minutes reaction time [20]. Therefore the low removal rate of COD in the current study is mostly attributed to the use of low voltage; only 1.6 V.

COD Removal and Kinetic Evaluation

Kinetic was estimated to regulate the reliance of organic content removal rate and electrical current. Figure 6 presents the linear plot of ln (CODo/COD) versus time and proves that organic matter degradation as a function of the electrical current follows a first order reaction and that the COD removal rate is directly proportional to the applied electrical current. The first order kinetic equation is as follows:

$$\ln (C/Co) = -kt \quad [32]$$

C_o is the initial concentration of organic matter or COD; C is the remained organic matter after the reaction, K is the rate constant and t is the reaction time. The highest COD removal was recognized at 500 mA and 120 min reaction time as the wastewater COD decreased from 1200 to 450 mg/L (62.5 % removal efficiency). Furthermore, approximately complete de-colorization occurred with high COD removal.

Energy Consumption

As mentioned before there was no significant difference between 0.5 A and 0.7 A for color removal and so 0.5 A was selected as cost effective current density. Energy consumption is a critical factor in electrocoagulation technology related with operating cost of the process [36, 37].Electrical energy consumption was calculated using the previously mentioned equation as below:

Ec (kWh/m^3) = 3.2 kWh/m^3.

The estimated energy consumption is 3.2 kWh/m^3 which is comparable with the reported values in literature review [1, 12, 13, 20, 21, 37].

Optimum conditions and quality of the treated wastewater

The optimum conditions were defined at 0.5 A current density, 1.6 V, initial pH 8 and 2 hours reaction time. A treated sample at this optimum operating condition was collected and subjected to complete analysis. The results of this analysis are shown previously in Table 1. The data revealed other impacts of chemical process on the inorganic pollutants. The process has some impacts on ammonia oxidation into nitrate since nitrate nitrogen increased from 1.4 to 1.8 which might be attributed to strong oxidant released from dissociation of water molecules into reactive oxygen that has the capability to oxidize ammonia into nitrate. Also the process improves the biodegradability of wastewater with increasing the BOD/COD ratio from 29% to 34%. Sulfate has been reduced from 4200 to 3800 mg/L which is attributed to the formation of metal or iron

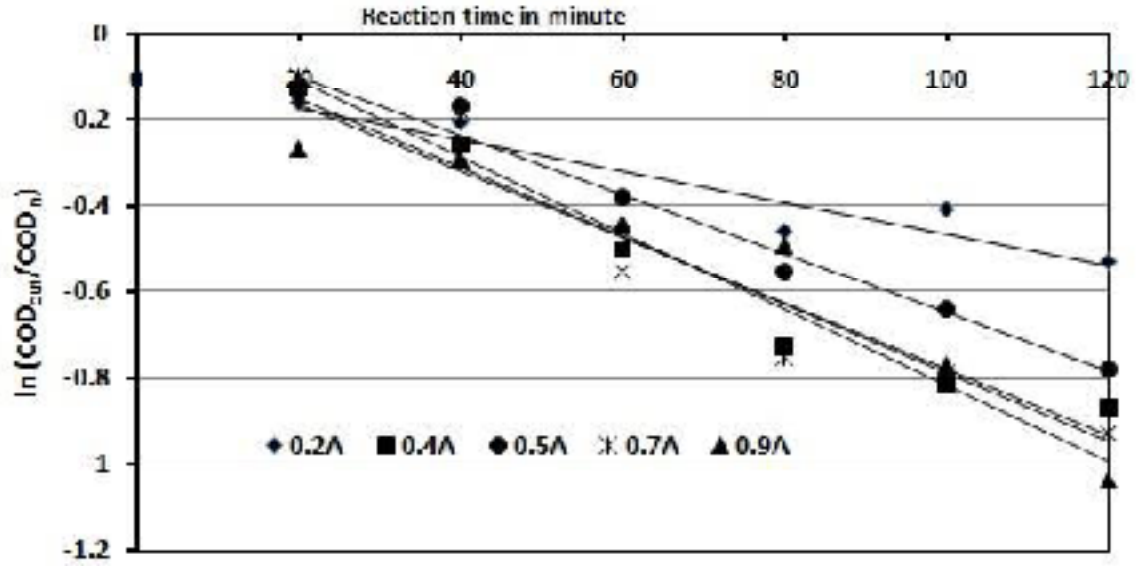

Fig. 6. Effect of electrical current on organic matters removal kinetics (first-order model).

sulfate (ferrous and ferric sulfate). Part of these products precipitates with ferrous and ferric hydroxide to form sludge. The process of electrochemical treatment reduces Phosphorus by 58% with average value of 2.5 mg/L from initial concentration of 5.9 mg P/L. This is mostly due to precipitation of P with the iron hydroxide since precipitation of P as hydroxide at alkaline pH is well known.

Impact of treatment process on pH and characteristics of sludge

The data in Fig. 7 clearly show that there is steady increase in the final pH of the wastewater as affected by the electric current and dissociation of water molecules into hydrogen gas and hydroxyl group which is similar to other reported data [30].

Impact of pH and current density on concentration, volume and settling properties of the sludge.

As presented in Table 2 the sludge concentration is maximum at high pH with average value of 5.2 g TSS/L at pH 12 and reduced to lowest value of 3.4 g TSS/L at pH 8. On the other hand, the Sludge Volume (SV) and Sludge Volume Index (SVI) are markedly decreased with pH reduction to reach minimum optimum values of 200 ml and 59 ml/g TSS for sludge volume and SVI, respectively at pH 8 then increase again to 270 ml and 66 ml/g TSS at pH 6.

The results depicted in Table 2 show the effects of current intensity on the final pH and sludge properties including sludge concentration as g TSS/L, sludge volume and sludge volume

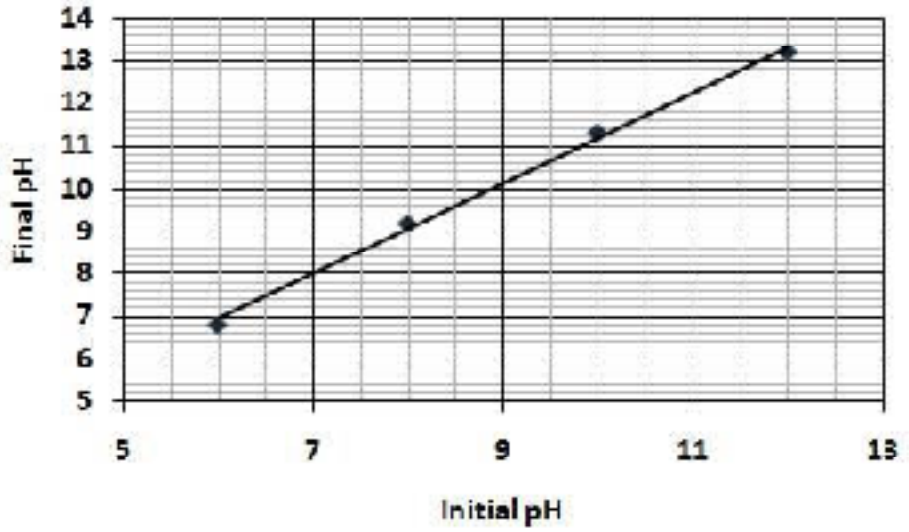

Fig. 7. Effect of current and treatment process on the final pH

TABLE 2. Impact of treatment process and current density on the final pH and sludge characteristics.

Initial pH	Final pH	SV, ml/L	TSS, g/L	SVI
12	13.2	400	5.2	77
10	11.3	300	4.3	70
8	9.2	200	3.4	59
6	6.8	270	4.1	66

Current density	Initial pH	Final pH	SV, ml/L	TSS, g/L	SVI
0.2 A	8	9.3	160	2.8	57
0.4 A	8	9.2	250	3.2	78
0.7 A	8	9.1	270	2.9	93
0.9 A	8	9.3	290	3	97

index as ml/g TSS. As clearly observed from the data, the effects of current intensity are stable and increase the final pH of the wastewater by around 1.1-1.3. There was no correlation between the current intensity and increase in the final pH. Also the results in Table 2 indicate clear impact of current intensity on the sludge volume and sludge volume index. Increase of the current intensity is related with tremendous increase in the sludge volume and sludge volume index without clear correlation with the sludge concentration.

Biological bioassay

The data of SOUR in Fig. 8, indicate reduction in the SOUR which reflects consistent reduction in the biological activity of the sludge. The decline in the biological activity starts with 5% of electro-chemically treated textile dye and control sample containing synthetic water with contaminants concentration similar to actual treated effluent. The decline in the biological activity of the biomass was detected in both samples with significant reduction in case of electrochemically treated dye sample. At 87% of wastewater, the biological activity was reduced by 63% in dye treated wastewater and 57% in control sample which indicates that only 9.5% of this inhibition ([63-57]/[63×100]) is attributed to the residual COD of the treated wastewater while

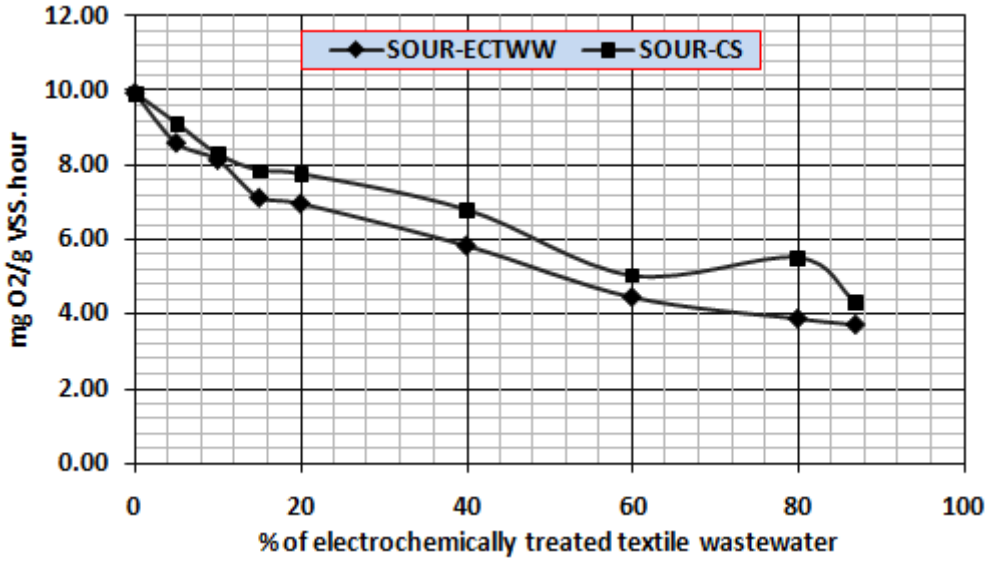

Fig. 8. Specific Oxygen Uptake Rate (SOUR) of both electrochemically treated wastewater (ECTWW) and Control sample (CS).

90.5% is attributed to the salt content of textile wastewater. These results indicate that not only dye from textile wastewater has negative impact on the biological activity of the activated sludge but also excessive minerals in the wastewater have major negative impact on the non acclimatized activated sludge biomass. This shows that reuse of the treated effluent in the industrial process is recommended and more awareness about salt content of textile wastewater should be considered even if this wastewater is disposed of in public sewerage network.

Conclusion

The highest removal percentages were 63% for COD and 98% for color at optimum conditions of pH8, 0.5 A, 1.6 V and 120 minutes electrolysis time. Data of kinetic study is in agreement with the first order kinetic model. Estimated amount of electrical energy required to obtain the most favorable color and COD removal was 3.2 kWh/m^3 wastewater. The results of bio-assay revealed that not only the dye and COD have toxic effects on the activated sludge biomass but also salt content of textile wastewater has negative effects and should be considered in the disposal limits before discharge to the public sewage networks.

Acknowledgement

The authors would like to express their deep thanks to the factory Management for supplying them with the used dye wastewater. They thank technicians; Ahmed Nasr, Mahmoud Elsayed and Hasan Amar for their lab analyses.

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المعالجة الكهروكيميائية لمياه الصبغة بمصانع النسيج المعالجة الكهروكيميائية للصرف الناتج من صباغة المنسوجات

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التخسير والترويب الكهربائي لإزالة المواد العضوية المتمثلة في الإحتياج الأكسجيني الكيميائي واللون من مياه الصرف الصناعي الناتجة من وحدة الصباغة بالصناعات النسجية يمثل الهدف الرئيسي لهذه الدراسة. تم إجراء التجارب المعملية بإستخدام نظام الوجبات في وحدة تحليل كهربائي تحتوي على أقطاب الحديد لدراسة تأثير الرقم الأيدروجيني، شدة التيار وزمن التحليل الكهربائي على نسب الإزالة. أوضحت النتائج نسب إزالة قصوى للأحتياج الأكسجيني الكيميائي (٦٥٪) واللون (٩٧٪) عند ٠,٩ أمبير و ٠,٤ أمبير لكل منهما على الترتيب عند فرق جهد كهربائي ١,٦ فولت وزمن تحليل كهربائي ١٢٠ دقيقة. أوضحت الدراسة أن نسب إزالة الإحتياج الأكسجيني الكيميائي تتأثر بدرجة الرقم الأيدروجيني للمخلف مع تسجيل اعلى نسبة إزالة عند الرقم الأيدروجيني ٨. كذلك أظهرت النتائج قدرة المعالجة الكهروكيميائية على تحسين معامل التحلل الحيوي للمخلف السائل حيث زادة النسبة بين الإحتياج الأكسجيني الحيوي والإحتياج الأكسجيني الكيميائي من ٢٩٪ الى ٣٤٪. أوضحت النتائج فاعلية المعالجة في إزالة اللون والإحتياج الأكسجيني الكيميائي. بالنسبة لشدة التيار لم يكن هناك فروق محسوسة إحصائيا بين ٥,٠ و ٧,٠ أمبير في إزالة اللون لذلك تم اختيار ٠,٥ أمبير كقيمة إقتصادية لعملية المعالجة الكهروكيميائية للمخلف وقد سجل معدل إستهلاك الكهرباء أثناء المعالجة ٣,٢ كيلو وات ساعة لكل متر مكعب من الصرف المعالج. تم أختبار تأثير المياه المعالجة على نشاط وحيوية الحمأة المنشطة المستخدمة في معالجة مياه الصرف الصحي وقد أوضحت النتائج أن كلا من الصبغة الملونة (المواد العضوية) والأملاح في الصرف الناتج من وحدات الصباغة بصناعات النسيج له تأثير سلبي على معدل إستهلاك الأكسجين للحمأة المنشطة والذي يستخدم كمعيار لدراسة نشاط وحيوية الحمأة. لذلك يوصى بتدوير المياه المعالجة في العملية الصناعية كلما أمكن ذلك أو النظر بعين الإعتبار لتركيز الأملاح والمواد الذائبة في التشريعات المصرية الخاصة بصرف المخلفات الصاعية السائلة على شبكة الصرف العمومية.