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Research paper

Removal Methods Assessment Through Reduction Algae Count in Uncovered Water Tank

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Abstract

The research includes study the effect of three factors (voltage, rotational speed, acidity) with time to remove or reduce the percentage of algae in uncovered water tank; these factors studied combined with each other or individually. the removal percentage of algae increased by increasing the electrical voltage, Best result of removal was obtained when using two factors, change in the voltage (4, 8,12 and 16) vole /cm and speed of rotation (50, 100, 150 and 200) rpm . The rate of removal of algae was 100% at voltage 16 volts with a rotation speed (200) rpm and 40 min. The values extracted for algae removal showed that the best result was (100%) at (voltage 16 vole/cm and acidity with pH 4) with time 30 min. It can be conclude, the best method to remove or reduction of algae in uncovered tanks was physical one as a compared with the other methods like chemical or biological methods. Therefore, it needs additional requirements unlike physical strategies decrease, the cost and time required to evacuate green growth.

Keywords: *algae; removal; tank; voltage; water.*

1. Introduction

Electrocoagulation has a long history as a water and wastewater treatment technology having been employed to remove a wide range of pollutants [Naje and Abbas,2013]. In 1889, researchers in England proposed treatment of water using electricity; in 1909, the United States applied EC to treat drinking water on a larger scale [Adapureddy and Goel,, 2012]

One of the drinking water pollutants is algae that contaminant and control on it in water treatment and industry is a worldwide issue, especially in tropical and semi-tropical zone algae in surface water and water reservoirs, which cause many problems such as color, odor taste and toxins compounds, which would pose potential hazards to human and animal health. [Elke and Claudia, 2006]

Therefore, electrochemical process is the process of control and re-operation because of its high efficiency, low maintenance and low labor, high speed of delivery and accurate results. [Chaturvedi,.,2013]

[Kumar and Sahu, 2013] studied the removal of reactive scarlet dye using electrocoagulation method. Tubular iron electrodes used. The impacts of different factors, such as pH, flow rate and current density on dye and COD removal examined. The energy consumption also analyzed. The experimental results showed that the removal of organic matter increased with increasing current density. At the flow rate of 200 mL/min., current density of 30 mA/cm^2, concentration of electrolyte of 0.1M Na_2SO4 and after 90 min. electrocoagulation, the %COD removal and % dye removal were 96.5% and 99.4%, respectively.

[Attour, et al.,2014] conducted an experimental investigation for the treatment of water containing phosphate using electrocoagulation process. The effects of several parameters such as conductivity, pH, current density, temperature and spacing between electrodes studied. The results showed that the removal efficiency increased with increasing temperature and the same efficiency obtained with low current density with long treatment time, or high current density with short time of treatment.

[Mikko, 2012] have connected electrocoagulation in crude water treatment and Wastewater applications the surface water utilized as a part of this examination contained high convergences of common natural issue (NOM). The impact of the primary parameters – current thickness, beginning pH, electric charge per volume, temperature and electrolysis cell development – on NOM expulsion were examined.. As per consequences of this investigation, aluminum is more appropriate terminal material for electrocoagulation applications since it produces Al (III) species.

[Fagnekar, and Mane., 2015] used the electrocoagulation method for the removal of turbidity from two types of water samples, the first type was synthetic turbid water with initial turbidity of 200 NTU and the second type was back wash water. Found the removal efficiencies for synthetic turbid water and back wash water at the optimum parameters (6 A, neutral pH for 20 min.) were about 91% and 89%, respectively.

[Elabbas, et al.2016] studied the ability of electrocoagulation process to remove simultaneously chromium and COD from a real chrome tanning wastewater in a batch stirred electrocoagulation reactor. The influence of the operating time, initial concentration of chromium and chemical oxygen demand and current density was studied. It was found that the use of aluminum alloy was superior to pure aluminum in the removal of chromium and COD. The concentrated effluents required around 6 h of treatment time and current density of 400 A/m^2 to reduce the pollutants concentrations to the environmentally acceptable levels.

A comparison between iron and aluminum electrodes ,where used in electrocoagulation process for the removal of Reactive Red 24 from synthetic wastewater was carried out by [Ghalwa,et al ,2016] The effects of parameter such as pH, initial dye concentration, current density, distance between electrodes, electrolyte type and concentration of electrolyte on the removal efficiency of dye and COD were investigated. The results showed that the removals of dye and COD by using iron were 99.6% and 91.5% and were 97.9% and 83.8%, by using aluminum and the optimum conditions were: pH of 7.2, distance between electrodes of 0.8 cm, NaCl concentration of 2500 mg/L and temperature of 20ºC.

[Mansoorian et al,2016**]** examined the efficiency of continuous electrocoagulation process in the treatment of spent filter backwash water. In this study, four metal plates with dimensions of 15 cm × 22 cm × 0.1 cm were used as electrodes, two plates as cathode and two plates as anode. The electrodes were made of aluminum and iron, respectively. The obtained results revealed that the removal of turbidity by electrocoagulation process was so dependent on the treatment time, current density and pH, and the amount of turbidity had an inverse relationship with the removal efficiency.

The ability of electrocoagulation technique in the treatment of wastewater, was taken from automobile garages was studied by **[**Nampoothiri, et al,2016**]** The experiments were conducted in a batch reactor. The cathode was made from stainless steel and two metals were chosen as sacrificial electrodes, mild steel in the first phase and aluminum in the second phase. Major parameters including pH, current density, electrocoagulation time and salt concentration were studied. The obtained results showed that the removal efficiency of COD using aluminum anode was in the range of (40-89.2%) and (11-82%) for mild steel anode.

[Hashim et al,2017a**]** studied the removal of iron from drinking water using a new cylindrical electrocoagulation reactor. The reactor consisted of a flow column containing six aluminum perforated discoid plates, 5.2 cm in radius and 1 mm in thickness. The perforated electrodes were stacked vertically within the reaction vessel with the plan of each plate parallel and perpendicular to the direction of flow. The experimental results showed that the removal of iron increased with increasing current density and electrocoagulation time and decreased with increasing initial concentration and gap between electrodes.

De-fluoridation of drinking water using a new batch, flow column electrocoagulation reactor was investigated by **[**Hashim et al,2017b**]** Six aluminum perforated discoid plates with diameter of 10.4 cm and thickness of 1 mm were used as electrodes. The perforated electrodes enhance water mixing process that increases the collision rate between coagulants and pollutants, which in turn enhances the removal efficiency. The effects of some factors including initial fluoride concentration, current density, pH, gap between electrodes and treatment time on the removal efficiency of fluoride were studied. The experimental results revealed that % fluoride removal of 98% was achieved within 25 min. of treatment time, at current density of 2 mA/cm^2, pH of 6 and gap between electrodes of 5 mm.

[Hashim et al,2017c **]** investigated the ability of a new batch electrocoagulation reactor for the removal of nitrate from drinking water. They used six aluminum perforated discoid plates as electrodes. The water being treated flows through the perforated aluminum electrodes, thereby efficiently mixing and aerating the water. The optimum conditions for the process were identified as pH=7, current density=2 mA/cm^2, inter electrode distance=5 mm and electrolysis time=55 min. At these conditions, the concentration of nitrate was reduced from 100-15 mg/L with operating cost of 0.455 US $/m^3.

[Pirkarami, and Olya, 2017**]** studied the effects of several parameters including anode type, pH, current density, temperature and concentration of electrolyte on the removal efficiency of Reactive Red 120 from synthetic wastewater through electrocoagulation process using solar energy. Four anode types were compared in terms of their effect on removal efficiency: iron, aluminum, a combination of iron and aluminum and titanium. The obtained optimum conditions were iron electrode, pH of 7, current density of 45 A/m^2, temperature of 25ºC and salinity of 15 mg/L.

2. Materials and Methods

2.1. Preparation of algae Solution

(Oscillatoria),Vulgaris which is one of the green algae was obtained from the Center of Science and Technology in Baghdad University, where a pure isolation of 10 ml was taken and quantity Multiply by 1000 ml after being placed in special incubators with standard conditions of temperature and light as shown in Figure (1). After (7-14) days, algae solution then diluted to 12 liters using a Haemacy to meter counting chamber t0 measure the cell density 0f the pre-cultured algae in 0rder to calculate the diluti0n ratio. Then, the algae v0lume diluted with tap water because the initial cell c0ncentration fixed at 327 cells/L.

Fig.1: A pure isolation of 10 ml with slandered conditions

2.2. Design Cell Electrolytic

The exploratory office for green growth expulsion process appeared in Figure (2)"."The electrolytic cell with a width of 25 cm, a length and a profundity of 30 cm was a glass Electrodes plates (20 cm x 10 cm x 0.1 cm) produced using aluminum have chosen for the anode and cathode. The terminal gathering comprised of five anodes and five cathodes as indicated by the cathode game plan associated in monopolar mode with a viable region of 1000 cm2 and separation of (2 cm)". "At that point submerged into the green growth arrangement at a tallness of 2 cm from the base and associated with an immediate current power supply source. In this examination, all the test runs performed at room temperature.

Fig. (2): Setup of Experimental System.

2.3. Chemical Materials

The chemical formula, purity of the materials used in the present work are Sodium hydroxide (NaOH) and Hydrochloric acid(HCl) with purity of 97% and (34-38)% ,respectively.

2.4. Experimental method and Procedures

The general procedure for preparation of samples in algae removal by experiments has described as follows:

A.Chemical (BG11) added in a Conical Flax glass container Containing algae solution. Where it considered as a nutrient for as it listed in Table (1).

Table 1 BG-11 Media.[17].

Material	Weight
$NaNO_3$	1.5 g
K_2HPO_4	0.04 g
$MgSO_4 \cdot 7H_2O$	0.075 g
$CaCl_2 \cdot 2H_2O$	0.036 g
Citric acid	0.006 g

Ferric ammonium citrate	0.006 g
EDTA (disodium salt)	0.001 g
Na_2CO_3	0.02 g
Trace metal mix A5	1.0 ml
Agar (if needed)	10.0 g
Distilled water	1.0 L

The process has been performed after sterilization of the container with distilled water and the pH value measurement should be (7-8) under the same circumstances mentioned above. A farm of algae have been ready with the possibility of conducting test drills on them, calculation of the number of algae was done before exposure or impact of electrical charges according to Table (2).

Table. (2): Number of Alga After Diluted.

Name of Group	1st Group (cell/mill)	2nd Group (cell/mill)	3rd Group (cell/mill)
1st trail	213	279	200
2nd trail	196	216	234
3rd trail	222	283	217
4th trail	189	258	245
Mean	205	259	224

B.Th. (1) liter algae solution is placed in the glass basin, which is an electrical cell containing the aluminum electrodes.
C. The electrical circuit has been switch on and electrical charge is (4, 8, 12, 16) volt for duration (10, 20, 30) min at each electric intensity and gradually with pH =7. All the parameters studied illustrated in detail in Table (3)

Table (3): effect of voltage on number of cells.

Parameters Tested	Value				
pH	7				
duration time (min)	0	10	20	30	40
Voltage(volt)	4				
Algae(No.) after effect					
Sample(1) cell/mill		201	189	182	177
Voltage(volt)	8				
Sample(2) cell/mill		167	154	137	128
Voltage(volt)	12				
Sample(3) cell/mill		188	131	76	32
Voltage(volt)	16				
Sample(4) cell/mill		112	63	25	12
Distance (cm)	2				

D. At each time intervals (10, 20, 30) min. by using stopwatch, Samples and examine them lower the microscope and use a special scale to measure the algae counting chamber and count the number of algae at each stage.
E. Effect of rotational velocity at (50, 100, 150, and 200) rpm using Device orbit shaker that was acted as a mixer the solution to maintain uniform distribution. All the parameters studied illustrated in detail in Table. (4)

Table (4): effect of rotational velocity on number of cells.

Parameters Tested	Value				
pH	7				
Running time (min)	0	10	20	30	40
Rotational velocity (rpm)	50				
Voltage(volt)	4,8,12,16				
Algae(No.) after effect					
Sample(1) cell/mill		247	219	208	199
Rotational velocity (rpm)	100				
Voltage(volt)	4,8,12,16				
Sample(2) cell/mill		205	200	171	166
Rotational velocity (rpm)	150				
Voltage(volt)	4,8,12,16				
Sample(3) cell/mill		158	131	60	21
Rotational velocity (rpm)	200				
Voltage(volt)	4,8,12,16				
Sample(4) cell/mill		111	42	17	2
Distance (cm)	2				

F. Before and after each run the electrodes have cleaned by water to remove any solids accumulated on the surface.
G. Investigated the impact of pH on removal of algae using pH (7, 9, 11) diluted solution of sulfuric acid and sodium hydroxide to adjusted pH of solutions. All the parameters studied have illustrated in detail in Table (5) and the beginning of each process, "the pH of the solution" has been adjusted to predetermined amount.

Table (5): effect of pH on number of cells.

Parameters Tested	Value				
pH	7				
Voltage(volt)	4,8,12,16				
Running time (min)	0	10	20	30	40
Algae(No.) after effect					
Sample(1) cell/mill		171	165	148	121
pH	9				
Voltage(volt)	4,8,12,16				
Sample(2) cell/mill		213	180	124	101
pH	11				
Voltage(volt)	4,8,12,16				
Sample(3) cell/mill		151	81	12	0
Distance (cm)	2				

3. Laboratory tests and analysis

1.Determination and calculation of algae growth, density and growth. There are several important techniques for the calculation of the preparation of algae, two of which were used to prepare the moss in the water, then take the site samples, and compare them,

2. Quantitative study: Place a drop of algae solution that has been concentrated on each of two slides after shaking well then put the lid quietly and leave it to stabilize the cells then the composite microscope examined.

3. Extract the total number as follows:
Number of cells = total number of moss cells counted in five large squares x dilution ratio x number of small squares in whole slide (16 x 25) x 10 / total number of small squares within the five large squares counted (16 x 5)

4. Calculate Algae Removal:
The algae ratio can calculated by making the specific formula for algae
"Percentage of algae removal" (%) = ((Ci- Cf)/Ci) x 100 (1)
Where:-
Ci is the initial concentration" of algae.
Cf is the final concentration" of algae.

4. Results and discussion

1. Effect of the electrical agent (voltage) on the percentage of the deletion of algae
The effect electrostatic volt as algae removal efficiency, at a constant pH for (7). "The" voltages that had applied were in the range of (4 - 16) V for different concentrations. The action of electric voltage on the elimination efficiency and effectiveness of algae shown in frame (4.2) with (40) min for each run. The concentration of algae before applied voltage has been (213, 196, 222 and 189) cell/mill at (4, 8, 12 and 16) V, respectively.
By comparison the results of all experiments, the best results obtained to remove the algae at voltage 16volts because the concentration of algae has been (112 cell/mille) before applied voltage decreased to (9 Cell / mille) after 40 minutes. Results data shown in Table (6).

Table (6): Removal Efficiency for Different Samples with pH=7

Voltage Applied (V)	Time (min)	Removal efficiency % for all groups			
4	10	5.6	14.8	15.3	40.7
8	20	11.2	21.4	41.1	66.6
12	30	14.5	30.1	65.7	86.7
16	40	16.9	34.7	85.5	93.6

As per Faraday's law, Electrolytic disintegration of the anode would lead aluminum" "particles to break down additional in water as the flow thickness and electrolysis time increment Thus," "expanding connected ebb and flow thickness brings about an expanding number of aluminum hydroxide flocs" "for the evacuation of green growth. In the meantime, the age rate of hydroxide particles is improved the" "measure of metal broke up or kept was subject to the amount of power go" "through the electrolytic arrangement. A straightforward connection between current thickness (A/cm^2) and the" "measure of substances M broke up (g of m/cm^2) can be determined."

$$W = ItM / zF \quad (2)$$

Where: - W/ is the amount of" aluminum dissolving (g/cm^2),
I/ is the current density, t is the time,
M/ is "the molecular weight of aluminum" (g/mol),
Z/ is the number of electrons transferred in the reaction. and F/ is the "Faraday's constant" (96486 C/ M0l) which leads to increase the floc production, also bubbles density increase and their sizes decrease resulting in a more efficient and faster removal **[**Ahmed et al,2010].

2. Effect of induction on efficient deletion of algae

The mixing speed is the most important operating influence factors on performance process the removal of algae, the rotating speed different in the zone of (50-100-150 and 200) rpm. It was studied at voltage for (4, 8, 12 and 16) volt for pH 7, at a different time. Effect of rotation of anode speed on efficient removal of algae is shown in Figure (3) for concentrations of algae (301,216,283 and 258) cell / mill.

Tables (8): "Algae removal" efficiency for different samples and different pH.

Voltage Applied (V)	Time (min)	pH	Removal efficiency % for all groups		
4	10	7	17.5	23	62.6
8	20	9	26	47	94.4
12	30	4	39.5	56.8	99

Voltage Applied (V)	Time (min)	pH	Removal efficiency % for all groups		
4	10	7	17.5	23	62.6
8	20	9	26	47	94.4
12	30	4	39.5	56.8	100

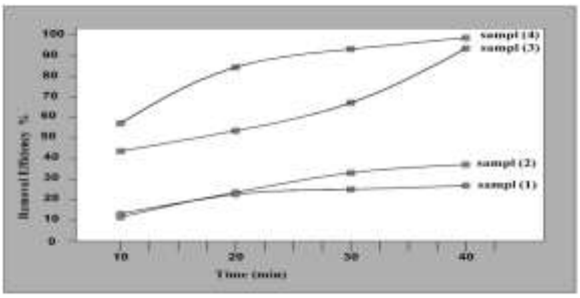

Figure (3): Algae removal efficiency as a function effect of agitation.

Result data shown in Table (7) It is noticed this expanding pivoting speed of the arrangement (50-100-150 and 200) rpm caused increment in expulsion effectiveness in low esteem. This speed has not provided a homogeneous blend in the pH one; nonetheless, the decline in the effectiveness at low mixing rate (50, 100) rpm might be because of none the destabilization of groups framed in the cell. So the best turning speed acquired at 200 rpm. It was higher expulsion of green growth in 200mg/l at 40 min, as displayed in Figure (3).This likewise demonstrated that the herds stored between terminals, in light of the fact that the groups couldn't blend homogeneously and this statement caused the addition of cell protection at low speed. This enhanced the blending conditions in the electrolyte mass was credited with crafted by **[**Sakarinen.,2016**]**.

3. Effect of Initial pH on the removal efficiency of algae .

The pH of solution plays an important role in remove green algae process. The experiments have been carried out at concentration of algae (200, 234 and 217) cell/ mill. With applied voltage electrician (4, 8, 12 and 16) V at a distance of between electrodes 2cm, without applying rotation speed. The influence of pH on remove green algae shown in Figure (4) at running time of (10, 20, 30 and 40) min. The s0lutions adjusted t0 the desired "pH" for all experiments using sulfuric acid 0r s0dium hydr0xide. Results data shown in table (8).

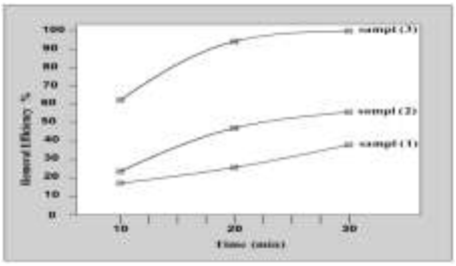

Figure (4): "Algae removal" efficiency as a function effect of (pH).

Algae removal efficiency slightly increases as the initial "pH" decreases. At the initial "pH" of 4 an algae removal efficiency of 99% has been achieved with an electro lysis time of 45 minutes algae removal could be achieved for all initial pH values with an electrolysis time of 60 minutes.

5. Conclusions

Experiments have carried out to determine the best operating conditions", which gave algae removal, by physically manner using electrical charges.

The following points can concluded from the present work:

1. Algae removal efficiency dependent on pH of the solution, applied voltage, rotational speed and time.
2. Algae removed percentage increased with increasing the voltage with time and constant pH for each samples, all samples have high percentage removal of algae at 16 V and 40 min.
3. It was observed , If two factors was applied together (voltage and rotating speed) with time and constant(pH), the algae removal percentage increased with increasing both of them for all different samples until reach maximum removal at(16v , 45min , 200rpm).
4. It can observed are suitable removal of algae form uncovered water tank at (high voltage with high rpm) but less (pH) values.

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