

ELECTROLYSIS PERFORMANCE VALIDATION IN WASTE WATER TREATMENT

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ABSTRACT

The rapidly growing population all over the world with increasing water pollution level and permeant need for food resources is leading to the recycling of wastewater and the recovery of new water resources. In fact, water is a very important resource it must not be wasted after being used in the various processes. Electrodes made from Iron, Steel, Aluminum and graphite are mainly the most common in the electrolytic treatment of wastewater Among the electrochemical processes. This process is a very suitable choice because it proved to achieve more satisfactory removal and also due to the easy and cost-effective in the technological aspect. The main research efforts in the future will focus on physio- chemical and/or biologically treated wastewater for the optimization of electrolytic technology in order to serve the required limits of discharged wastewater for its reuse.in order to help the design of in site-treatment mechanism. The main purpose of this paper is to validate ability, efficiency and the future of this type of in-site treatment methods. Experiments made on a prototype of the electrolysis process by measuring the removal of the pollutants throw the entire process. Considering all the factors that may affect the results.

Keywords: Electrolysis, Wastewater, treatment and electrodes.

المخلص:

في ظل أزمة تلوث المياه والطلب المتزايد لإيجاد مصادر نظيفة للمياه لاستخداماتها المختلفة في الزراعة والصناعة والاستخدام الادمي يتجه البحث العلمي الي استكشاف طرق جديده لمعالجة مياه الصرف الصحي للوصول الي مجال أوسع من استخدامها في المجالات الزراعية والصناعية. من أهم هذه التقنيات يتم تطوير التحليل الكهربائي لمياه الصرف الصحي للوصول الي صورته من الحماء التي يمكن ازالته. ينتج من هذه العملية مركبات هيدروكسيد الحديد وهيدروكسيد الالمونيوم الذي له إثر في ترويب وتجميع الملوثات لتحويلها الي صورته أسهل لإزالتها عن طريق الطفو او الترسيب، أيضا تعتبر هذه الطريقة من طرق معالجة مياه الصرف في الموقع التي يمكن استخدامها كوحده تضاف الي المبني او المنشأة بدون الحاجة الي شبكات صرف ومحطات معالجه ضخمه فتتم عملية المعالجة مباشرة بالقرب من مصدر مياه الصرف الصحي. لذلك تهدف هذه الدراسة إلى البحث في تحسين كفاءة المعالجة بالتحليل الكهربائي من اجل الوصول بجودة المياه الي درجه تمكننا من اعادة استخدامها في الموقع. تم إجراء هذا البحث على نموذج من خلية تحليل تتكون من مصدر طاقة كهربيه ومحول (٢٠-٥) فولت واقطاب معدنيه وتم اجراء الاختبارات على عينات صرف صحي وصرف صناعي في معمل الهندسة الصحية الخاص بقسم الهندسة الصحية في جامعة عين شمس. واثناء عملية المعالجة تم قياس تغير خصائص مياه الصرف ومعدلات المعالجة خلال فترات زمنية طوال مدة العملية. أظهرت النتائج إمكانية معالجة مياه الصرف الصحي بواسطة التحليل الكهر بي للوصول بنسب ازاله تتراوح ما بين (٨٥-٩٥) % في زمن معالجه يتراوح بين ٦٠ - ٩٠ دقيقة وذلك من المواد الذائبة، المواد العضوية، الزيوت والشحوم، المواد المعلقة والمواد الصلبة وقد أظهرت النتائج إمكانية وصول المياه المعالجة الي نسب تسمح بإعادة الاستخدام في بعض المجالات الزراعية او التخلص منها في مجاري المياه المختلفة.

يمكن استنتاج أن التحليل الكهربائي لمياه الصرف الصحي قد يصبح أكثر انتشاراً باستخدام وحدات معالجه خاصه بخدمة وحدات سكنيه صغيره ونقل مياه الصرف المعالجه الي أماكن إعادة الاستخدام او أماكن التخلص منها وقد تتوفر الإمكانية باستخدامها في نفس مكان المعالجة في ري المساحات الخضراء لمحيطه بوحدات المعالجة لتوفير تكاليف شبكات الصرف الصحي مع تطوير طرق التخلص من الحماء الناتجة عن عملية المعالجة وبذلك تصبح تكاليف المعالجة وإعادة الاستخدام مرتبطة بالوحدات السكنية بدلاً من ارتباطها بمحطات معالجه مركزيه مما يتيح مجالات أوسع لإعادة الاستخدام و مدي أوسع لانتشار هذه الطرق في الأماكن النائية والصعب ربطها بشبكات الصرف الصحي كل هذه العوامل قد تجعل هذه الطرق أكثر انتشاراً في المستقبل.

الكلمات الدالة: التحليل الكهربائي، مياه الصرف الصحي، تحسين كفاءة المعالجة، صرف صناعي

1. INTRODUCTION:

Fresh Water is a natural resource that is considered very limited. Commonly appropriate quality water supply is not enough for domestic and industrial use. Many water streams pollutants are considered toxic and harmful to human health and to the environment. Ecological protection Strategies generally include the new or improved industrial processes is developed to have no or minor effects on nature and of processes for the inevitable waste treatment. Wastewater treatment higher cost treatment of the effluent due to its discharge restrictions to the environment have pushed the industries to adopt programs of the water consumption minimization and favoring the new methodologies development for the resources optimization. Corcoran *et al*, (2010).

There is an urgent need of a more cost-effective on-site treatment method of the polluted raw water, and by decreasing the use of required additives for water sustainability management. The electrolytic Treatment system of wastewater represents an innovative technology of treatment in which the use of an anode and cathode metal cause the active electrical coagulants generation and tiny hydrogen and oxygen bubbles to perform the process of treatment. The main purpose is to measure the efficiency of electrolysis to be an effective resource for treated wastewater and the characteristics of treated wastewater by which it can be reused.

2- METHODOLOGY

The mechanism of electrolysis treatment can be explained by understanding the factors affecting the process.

Factors affecting the removal ratio of pollutants during the process:

1. The reactor design
2. The material and shape of the electrodes.
3. The power supply for the process
4. The type of water pollutants
5. The amount of these pollutants
6. The time of the treatment process

The type of water pollutants

The samples will be collected from a detergent factory in the industrial zone located in Sadat city these wastewater samples contain chemical pollutants from the manufacturing process in which chemicals samples will be collected from the different manufacturing lines in the factory during the different steps of the process.

Some other samples will be collected from a gas station in dabah road these wastewater samples contain sewage waste from municipal waste beside oil and chemical pollutants from other processes in the station collected from the different sewage tanks in the gas station.

3- Results and Data Analysis:

Sample testing was made in the Ain Shams University labs by using different types of raw wastewater in order to measure the process ability to treat the wastewater, however test samples include pure chemicals to study the electroflotation process as per experiments it was found that during the treatment process of water polluted with nothing but chemical during the absence of any other organic pollutants the sample is prepared to contain pollutant of detergents the whole electric energy consumption is directed to the flotation these type of

results will help us to study the flotation phenomena alone and combined with the electrocoagulation/flotation process.

Total suspended solids removal

Tested sample of domestic Wastewater is treated and during the process, Wastewater samples are taken from the device during the treatment process to measure the removal ratio of (TSS)the following data were collected

Table (3,1) TSS samples during different time intervals.

| Treatment Duration (min) | 0 | 15 | 30 | 45 | 60 | 90 |
|--------------------------|-----|-----|-----|----|----|----|
| TSS Mg/L | 350 | 280 | 120 | 65 | 25 | 25 |



Figure (3.1) TSS removal curve during different time intervals

Oil and grease removal

Wastewater samples are taken from the device during the treatment process to measure the removal ratio of Oil and grease the following data were collected.

Table (3,2) Oil and grease samples during different time intervals

| Treatment Duration (min) | 0 | 15 | 30 | 45 | 60 | 90 |
|--------------------------|-----|-----|-----|----|----|----|
| TSS Mg/L | 320 | 210 | 130 | 85 | 35 | 30 |



Figure (3.2) Oil and grease removal curve during different time intervals

Biochemical Oxygen Demand removal:

Tested sample of a sewage Wastewater collected from a gas station treated and during the process samples was taken from the device during the treatment process and proper adjustment is made on the power supply to ensure the treatment process was not affected by the volume change to measure the removal ratio of (BOD) the following data were collected.

Table (3,3) BOD samples during different time intervals

| Treatment Duration (min) | 0 | 15 | 30 | 45 | 60 | 90 |
|--------------------------|-----|-----|-----|----|----|----|
| BOD Mg/L | 750 | 410 | 180 | 90 | 30 | 29 |

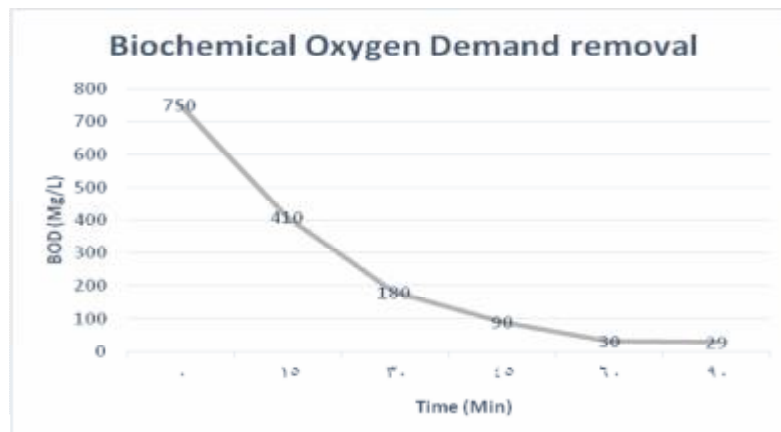


Figure (3.3) BOD removal curve during different time intervals

Organic Nitrogen removal

Wastewater samples are taken from the device during the treatment process to measure the removal ratio of Organic Nitrogen the following data were collected.

Table (3,4) Organic Nitrogen samples during different time intervals

| Treatment Duration (min) | 0 | 15 | 30 | 45 | 60 | 90 |
|--------------------------|-----|-----|-----|-----|-----|----|
| Organic Nitrogen Mg/L | 265 | 220 | 175 | 115 | 100 | 95 |

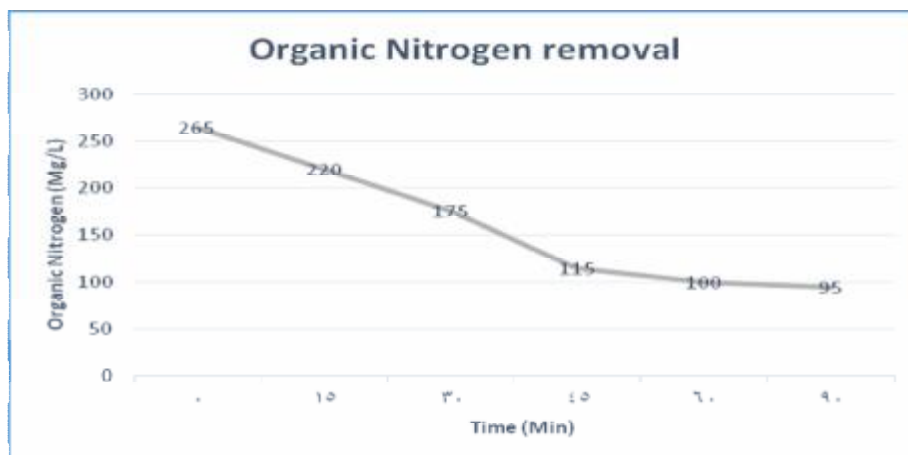


Figure (3.4) Organic Nitrogen removal curve during different time intervals

Total dissolved solids removal

Tested sample of domestic Wastewater is treated and during the process, Wastewater samples are taken from the device during the treatment process to measure the removal ratio of (TDS)the following data were collected

Table (3.5) TDS samples during different time intervals.

| Treatment Duration (min) | 0 | 15 | 30 | 45 | 60 | 90 |
|--------------------------|-----|-----|-----|----|----|----|
| TDS Mg/L | 380 | 210 | 145 | 85 | 40 | 40 |

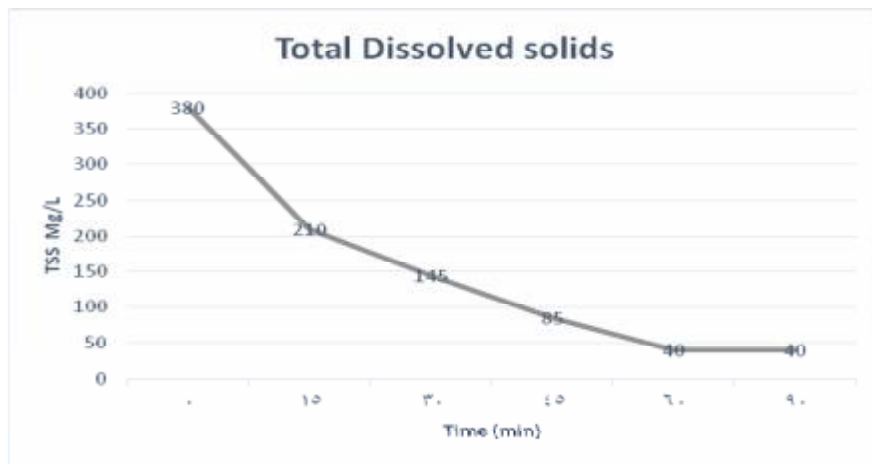


Figure (3.5) TSS removal curve during different time intervals

Relation Between Electrolysis Efficiency and Conductivity

Generally, there is an essential relation between the electrolysis and the conductivity of the performance of the treatment process as high conductivity will allow more ion release in less time duration while low conductivity will obviously cause the treatment to become less effective and will increase the duration needed to reach desired rates of removal.

The test sample is collected from a detergent plant containing only chemical waste From the outlet of the machines.

Table (3,6) Sample (2) the values of (COD) during different time intervals

| Time from the start of the process (min) | COD Mg/L | Conductivity MS/cm |
|--|----------|--------------------|
| 0 | 1300 | 1.46 |
| 15 | 900 | 1.09 |
| 30 | 640 | 0.8 |
| 45 | 420 | 0.58 |
| 60 | 380 | 0.42 |

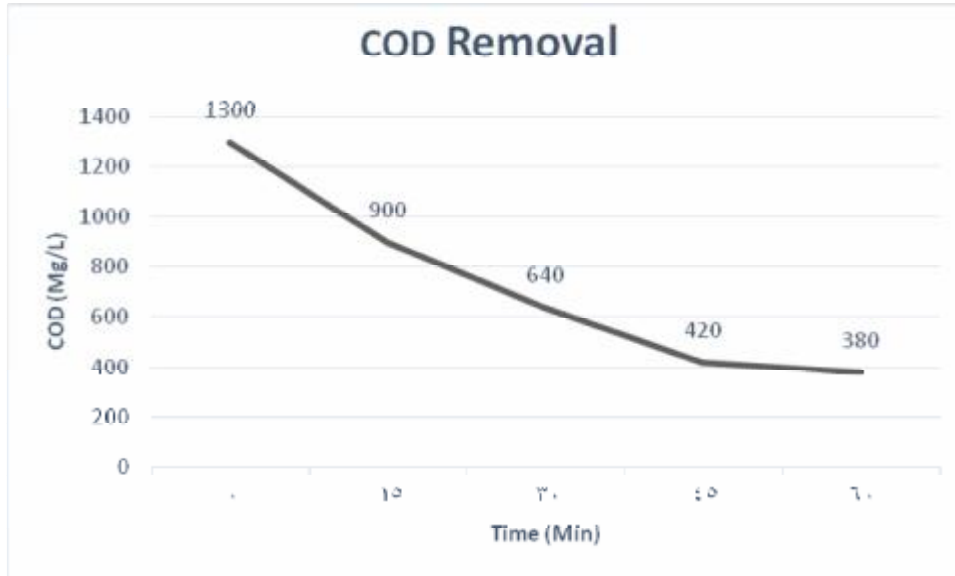


Figure (3.7) COD removal curve during different time intervals

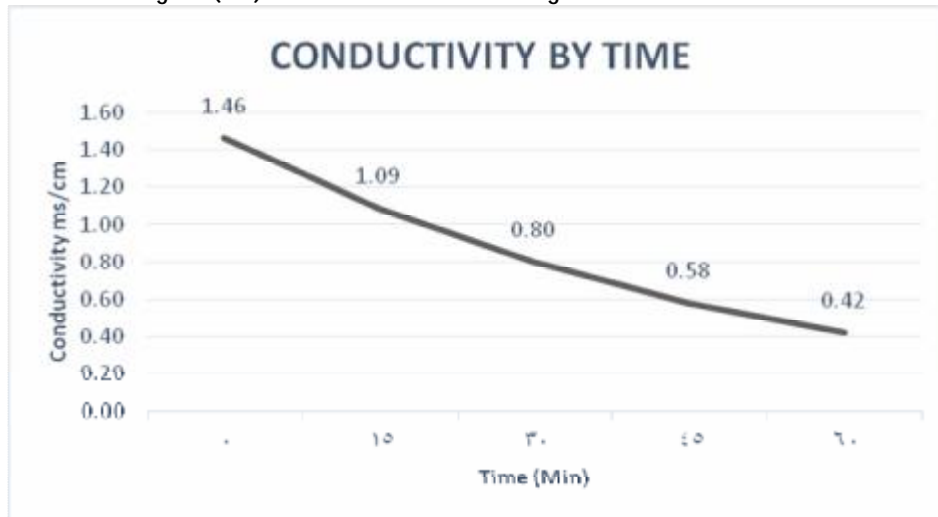


Figure (3.8) Conductivity curve during different time intervals

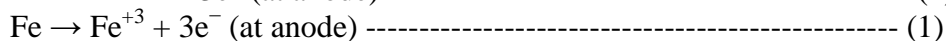
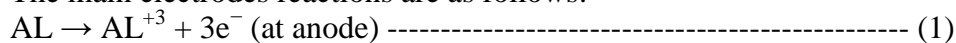
4- DISCUSSION

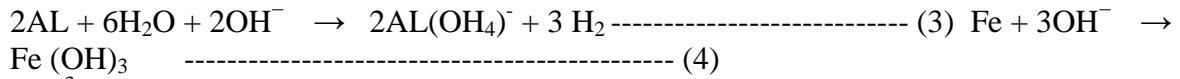
Electrolysis technique is considered an electrochemical treatment technology of wastewater that is now experiencing both increased significant technical improvement and popularity. It is a complicated process containing many physical and chemical phenomenon that use consumable electrodes to provide ions supply into the body of the wastewater. In the process, generation of the coagulant is made in situ by Fe and Al electrode electrolytic oxidation of the anode material which continuously produces ions in the system. The ions released causes neutralization of the particle's charges and thereby initiate coagulation .

Treatment process

The main electrolysis processes are electrolytic reactions at the electrodes surface forming of coagulants in aqueous phase, soluble or colloidal pollutants adsorption on coagulants, and removal by floatation and sedimentation.

The main electrodes reactions are as follows:





AL⁺³ and OH⁻ generated Ions by the electrode reactions (1) and (2) cause the form of various monomeric species which finally transform into AL(OH₄)⁻, Fe(OH)₃ according to precipitation complex kinetics while using other types of electrodes will generate other types of coagulant as in this Electrolytic equipment is easy and simple to operate. There are many parameters such as shape, size and distance between electrodes, current density, reaction time conductivity and ph. which must be carefully selected to optimize the efficiency of the process. Electrode effect is to be investigated as to its nature ‘cell voltage, mixing, electrolysis time and current density on aqueous solutions of reactive dyes.

The particles destabilized and then aggregate to cause the formation of flocs. In the meantime, tiny bubbles of hydrogen gas produced at the cathode zone causing the floatation of most flocs, successfully help to separate particles effectively from wastewater effluent. On the other hand, the cathode may be attacked chemically by ions of OH⁻ generated together with H₂ at high values of pH

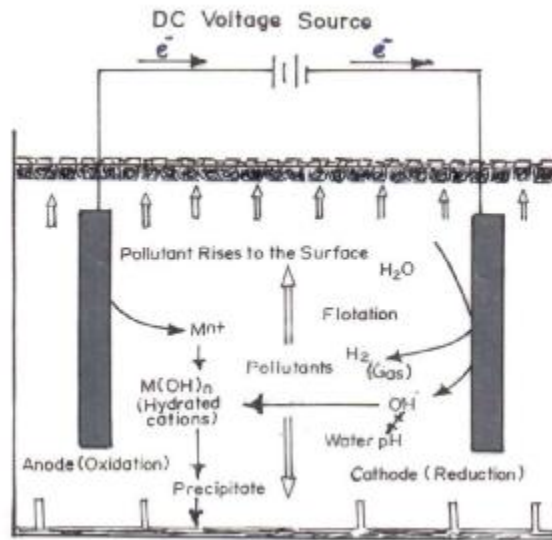


Figure (5.2) The sludge produced due to flotation on the surface of wastewater, A.K. Chopra, et al, (2011)

Treatment efficiency:

A various result shown various parameters of wastewater removal efficiency

Figure (4.1) shows the various results of the removal ratio of the treatment process which the device was able to achieve.

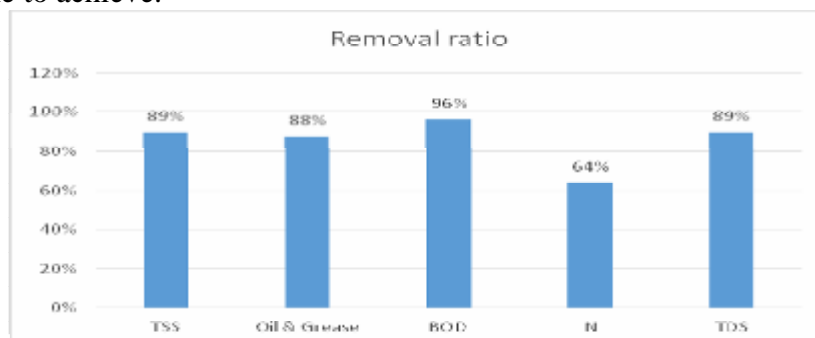


Figure (4.1) The Removal ratio of the various parameters.

5-CONCLUSION

As the increase of world population and the limited water resources, the modification of a new technique such as electrolysis enables us to make the best advantage of the water resources as these new techniques will indirectly decrease the fresh water consumption by using the treated wastewater in agriculture purposes. Advantages of electrolysis as its convenient operation, simple equipment and not require of other chemical substances for the floc generation and sedimentation. Such technology can be helpful in the treatment of the wastewater to produce high water treatment quality at an affordable price. The application of in-situ wastewater techniques could be the solution of water pollution as the treatment cost will not be a problem facing the government of the countries as the cost itself will be carried by The unit residents by applying some laws which obligate the citizens to such techniques the water pollution could be cut from the source other than less cost due to the less wastewater drainage networks when using the treated water also in situ in landscape irrigation or any other purposes. The cost of the infrastructure is a big problem facing the development in any countries and such treatment processes could be the key to better development.

Future of the Electrolytic Treatment The research of the electrolysis technique has proved that the process could reach very good results but the true application of the process will be more effective in new cities especially in the desert areas in which the sludge disposal could be much easier and the opportunity for new sewage network design or the ability for in situ usage in agriculture and landscape irrigation purposes. Electrolytic treatment methods could be the key to a promising wastewater treatment technique. Instead of mega wastewater treatment plants it could be more suitable to treat wastewater with smaller techniques that treat wastewater in a house scale.

The application of such techniques will replace the using of high-cost sewage pipe networks and will help for more development

The Problem with Electrolytic Treatment

The need for Electricity: the absence of the electric current will cause the treatment to collapse leading to environmental problems.

- Capital cost problems: Cities create and improve such treatment techniques will require a capital cost even though the less needed by conventional methods.
- The design problems for providing the sustainable power source, decreasing the needed power, waste treatment and emergency storage design.
- Maintenance problems: the continuous need for professional labor for maintenance and cleaning the spare parts will create some sort of a problem regarding the widespread of such treatment techniques.
- Produced Sludge problems: the produced sludge in situ could be a problem as it will need a treatment unit beside the electrolytic main unit, such problem will make other treatment techniques desired to be used instead of this process.

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