沙漠研究 **22**-1, 333 -336 (2012)
Journal of Arid Land Studies

"ICAL 1 / DT X"
－Refereed Paper－

Wastewater Treatment for a Possible Water Reuse in Semi-arid Climate Zone

Moncef KHADHRAOUI*[1)] and Chokri BELAID[1)]

Abstract: The main objective of this work was to investigate on the possible conjunction of electrochemical processes (electrooxidation and electrocoagulation) for the treatment of dyes bearing wastewater for a possible valorisation in irrigation fields. The used methods were also tested separately to see the extent of the treatment yield of each technique. Experiments were conducted in laboratory confectioned reactors under different operating conditions. Obtained results under the optimized experimental conditions show that both electrooxidation and electrocoagulation applied separately exhibited a limited performance towards suspended matter, chemical oxygen demand, color and turbidity removal. In fact, neither the electrooxidation nor the elecrocoagulation enabled to meet the discharge criteria of wastewater release into the receptor media. It was also noticed that the electrocoagulation favored the removal of suspended matter (95%) whereas the electrooxydation lead to an efficient color removal (96%). On another hand, conjunction of these processes enabled a high pollution reduction rate reaching nearly 98% in terms of color, chemical oxygen demand and suspended matters. The obtained results also indicate that the combination of the above mentioned processes reduced significantly the phytotoxicity of the wastewater and enhanced considerably its biodegradability exhibited through the drop of COD/BOD_5 ratio. Based on this, it was suggested that conjunction of electrochemical processes could be another alternative for the enhancement of pollution removal efficiency from textile wastewaters. Furthermore attempts were made to reuse the treated wastewater in the irrigation field. The results indicate that electrochemically treated wastewater showed no phytotoxicity and no cytotoxicity toward the tested plants and microorganisms and therefore can be thought about for a possible exploitation to irrigate certain plants and trees.

Keywords: Irrigation, Reuse, Valorisation, Wastewater treatment

1. Introduction

Treatment and re-use of wastewater is nowadays a major need all over the world due to the low availability of water resources, as well as to the negative impact on environment through the discharge of the un-treated wastewater [1, 2]. This problem is particularly pressing on the Mediterranean countries among them Tunisia where the shortage of rain is often encountered and environmental problems are well taken in consideration. In parallel to this condition, a considerable volume of an available treated domestic and industrial wastewater find its way to the receiving water bodies and the benefit of its exploitation are therefore lost. These waters, if carefully treated and reused can alleviate the over exploitation of the currently water resources and reduces environmental impacts.

Among the water consuming industries, textile industries are known by their huge water consumption as well as by their wastewater containing recalcitrant compounds affecting the receptor media once they are discharged insufficiently treated [3, 4]. Conventional physical/chemical methods used to decontaminate such kind of wastewaters are time and energy consuming and can not guaranty sufficient contaminants removals enabling water re-use [5, 6]. Within this regard, the main objective of this work was therefore to investigate on the possible conjunction of electrochemical processes (electrooxidation and electrocoagulation) for the treatment of dyes bearing wastewater for a possible valorisation in irrigation fields. Different studies showed that the use of the so-called advanced oxidation processes are gaining popularity in term of wastewater treatment and recycle [7, 8]. The used methods were also tested separately to see the extent of the treatment yield of each technique. Furthermore to assess the possible reuse of the treated wastewater in the irrigation field and alleviate the burden on underground water overexploitation as well to promote the practice of treated wastewater to irrigate golf courses and public gardens, phytotoxicyty tests were carried via irrigation of broad beans by raw and treated wastewaters.

2. Materials and Methods

Treated samples were obtained from a local factory having general characteristics exceeding the Tunisian wastewater quality standards in term of color, chemical oxygen demand, suspended matter etc..(Data not shown). Sketch of experimental apparatus for the tested treatment techniques are presented in **Figure 1**. The treated volume was about 1 L.

* Corresponding Author: montunisia@yahoo.fr

Route de Soukra Km 3,5 Po. Box 1173, 3038 Sfax, Tunisia

1) University of Sfax , Laboratory of Water, Energy and Environment, National School of Engineering of Sfax (ENIS). Postal address

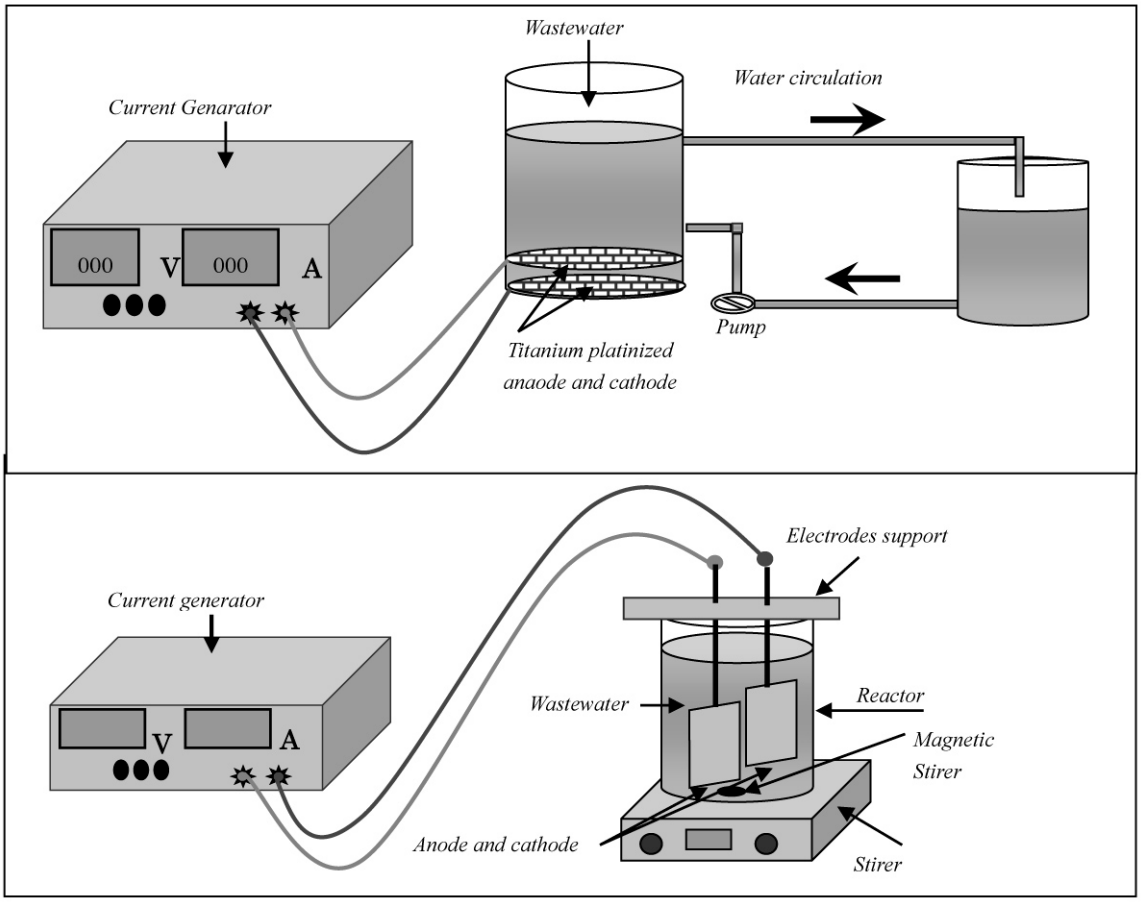

Fig. 1. Sketch of the electrocoagulation (upper one) and electroxidation treatment methods.

Runs were conducted under different operating conditions in terms of current intensities. Several parameters were monitored to assess treatment efficiency, such as chemical oxygen demand, suspended matter, salinity, color etc…

Phytotoxicity tests were conducted to evaluate the possible reuse of the treated textile water in the irrigation fields. Series of pots containing broad bean were thus irrigated with the raw and the treated water. For comparison, a run using tap water was also conducted. The effect of the water quality on the plant growth was assessed by studying the modification morphology of the plant such calculating the germination index, measuring the plant high and the number of the leaves.

3. Results and Discussion

Obtained results under the optimized experimental conditions show that both electrooxidation and electrocoagulation applied separately exhibited a limited performance towards suspended matter, chemical oxygen demand, color and turbidity removals. Indeed, for the electrocoagulation, the final COD (325 mg/l) and final BOD5 (70mg/l) remain larger than the standards. Also, we noticed there was a residual color in the treated wastewater as shown in **Figure 2**. As for the elecroxydation we can say that the removal efficiency depends also on each parameter characterising the treated wastewater. However all values remain higher than those of the standards for wastewater discharge. Nonetheless there was no residual color. One advantage of this latter technique, over the electrocoagulation is that it does not generate any secondary pollutants since the main reagent is the electron, a clean reagent, that 'incinerates' the organics without giving any sludge. Anyway, and as a deduction for two these tests, it was concluded that neither the electrooxidation nor the electrocoagulation enabled to meet the discharge criteria of wastewater release into the receptor media. Nonetheless, it was also noticed that the electrocoagulation favored the removal of suspended matter (95%) whereas the electrooxydation lead to an efficient color removal (96%) (**Fig. 3**). On another hand, conjunction of these processes enabled a high pollution reduction rate reaching nearly 98% in terms of color, chemical oxygen demand and suspended matters. The COD removal could be interpreted either due to the adsorption of dye molecules on oxy-hydroxide or due to interaction of metal ions forming insoluble metal-dye precipitate or by both mechanisms. The obtained results also indicate that the combination of the above mentioned processes reduced significantly the phytotoxicity of the wastewater and enhanced considerably its biodegradability exhibited through the drop of COD/BOD_5 ratio. Furthermore attempts were made to reuse

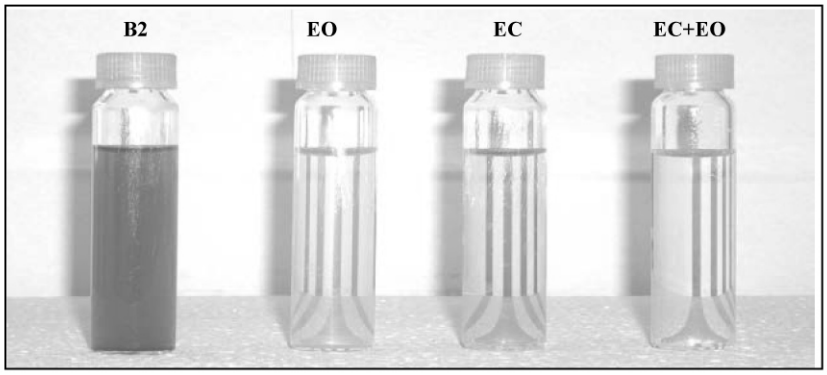

Fig. 2. Color of the different waters before and after treatment (B2: raw wasterwater, EO: electrooxidizezd wastewater; EC: electrocoagulated wastewater; EC+EO: Coupled process).

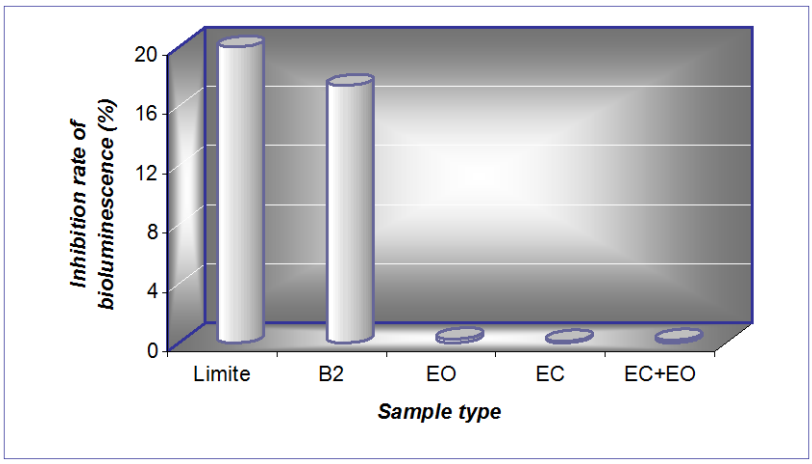

Fig. 3. Citotoxycity of the differents kind of waters (Limite: control; B2: raw wasterwater, EO: electrooxidizezd wastewater; EC: electrocoagulated wastewater; EC+EO: Coupled process.

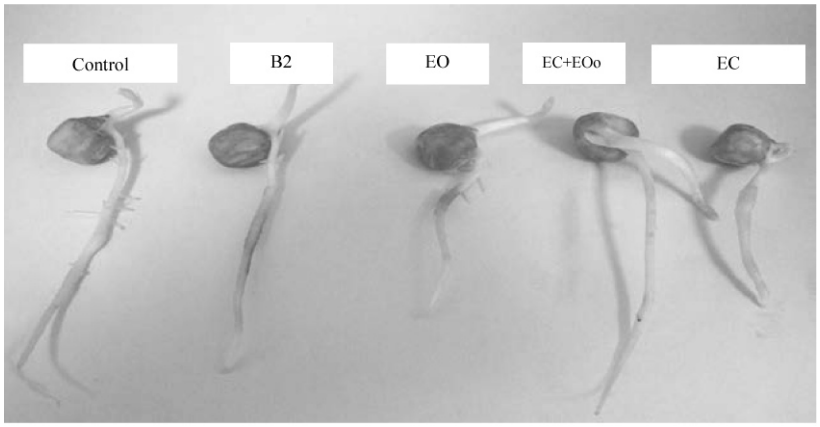

Fig. 4. Germination tests using different kinds of waters (control; B2: raw wasterwater, EO: electrooxidizezd wastewater; EC: electrocoagulated wastewater; EC+EO: Coupled process.

the treated wastewater in the irrigation field. As shown in **Figures 3** and **4**, the results indicate that electrochemically treated wastewater showed no phytotoxicity and no cytotoxicity toward the tested plants and microorganisms and therefore can be thought about for a possible exploitation to irrigate certain plants and trees. In the same way (data not shown), it was found that the morphology of the plants irrigated with different kind of waters presents almost similar high and same leaves length and numbers. One exception for the plant irrigated with the electro-oxidized wastewater which presented less length and this might be due to some by-product generated upon applying this technique which should be

confirmed by further analysis.

4. Conclusion

This paper describes the treatment and reuse of textile wastewater in the irrigation field. It was concluded that conjunction of electrochemical processes could be another alternative for the enhancement of pollution removal efficiency from textile wastewaters. Furthermore tests used to exploit the treated wastewater to irrigate broad beans and to asses its toxicity toward microorganisms living in irrigated soil. The results indicate that electrochemically treated wastewater showed no phytotoxicity and no cytotoxicity toward the tested plants and microorganisms and therefore can be thought about for a possible exploitation to irrigate certain plants and trees in arid and semi arid climate zone.

References

Bousselmi L., Ghrabi, A. (2000): A study on textile wastewater (A review). *Waste Waste and Environment Research*.

Brown M.A., Devito S.C. (1993): Predicting azo dye toxicity. *Critical review in Environmental Science and Technology*, **12**: 405- 414.

Correa V.M., Stephenson T., Judd S.J. (1994): Characterization of Textile Wastewaters. *Environnemental Technology*, **15**: 917-929.

Khadhraoui M., Trabelsi H., Ksibi M., Bouguerra S., Elleuch B. (2009): Discoloration and detoxicification of a Congo red dye solution by means of ozone treatment for a possible water reuse. *Journal of Hazardous Materials*, **161**: 974-981.

Lin S.H., Peng C.F. (1994): Treatment of textile wastewaters by electrochemical method. *Water Research*, **28**: 277-876.

Pagga U., Brown D. (1986): The degradation of dyestuffs part II: behaviour of dyestuffs in aerobic biodegradation tests. *Chemosphere*, **15**: 479-491.

Raghavachary C. (1997): Colour removal form industrial effluents. A comparative review of available technologies. *Chemical Engineering World*, **32**: 53-54.

Rozzi A., Malpei F., Bonomo L. (1999): Textile Wastewater Reuse in Northern Italy (COMO), *Water Science and Technology*, **39**: 5.