Journal of Fundamental and Applied Sciences

ISSN 1112-9867

Available online at http://www.jfas.info

Research Article

CONTRIBUTION OF THE ELECTROCHEMICAL PROCESS IN THE TREATMENT OF PAINT EFFLUENTS

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Received: 06 September 2022 / Accepted: 04 October 2022 / Published: 25 October 2022

ABSTRACT

Paint discharges contain polluting agents that are highly harmful to the environment. The work proposed makes it possible to apply electrocoagulation as a process for treating paint-based effluents. Two types of paints (water and oil paints) are considered in this study. The electrocoagulation reactor used is equipped with two flat aluminum electrodes. The electrocoagulation process in an acid medium gives a better electrolysis yield allowing a sufficient quantity of ionic coagulant (Al^{3+}) to be obtained. The ionic coagulant will, among other things, considerably reduce the turbidity parameters of the pollution. The depollution process used for the various paints considered in this study makes it possible to conclude that the method is promising on an industrial scale due to the fact that the mud obtained does not have a complex composition either to recycle their rejection or the starting products in nature.

Keywords: Electrocoagulation - Effluent of painting - Electrochemical reactor.

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doi: http://dx.doi.org/10.4314/jfas.1267

1. INTRODUCTION

The rejections of painting [1] include agents of pollution hard harmful to environment. The Electrocoagulation [2-7] is a technology introduced for this type of rejection to minimize the disadvantages of conventional technologies of treatment. It also has advantage to reduce certain parameters of pollutions such as (turbidity, colloidal, colour subjects, heavy metals etc) by adsorption on flocks of metallic hydroxide [8-9].

2. CHEMICAL COMPOSITION OF PAINTING SOLUTIONS

Chemical composition of painting A preparation of painting is principally composed of a sociable which will form the film of surface and that is am emulsified or dispersed. Resolution or dispersion is often supplemented by addendum of pigment or expenses (table1).

Table1. Chemical composition

Water	40 - 65 %
Solvents	10 - 15 %
Resins	15 - 25 %
Tensioactifs, Conservators, Biocides	2 - 4 %
Charges, pigments	2 - 20 %
Residue, Heavy metal, Impurity	0 - 0.2 %

The worldwide production of painting is estimated in 85.6693tonnes/year. The complete quantities of solvents were used in the manufacture of painting, inks, glues and adhesives are near 260000 tonnes a year.

The programs of COV resulting from manufacture are about 5000 in 10000tonnes/year [1].

The waste of painting is linked to heavy industrial activities, manufacture of piles, fluorescent tubes, batteries, oils of emptying, solvents, varnishes, rests of painting. To preserve the environmental aspect, of norms of rejections for this type of pollution is decreed and they name the French ALLIOS society which offers new stricter stocks in terms of daily flux of rejection but which are more adapted to their actual performances (table2).

3. REGULATORY ASPECTS

The viscous nature of painting implicates a big volume of loss during manufacture (several kilograms of subjects can remain glued together on the walls of a vat containing several tonnes). Gold subjects constituting this painting are very consumer of oxygen because on average present 1gramme of raw materials in water represents 1000 mg/L of DCO. The station of treatment must therefore let through no more than 2grammes of subjects by litre of treated water.

Table2. Rejection norm parameters

Flow mater	$< 15\ m^3/j$	Flux (kg/j)
MEST	300 mg/L	< 4.5
DCO	2900 mg/L	< 43.5
DBO5	1000 mg/L	< 15
Total Nitrogen	150 mg/L	> 2.3
Total Hydrocarbures	10 mg/L	< 0.15
pH	5.5 < pH < 8.5	-----

4. ELECTROCOAGULATION PROCESS

During technique of Electrocoagulation, coagulant is generated in situ by the electrolytic oxidation of an appropriate solid anode. The Electrocoagulation (EC) is a technology which results from the correlation of three fundamental technologies which are: electrochemistry, coagulation and flotation. It is based on the fact that the stability of colloids, suspensions and emulsions, is influenced by electrical expenses.

During Electrocoagulation, the destabilization of colloids is made further to the electrical field between electrodes and action of composite coagulants produced by oxidation of the anode.

Flotation is ameliorated by the training of the bubbles of gas during the electrolysis of solvent (water). The main reactions put into play for aluminium electrodes subjected to a direct current are the following:

- **Anodic reaction:** Metal is oxidized according to the reaction:

$$Al \longrightarrow Al^{3+} + 3e^-$$

Then, formation of the aluminium hydroxide:

$$Al^{3+} + 3H_2O \longrightarrow Al(OH)_3 + 3H^+$$

The formed entities, Al^{3+} and OH^- will react chemically to form the aluminium hydroxide, according to the reaction (4) following:

$$Al \quad + 3H_2O \longrightarrow Al(OH)_3 + 3H^+$$

The stability of the hydroxide form depends on the solution pH. The principal parameters influencing electrocoagulation are the pH and the medium conductivity.

- **Cathodic reaction: Water is reduced according to the reaction**

$$3H_2O + 3e^- \longrightarrow 3/2\ H_2 + 3\ OH^-$$

These metal hydroxides are insolvable and play the role of coagulant and react with subjects in suspension and/or colloids, were from elimination of pollutants. In general, for the cleanup of wastewater, they use aluminium or iron electrodes. However, an application of a very well brought up intensity of current draws away only an over consumption of electricity which is translated by the heating of the resolution accompanied by the reduction of the electrical resistance of middle.

5. EXPERIMENTAL

5.1. Experimental protocol

The experimental part aims primarily the treatment by electrocoagulation of the suspended matter is with water (aqueous solution) or of oil-base paint in the form of emulsion.

5.2. Composition of the solutions to be treated

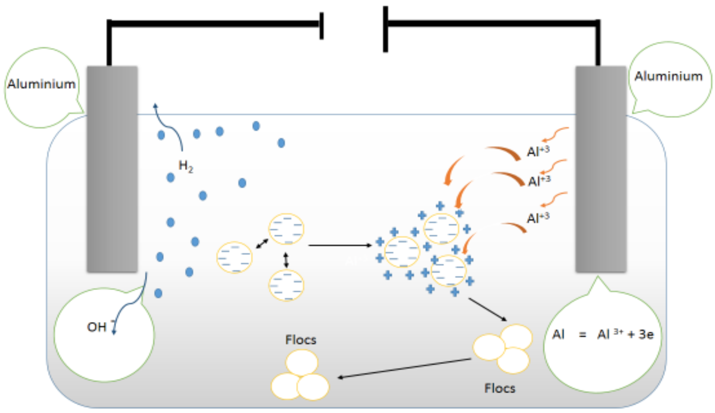
One on the other hand notes that the composition of painting corresponds in kind to that of the vehicles that with water corresponds to commercialized vinyl (table3).

Table3. Composition of paintings

	Painting	**Vinyl**
Composition	Binder: Nitro-Alkyd Pigment: Black Solvent: Aromatic, alcohol, Esters, ketone Additives: any other business	Binder Pigment Solvent: Water Additive

5.3. Experimental apparatus

The treatment of different resolutions made Electrocoagulation with the aid of the installation of introduced by the schema 1.



Schema1. Experimental apparatus

The used electro coagulator is a reactor filled with 800mL of the effluent to be treated and this in chosen surgical conditions provided with two aluminium electrodes. The volumes of useful resolutions are respectively 800mL and 600mL. Electrodes have dimensions (19.5cm-4cm-0.5cm) and the active surfaces are 24cm^2 and 34cm^2. An agitation of resolution is assured with the aid of a magnetic stirrer, and is supported constant during manipulation.

6. MATERIALS OF MEASUREMENT AND ANALYSIS

6.1. pH and conductivity

The pH of resolutions is regulated with resolutions of NaOH and HCl (1mole / L), so the conductivity of resolutions is followed with the aid of a conductimetre portray Hydrocheckmate Messzelle LM 302. The analysis is made on a sample of water the volume of which must be sufficient to plunge the sonde of the conductimetre.

The solution pH is controlled with solutions of NaOH and HCl (1mole/L), thus the solution conductivity is followed using a standard conductimeter Hydromat Messzelle LM 302.

6.2. Intensity of current and potential:

The intensity and the potential were measured by means of a millivoltmeter. Samples are prepared starting from various solutions effluents (vinyl, emulsion, and painting), the value of the intensity of current was measured in regular intervals (15 minutes).

6.3. TURBIDITY

The treatment of painting and some used emulsion is followed by the measure of turbidity with a turbidimiter of type WTW of model KAL. KIT P Turb 550 / 550IR.

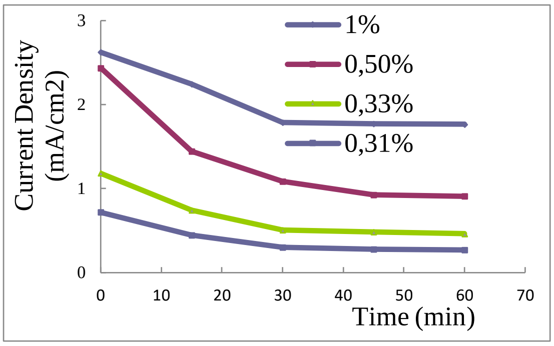
6.4. Methodology

After electrolysis, an adjustment of pH at 7 is considered. The importance of the influence of the pH on the performance of the electrochemical processes was highlighted. For this, we traced an objective in this part which consists in studying the impact of the initial pH on the kinetics of the solutions. We varied this one in a range from 2.5 to 5.5 by maintaining the other factors constant.

7. RESULTS AND INTERPRETATIONS

7.1. Vinyl - Water

After having finished with the pre-tests, we prepared our aqueous solutions vinyl water for various D1=1% dilutions; D2=0.5%; D3=0.33%; D4=0.31%. The tension work imposed is of 9Volts and surfaces it electrodes is of 34cm^2. With the same operating conditions that previously, the results are represented by the figures (1&2).



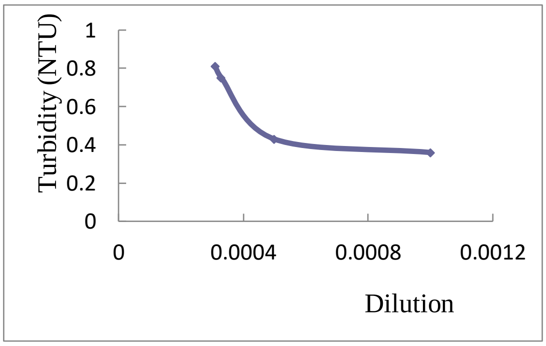


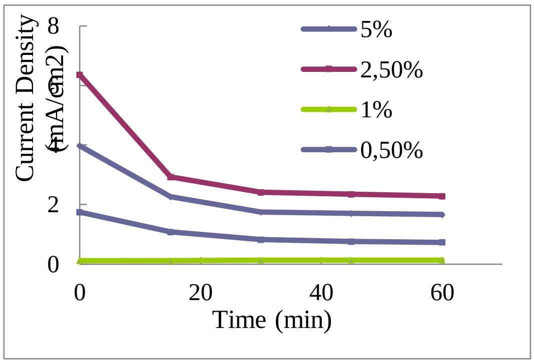
Fig.1. Electrolyse Vinyl-Water **Fig.2.** Evolution of turbidity Vinyl according to dilution

We notice that the shape of the curves is similar. It is about a reduction for finally reaching a stage. This last is reached more quickly for a dilution D1 (Dilution 1/100). This is explained by the insufficiency of the formation of the coagulant.

The presence of the stage is due to the stability of this formation. In the same way we note as turbidity is proportionally opposite with dilution due to the decantation of more or less the formed fast alumina hydroxides. Indeed, the quantity of MES is weak in the most diluted solution.

7-2. Painting-Thinner

The paint oil was diluted by different volumes from thinner, by always maintaining the same factors operational. For a surface of electrodes equal to $17.6cm^2$ and work tension of 10Volts, we obtained the results illustrated by the figures (3 and 4) which give the current density according to time and turbidity according to dilution.



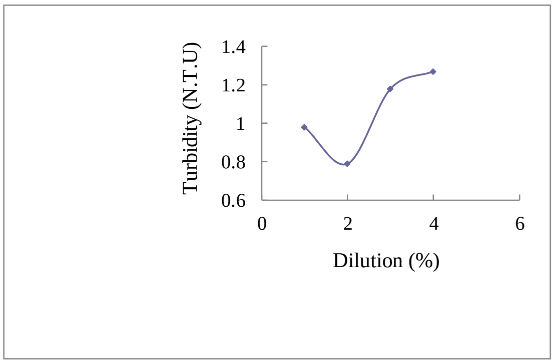


Fig.3. Electrolyse solution Painting-thinner **Fig.4.** Evolution of the painting turbidity according to dilution

We observe that the graphs have the same pace as the preceding case (vinyl), only that the stage is practically marked for all the solutions. Therefore, the quantity of coagulant is insufficient also in this case. But we noted the absence of the formation of the coagulant for the solution of dilution D3.

7.3. Emulsion (Thinner – Water)

The emulsion used during this part was prepared using the cellulose thinner. The emulsion results by mixing the thinner with water for various dilutions: 5%; 10%; 15% and 20%. For the preparation of the samples of 600ml of emulsion, we poured the volume of our thinner corresponding to the concentration indicated, in a recipient 1litre and we supplemented volume with distilled water. The solution undergoes a strong mechanical agitation during 5minutes. The tension imposed between the two aluminium electrodes of surface $S=24cm^2$ is of 3Volts. The results are represented by figures (5 and 6).

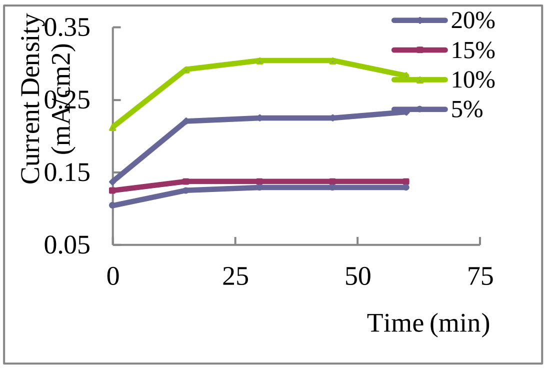


Fig.5. Electrolyse solution emulsion

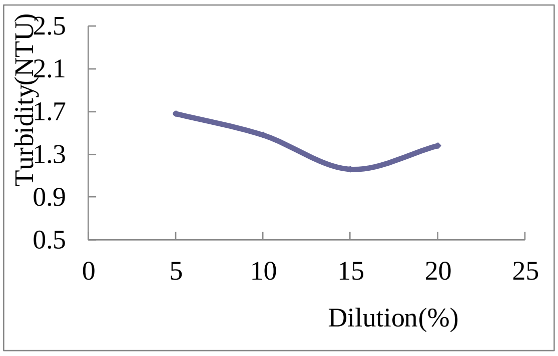


Fig.6. Evolution of turbidity emulsion

Contrary to the solutions of painting and vinyl, the currents density of emulsion (figure5), increase in the course of time. The stage was reached at the end of 15 minutes for all the solutions, but we notice a reduction in this density of current for the concentration of 10%; thus, a light increase for 20%. This enables us to deduce that dilution supports the formation of the coagulant to have a good decantation of MES particles. According to the figure6 of turbidity according to dilution, we note on the one hand a decrease from 5 to 15% what reflects a clearness of the solution, and other share a growth from 15 to 20%, this interprets a presence as of MES the solution.

8. CONCLUSION

In the light of these results, we can conclude that the effluents of painting to water or oil constitute an environmental constraint which appears by a rejection of emulsion where a coupling of treatment could reduce the degree of pollution.

Electrocoagulation makes it possible to break the emulsion by introducing an agent coagulant in ionic form without presence of its Co-ion. This technique will have to be the qualitative and quantitative mastery object in order to optimize the quantity of the coagulant in solution. In addition, the reactions concerned modify the pH consequently solution if precipitation is used, a rigorous control of the acid-basic character of the solution is essential.

The process with membrane under such conditions is also to use in order to eliminate the complex ions and the divalent and trivalent ions in particular.

Turbidity as parameter of pollution very marked in this type of effluent is studied. We can conclude for a few milliamperes from intensity of electrical current generated by an electric power from the order from ten volts allowed the reduction of the turbidity in a very effective way.

This work enabled us to put the light on the rejections of painting, their degree of pollution as well as the methods of treatments which can be considered.

The results are promising and to better determine the environmental aspect of this type of rejection our recommendations for the continuation of this work can be registered like the establishment of a diagnosis of the national industrial wastes, an installation of an electro coagulating pilot for the scale treatment great, and adapt the process to membrane in coupling with electrocoagulation.

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