# STUDY ON REMOVING COLOR AND TSS OF NAM SON LANDFILL LEACHATE BY ELECTROCOAGULATION PROCESS

*Đến tòa soạn 2-11-2018*

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## TÓM TẮT

## NGHIÊN CỨU KHẢ NĂNG LOẠI BỎ ĐỘ MÀU VÀ TỔNG CHẤT RẮN LƠ LỬNG TRONG NƯỚC RỈ RÁC NAM SƠN BẰNG PHƯƠNG PHÁP KEO TỤ ĐIỆN HÓA

*Dân số tăng nhanh đi kèm với quá trình đô thị là nguyên nhân chính tạo ra hàng triệu tấn chất thải rắn. Phương pháp phổ biến và thuận tiện nhất được lựa chọn tại hầu hết các nước đang phát triển để giải quyết vấn đề này là chôn lấp do chi phí cho công nghệ thấp và dễ dàng vận hành. Tuy nhiên, nước rỉ rác từ các ô chôn lấp lại là vấn đề khó khăn đối với các nhà khoa học cũng như các nhà quản lý môi trường do nồng độ các chất gây ô nhiễm cao. Trong bài nghiên cứu này, một hệ thống keo tụ điện hóa quy mô phòng thí nghiệm với tám điện cực sắt đã được thiết kế để khảo sát hiệu suất loại bỏ TSS và độ màu trong nước rỉ rác Nam Sơn. Một loạt các yếu tố ảnh hưởng: cường độ dòng điện, thời gian điện phân, pH ban đầu của nước thải và khoảng cách điện cực đã được nghiên cứu để đánh giá hiệu quả của quá trình xử lý. Kết quả cho thấy ở điều kiện tối ưu với cường độ dòng điện: 3A, thời gian điện phân: 60 phút, pH ban đầu của nước thải bãic hôn lấp: 8, khoảng cách điện cực: 1cm, hệ thống có thể loại bỏ khoảng 71,6% màu và 39,2% TSS trong nước rỉ rác.*
***Từ khóa:*** *Keo tụ điện hóa; nước rỉ rác Nam Sơn; điện cực sắt; TSS; độ màu.*

## 1. INTRODUCTION

Nam Son dumpsite – the biggest landfill in Northern Viet Nam that locates in Soc Son district and is about 50km far from Ha Noi city centre. The landfill is located in three communes Nam Son, Bac Son and Hong Ky with total area approximately 156 ha in 2017. Each day, this landfill receives about 4300 to 4500 tons solid waste that will release about 5200 $m^3$ leachate per day [1]. Actually, the capacity of the existing wastewater treatment plant in Nam Son dumpsite cannot meet the demand of the landfill.

Leachate is one of major issues with landfill that must be managed to prevent environmental pollution. It is harmful to environment since its composition contains various contaminants such as heavy metals, persistent organic pollutants [2]. The technology selection is based on the characteristic of wastewater. In fact, there are several methods that have been used to remove TSS and color from leachate such as chemical coagulation, biochemical coagulation… [3]. Even though, some of these methods are economical and easy to operate, they show some disadvantages such as generating secondary pollution and waste chemical substances [4].

Recently, the use of electrocoagulation (EC) for disposal of wastewater has gained popularity. In EC, differences current intensities are used to generate coagulants and flocculation that can eliminate colour, TSS in wastewater [5]. EC has been applied successfully for treating wastewater containing textile dyes [6], biodiesel [7], pharmaceuticals [8], and heavy metals [9]. The pollutants could removal by sedimentation as following equations [10]:

At anode:

$M_{(s)} \rightarrow M^{n+} + ne^-$ (1)

At cathode:

$2H_2O_{(l)} + 2e^- \rightarrow H_{2(g)} + 2OH^-$ (2)

In solution:

$M^{n+} + n\,OH^- \rightarrow M(OH)_n + nH^+$ (3)

Several researches on using of EC to remove TSS and colour in wastewater has been studied. Nguyen Xuan Hoang [11] has reported that pre-treatment of landfill leachate could remove 58.16% turbidity and 65.73% colour. Valante [12] showed that electrocoagulation with aluminium electrodes in treating wastewater from dairy industry could eliminate 92% TSS. Kherfan Sadeddin [13] has used EC to treat feed water. Removal efficiencies of total suspended solids TSS and turbidity were more than 99% and 98%. Mohammad Al-Shannag [14] also proved that this technology could remove 80% TSS from paper industrial wastewater. Base on all the literature reviews, there is a few researches on treatment of TSS and colour in leachate using EC. So, it is necessary to have more researches in this field.

## 2. MATERIALS AND METHOD

### 2.1. Materials

*Chemical Reagents*

The chemicals used in the study were NaOH (99.5%, Merck), $H_2SO_4$ (98%, Merck), and ultra-pure water.

*Leachate sample collection*

The wastewater used in this study was taken from Nam Son landfill in July, 2017 with a large amount and preserved in cold condition under 4ºC. Its main characteristics were as follows: TSS concentration of 1670 ± 50 mg/L, colour of 2560 ± 30 Pt-Co, pH of 8 ± 0.1.

### 2.2. Electrocoagulation system in laboratory

All experiments were carried out in a laboratory-built cell as shown in Figure 1. The experiments were performed at room temperature in a 2000 mL batch reactor (125 mm length, 100 mm width and 125 mm height). Electrodes were made of iron with dimension of 110 mm × 100 mm and installed in parallel. The magnetic stirrer was operated at speed of 200 rpms. The working volume of the electrolytic cell was 1800 mL. The 0.1 M $H_2SO_4$ and 0.1 M NaOH solutions were used for adjusting pH. Anodes and cathodes were connected to the outlets of a DC power supply model VSP4030 (B&K Precision, CA, US).

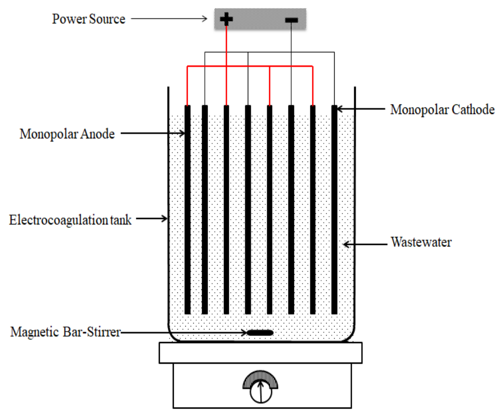


*Figure 1. Scheme of the EC system at laboratory scale*

### 2.3. Experimental procedure

The experiments to investigate effects of the several factors on removal of TSS and colour in landfill leachate by EC process were conducted at following conditions.

- Current intensities: 1, 2, 2.5, 3, 3.5, and 4A.
- Contact time: 10, 20, 30, 40, 60 and 80 minutes.
- Initial pH: 5, 6, 7, 8 and 9.
- Inter-electrodes distances: 1, 3, 5, 7 cm.

### 2.4. Apparatus and analytical procedures

Hana HI 991001 pH-meter (Hanna instruments Canada Inc.) was used to measurement pH values. The TSS concentration was analysed by standard method SMEWW 2540D:2012. Colour was analysed by optical measurement method according to TCVN 6185-2008 (ISO 7887-1994).

The removal efficiency was calculated by the following equation (4):

$$\% H_{removal} = \frac{A_o - A_t}{A_o} . 100\% \qquad (4)$$

Where $A_t$ and $A_o$ are the contaminants concentrations at time t and initial time.

## 3. RESULTS AND DISCUSSION

### 3.1. The current intensity and contact time effect

Contact time and current intensity were two sensitive operating parameters that affect to TSS and colour treatment ability of EC process. The relationship between them is shown in Fig.2 and Fig. 3.

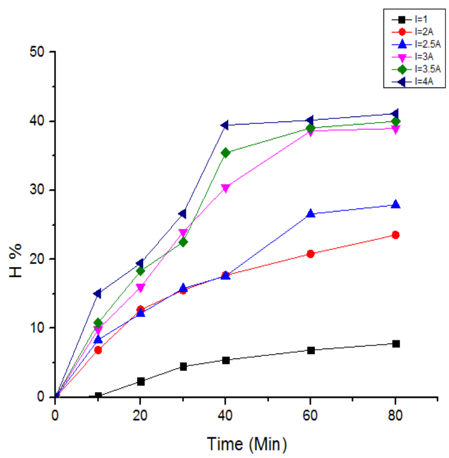


*Figure 2. Effect of current intensity and electrolysis time on TSS treatment (pH = 8, room temperature, d = 1cm)*

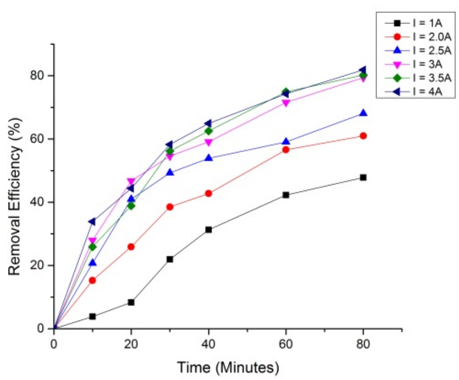


*Figure 3. Effect of current intensity and electrolysis time on colour treatment (I = 3A, room temperature, d = 1cm)*

Figure 2 and 3 illustrate that the amount of pollutants eliminated by EC process was proportionate to current intensity and operating time. This result associated to the amount of cation generated by dissolved reaction at the anode. This result is also fitting with the Faraday's law [15].

In detail, when current intensity changed from 1 A to 4A, the TSS and colour removal efficiencies increased dramatically from 6.85% to 41.1% and from 47.83 to 81.85, respectively. Actually, the leachate treatment efficiency by EC at the intensity of 3 and 4A were not considerably different. In addition, with current intensity of 3A the EC process worked more effectively in the first 60 min from 0 to 38.61% for TSS removal and from 0 to 71.59% for colour removal, after that this efficiency were nearly unchanged from 60 to 80 minutes. It can be explained that metal oxide film deposited on the surface of iron anodes hampered the reaction rate. This result was in agreement with the research of Alaadin A. Bukhari [5].

To reduce the energy consumption cost, the current intensity of 3A and electrolytic time for 60 min were recommended.

### 3.2. The pH effect

Another factor significantly influences EC process is pH. In order to examine its effect, the initial pH was adjusted in the range of 5 – 10. The effects of initial pH on TSS and colour removal efficiencies are shown in Figure 4.

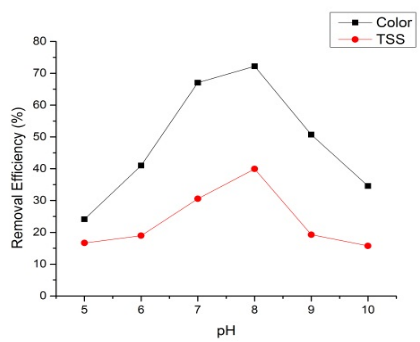


*Figure 4. Effect of initial pH on TSS and colour treatment, Fe electrode (electrolysis time 60 minutes, I = 3A, room temperature, d = 1cm)*

Fig.4 indicates that, at reaction time of 60 min, the highest removal efficiencies of 40.16 % and 72.7% for TSS and colour, respectively, were found at pH 8. When wastewater has acid characteristic, the amount of $OH^-$ at cathode decreases. That means, corrosion of iron electrode is also serious because of occurring metal hydrolysis reaction. These explain why at pH of 5 contaminates removal efficiencies for TSS and colour were only 13.44%, 24.99% respectively. In contrast, high $OH^-$ concentration leads to strong oxidation ability of oxygen that reacts with Fe on the electrode surface, resulting in and reduction of the contaminants removal ability. Actually, highest efficiencies of around 40.09% for TSS and 72.7% for colour can be achieved at neutral pH, because $Fe(OH)_3$ is stable, insoluble and available for pollutant adsorption from wastewater. The above results indicate that the optimal initial pH was 8.

### 3.3. The inter electrode distance effect

Effects of inter-electrode distance on TSS and colour removal by EC process were investigated at various inter-electrode distances of 1, 3, 5 and 7 cm. The results are shown in the Figure 5.

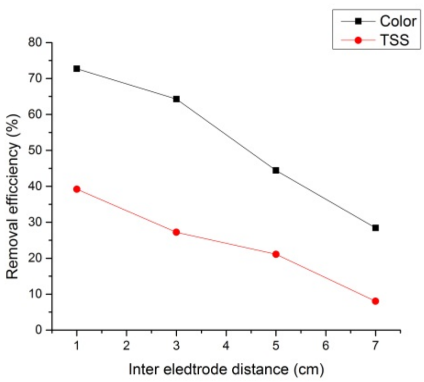


*Figure 5. Effect of inter-electrode distances on TSS and colour removal by EC process Fe electrode (electrolysis time 60 minutes, I = 3A, room temperature, d = 1cm)*

Figure 5 shows that TSS and colour removal efficiencies decreased with increasing inter-electrode distance from 39.2%to 8.02 % and from 72.72% to 28.44% respectively. In fact, when the inter-electrode distance increases, the resistance between the two electrodes increases, resulting in reducing iron oxidation rate at the anode. When the oxidation rate at the anode slows down, amount of cation at the anode also decreases. As the result, the rate of generation of ion metal and coagulants, decreases rapidly. So, it is beneficial to choose an optimum short inter-electrode distance of 1 cm to minimize energy consumption and increase the leachate treatment efficiency.

## 4. CONCLUSION

The results show that EC process could effectively treat TSS and colour in landfill leachate. When the current intensity and operating time increased, the TSS and colour removal efficiencies also increased. In the neutral environment, the TSS and colour removal efficiencies were higher than those in the acidic and basal media. Under the optimum condition with initials pH of 8, current intensity of 3A, and electrolysis time of 60 minutes EC process using iron electrodes could remove approximately 39.09% TSS and 71.6% colour.


**Acknowledgements**

This work was carried out with the equipment support from Institute of Environment Technology, VAST.


## REFERENCES


1. Nguyen Manh Khai., Hoang ThiQuynhTrang., (2012). “Chemical Precipitation of Ammonia and Phosphate from Nam Son Landfill Leachate, Hanoi ”, Iranica J. Energy & Environ., 3 Special Issue on Environmental Technology, pp.32-36.

2. Labanowski, J., Pallier, V., Feuillade-Cathalifaud, G., (2010). “Study of organic matter during coagulation and electrocoagulation processes: application to a stabilized landfill leachate”. J. Hazard. Mater. 179, pp.166 - 172.

3. Renou, S., Givaudan, J.G., Poulain, S., Dirassouyan, F., Moulin, P., (2008). ‘Land*fi*ll leachate treatment: review and opportunity”. J. Hazard. Mater. 150, pp.468 - 493.

4. Jeworski, M., Heinzle, E., (2000). “Combined chemical-biological treatment of

wastewater containing refractory pollutants". Biotechnol. Annu. Rev. 6, pp.163 - 196.

5. Alaadin A. Bukhari, (2008). "Investigation of the electro-coagulation treatment process for the removal of total suspended solids and turbidity from municipal wastewater", Bioresource Technology. 99, pp. 914 - 921.

6. Song, S., He, Z., Qiu, J., Xu, L., Chen, J., (2007). "Ozone assisted electrocoagulation for decolonization of C.I. Reactive Black 5 in aqueous solution: an investigation ofthe effect of operational parameters". Sep. Purif. Technol. 55, pp.238 - 24.

7. Chavalparit, O., Ongwandee, M., (2009). "Optimizing electrocoagulation process forthe treatment of biodiesel wastewater using response surface methodology". J. Environ. Sci. 21, pp.1491 - 1496.

8. Farhadi, S., Aminzadeh, B., Torabian, A., Khatibikamal, V., AlizadehFard, M., (2012). "Comparison of COD removal from pharmaceutical wastewater by electrocoagulation,photoelectrocoagulation, peroxielectrocoagulation and peroxiphotoelectrocoagulation processes". *J.* Hazard. Mater.pp.219 - 220, 35 - 42.

9. You, H.J., Han, I.S., (2016). "Effects of dissolved ions and natural organic matter on electrocoagulation of As(III) in groundwater". J. Environ. Chem. Eng. 4, pp.1008 - 1016.

10. Dia, O., Drogui, P., Buelna, G., Dube, R., Ihsen, B.S., (2017). "Electrocoagulation of biofiltrated landfill leachate". Fractionation Org. matter Influ. Anode Mater. 168, pp.1136 - 1141

11. Nguyen Xuan Hoang, Le Diep ThuyTrang, Ngo Thi Thy Truc, Le Hoang Viet, (2017) " Pre-treatment of landfill by electrocoagulation combined with Fenton-Ozone process". *Can Tho* University Journal of Science*,* pp.153 – 161.

12. Gerson de Freitas Silva Valente, Regina Célia Santos Mendonça., José Antônio Marques Pereira. (2015), The effciency of electrocoagulation using aluminium electrodes in treating wastewater from a dairy industry". Santa Maria Sept. vol 45.

13. KherfanSadeddin.,AlnaifNaser., AlloushFiras. (2011), "Removal of turbidity and suspended solids by electro-coagulation to improve feed water quality of reverse osmosis plant". Desalination 268, pp.204–207

14. Mohammad Al-Shannag., WalidLafi., K halid Bani-Melhem., FawziGharagheer and OqlahDhaimat. (2012), "Reduction of COD and TSS from Paper IndustriesWastewater using Electro-Coagulation and ChemicalCoagulation" Separation Science and Technology, 47: pp.700 - 708.

15. Li X., Song J., Guo J., Wang Z. and Feng Q. (2011). "Landfill leachate treatment using electrocoagulation". Procedia Environmental Sciences, 10, pp.1159 - 1164.