

z z z

COD

m.malakootian@yahoo.com

y/y / : y/y / :

COD

Reactive Blue 19

reactive Blue 19

Fe²⁺

COD

COD

j Çimin

éçç mg/L

êç v

èçç mg/L

éçv

ñèçç

pH II

y# mg/L

COD

COD ñ

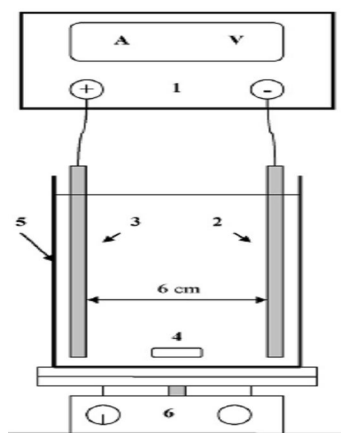
Reactive Blue19

Reactive Blue19

!
!
!

Anthraquinone
 (COD
 Fe²⁺
 pH
 H₂O₂
 CO₂
 E⁰ = 2.87 V
 E⁰ = 3.06 V
 (RB19)

| | |
|--|--|
| Methylene Blue | H_2O_2 |
| | Fe^{2+} |
| | Fe^{3+} |
| () | () |
| " fl | $\text{O}_2\text{H}_2 \rightarrow \text{O}_2 + 4\text{H}^+ + 4\text{e}^-$ (è) |
| RB19 | $\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{O}_2\text{H}_2$ (è) |
| RB19 | $\text{Fe}^{3+} + \text{e}^- \rightarrow \text{Fe}^{2+}$ (è) |
| RB19 fl | $\text{Fe}^{2+} + \text{O}_2\text{H}_2 \rightarrow \text{Fe}^{3+} + \text{OH}^0 + \text{OH}^-$ () |
| " fl | fl |
| | H_2O_2 |
| COD | fl |
| " COD | fl |
| | Fe^{2+} H_2O_2 |
| | () |
| ml | mercury pool |
| | (gas-diffusion electrode) |
| cm cm mm | " |
| DC power | () H_2O_2 |
| " | / V |
| " | pH |
| (Philips Model) Spectrophotometer UV-Vis | " |
| pH pH PU 8740 | Fe^{2+} |
| COD " fl | () |
| (Hunna instrument) COD | |
| Excel | |
| NaOH H_2SO_4 pH " | fl |
| " M | () Methyl Red () Acid Yellow 36 |
| Merck | fl) Acid red 14 fl) Reactive black 5 |
| " Dystar | Chlobromuron |
| fl pH | TOC fl propham fl |
| | ! fl |
| | " fl) diuron fl |



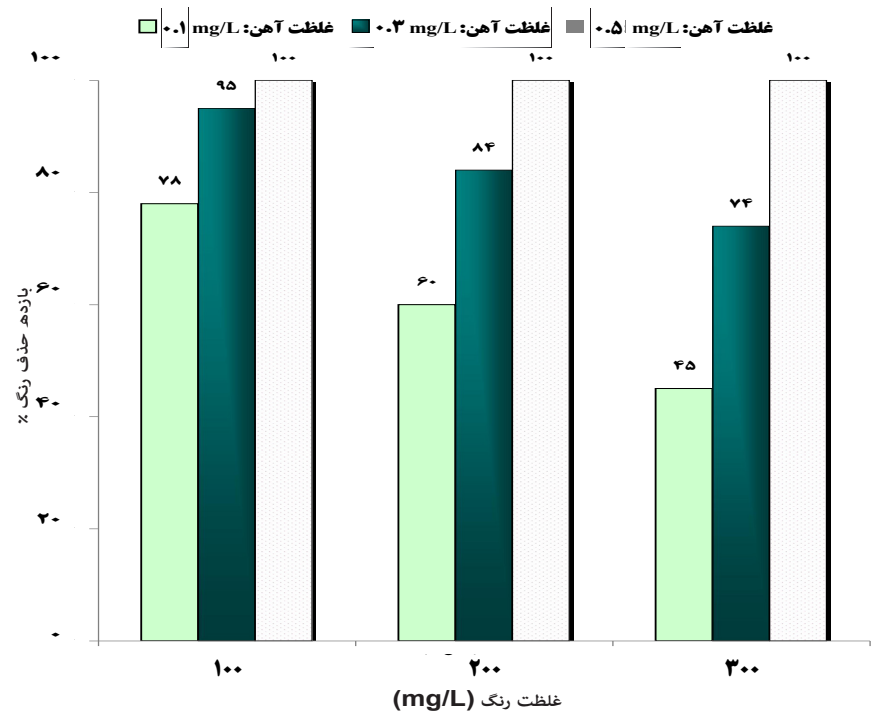
.....
 fl L
 fl L

.....

 pH

.....

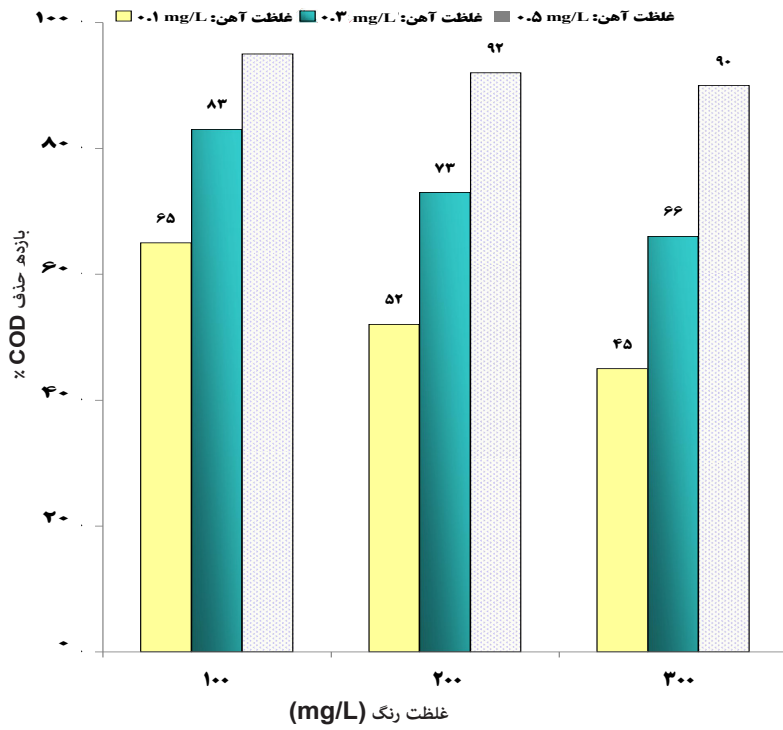
 pH



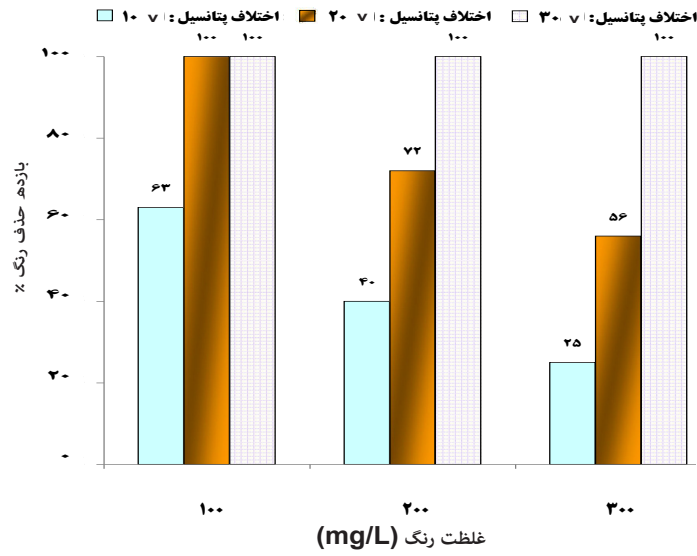
.....
 (.....)

 pH= min

COD" nm
 COD " nm
 COD " nm
 " L
 Fe²⁺ " nm
 Na₂SO₄ L mol
 Fe²⁺ nm
 pH= | min COD
 " | mg/L



COD (| mg/L | pH= | min | L



(\bar{y} \bar{y} \bar{y} mg/L) \bar{y} mg/L $\text{pH} = \bar{y} \bar{y} \text{ min}$ \bar{y}

\bar{y} mg/L

\bar{y} COD

COD

COD

\bar{y} mg/L

$\text{pH} = \bar{y} \bar{y} \text{ min}$

\bar{y} mg/L

" \bar{y} \bar{y} \bar{y} mg/L

\bar{y} mg/L

COD

\bar{y} \bar{y} mg/L

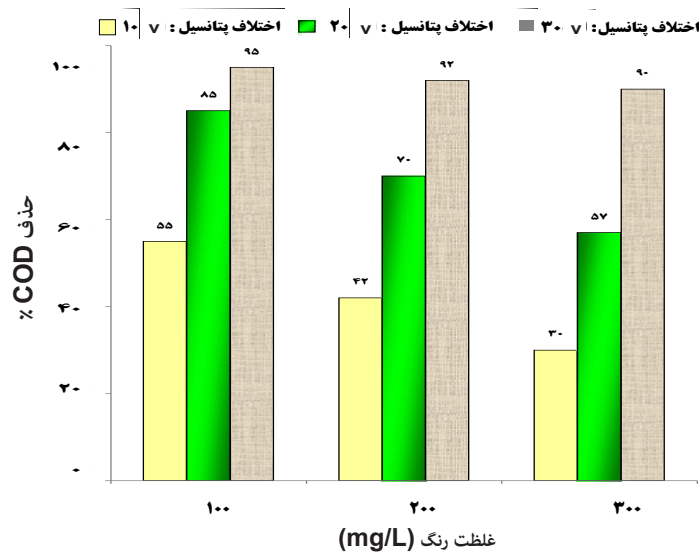
\bar{y} \bar{y} mg/L

COD

\bar{y} mL

COD \bar{y}

\bar{y}



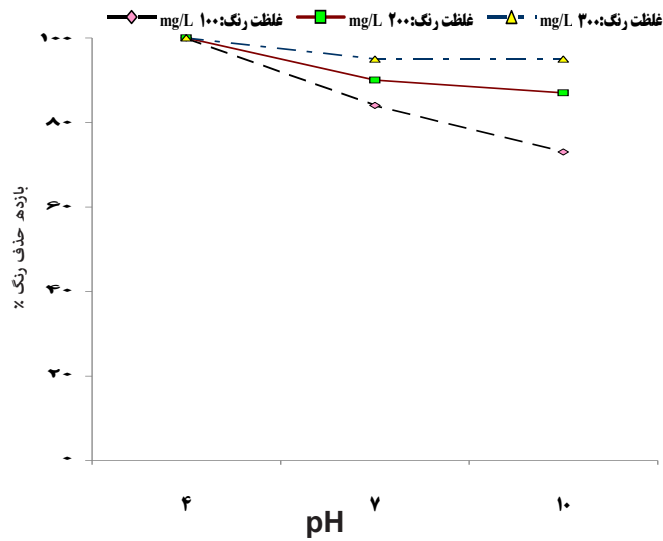
COD

(\bar{y} \bar{y} \bar{y} mg/L)

\bar{y} mg/L

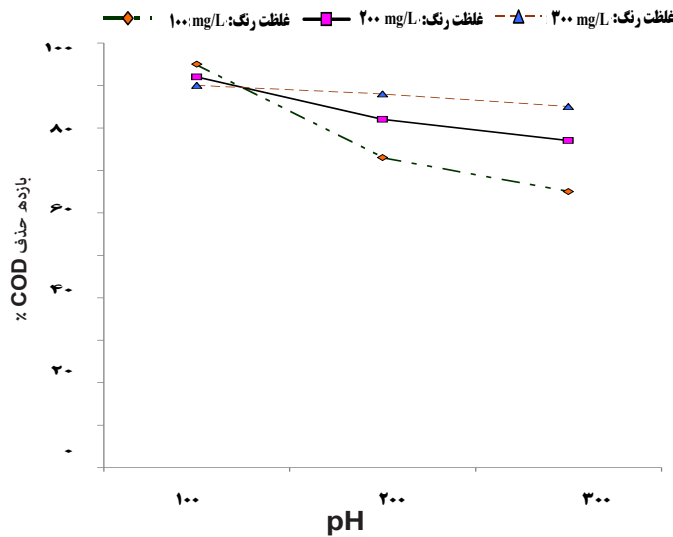
$\text{pH} = \bar{y} \bar{y} \text{ min}$

\bar{y}

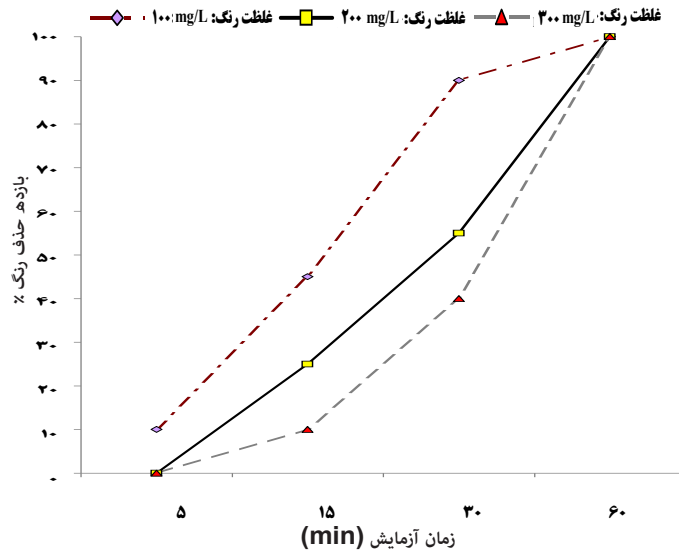


شکل ۱: درصد حذف رنگ در برابر تغییرات pH برای غلظت‌های مختلف رنگ (۱۰۰، ۲۰۰، ۳۰۰ mg/L)

در این آزمایش، تغییرات pH در محدوده ۴ تا ۱۰ مورد بررسی قرار گرفت. نتایج نشان داد که با افزایش pH، درصد حذف رنگ در تمام غلظت‌ها کاهش می‌یابد. این امر می‌تواند به دلیل تشکیل گونه‌های یونی رنگ در pH بالاتر است. همچنین، در pH=۷، درصد حذف رنگ برای غلظت ۲۰۰ mg/L بیشترین مقدار را نشان داد. نتایج مشابهی در مورد تغییرات COD نیز مشاهده شد. در pH=۷، درصد حذف COD برای غلظت ۲۰۰ mg/L بیشترین مقدار را نشان داد. این یافته‌ها نشان می‌دهد که pH عامل مؤثری در حذف رنگ و COD است.



شکل ۲: درصد حذف COD در برابر تغییرات pH برای غلظت‌های مختلف رنگ (۱۰۰، ۲۰۰، ۳۰۰ mg/L)



(\bar{y}_i \bar{y}_i \bar{y}_i mg/L \bar{y} mg/L i \bar{y}_v pH= L

\bar{n} \bar{y} \bar{y}_{min}

\bar{y}_{min}

COD

COD

\bar{y} V

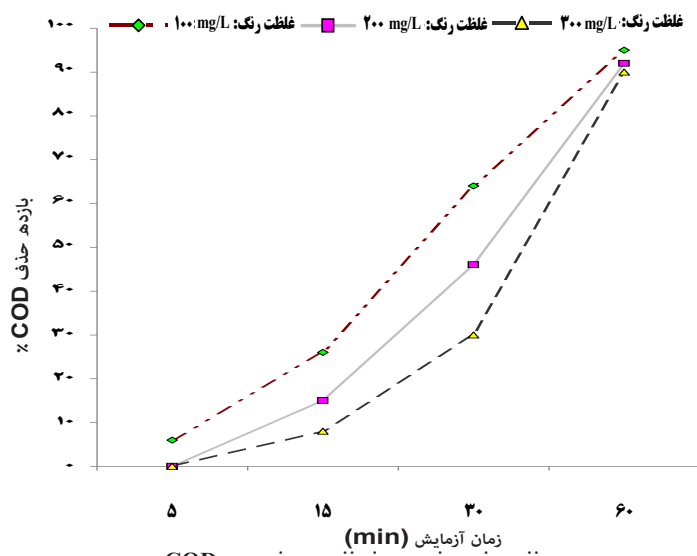
pH=

\bar{y}_i \bar{y}_i \bar{y}_i mg/L

\bar{y} mg/L

min

RB19



(\bar{y}_i \bar{y}_i \bar{y}_i mg/L \bar{y} \bar{y} /mg/L i \bar{y}_v pH=)

| | | | |
|--------------------|-----------|---|-----------------------------------|
| Reactive Black5 | chiou | | |
| pH | | | COD |
| | pH | " | COD |
| pH | pH | | |
| "fl L | | | |
| | | " | |
| | "fl L | | |
| (ymg/L | | | |
| min | | | |
| n y | pH | "fl L | |
| y min | fl ymg/L) | pH | " |
| zhou | " | | |
| Methyl Red | | " | |
| | | H ₂ O ₂ | Fe(OH) ²⁺ / pH |
| "fl L | | | |
| Acid Yellow 36 | Gonzalez | " | OH ⁰ |
| | | | |
| "fl L | n min | (H ₃ O ₂ ⁺ L | fl L |
| | | H ₂ O ₂ | |
| | " | OH ⁰ | |
| | | pH | "fl L |
| | | Fe(OH) ₃ | Fe ³⁺ Fe ²⁺ |
| | | " | |
| | | " | |
| "fl yL | | H ₂ O ₂ | pH |
| COD | | (L | |
| y min | | pH | pH |
| " | n y! n y | | " |
| | | pH | pH COD |
| | " | | |
| Fe ²⁺ " | | Reactive Blue 19 | |
| " | | Methyl Red | zhou |
| | | "fl L | |

6. Hsieh LL, Kang HJ, Shyu HL. Optimization of a ultrasound-assisted nanoscale Fe/Fenton process for dye wastewater through a statistical experiment design method. *Environmental Informatics Archives*. 2007;5:664-73.
7. Ghaneian M, Ehrampoush MH, Ghanizadeh Gh, Dehvary M, Abootoraby M, Jasemizad T. Application of solar irradiation / $K_2S_2O_8$ photochemical oxidation process for the removal of Reactive Blue 19 dye from Aqueous Solutions. *Iranian Journal of Health and Environment*. 2010;3(2):165-76 (in Persian).
8. Wang C, Hu JL, Chou WL, Kuo YM. Removal of color from real dyeing wastewater by Electro-Fenton technology using a three-dimensional graphite cathode. *Journal of Hazardous Materials*. 2008;152(2):601-606.
9. Martinez SS, Bahena CL. Chlorbromuron urea herbicide by electro-Fenton reaction in aqueous effluents. *Water Research*. 2009;43(1):33-40.
10. Ozcan A, Sahin Y, Koparal AS, Oturan MA. A comparative study on the efficiency electro-Fenton process in the removal of prothiam from water. *Applied Catalysis B: Environmental*. 2009;89(3-4):620-6.
11. Virkutyte J, Jegatheesan V. Electro-Fenton, hydrogenotrophic and Fe^{+2} ions mediated TOC and nitrate removal from aquaculture system: Different experimental strategies. *Bioresource Technology*. 2009;100(7):1289-97.
12. Zhang H, Fei C, Zhang D, Tang F. Degradation of 4-nitrophenol in aqueous medium by electro-Fenton method. *Journal of Hazardous Materials*. 2007;145(1-2):227-32.
13. Pimentel M, Oturan N, Dezotti M, Oturan MA. Phenol degradation by advanced electrochemical oxidation process electro-Fenton using a carbon felt cathode. *Applied Catalysis B: Environmental*. 2008; 83(1-2): 140-49.
14. Oturan N, Trajkovska S, Oturan MA, Couderchet M, Aaron JJ. Study of the toxicity of diuron and its metabolites formed in aqueous medium during application of the electrochemical advanced oxidation process electro-Fenton. *Chemosphere*. 2008;73(9):1550-56.
15. Rajkumar D, Song BJ, Kim JG. Electrochemical degradation of Reactive Blue 19 in chlorid medium for the treatment of textile dyeing wastewater with identification of intermediate compounds. *Dyes and Pigments*. 2007;72(1):1-7.
16. Panizza M, Cerisola G. Electro-Fenton degradation of synthetic dyes. *Water Research*. 2009;43(2):339-44.
17. Chiou CS, Chang C, Shie JL, Liu CC, Li YS. Decoloration of reactive Black 5 in aqueous solution by electro-Fenton reaction. *Journal of Environmental Engineering and Management*. 2006;16(4):243-48.
18. Wang A, Qu J, Ru J, Liu H, Ge J. Mineralization of an Azo dye Acid red 14 by electro-Fenton's reagent using an activated carbon fiber cathode. *Dyes and Pigments*. 2005;65(3):227-33.
19. Ghanizadeh Gh, Asgari G. Removal of Methylene Blue dye from synthetic wastewater with bone char. *Iranian Journal of Health and Environment*. 2009;2(2):104-13 (in Persian).
20. Masombaigi H, Rezaee A, Nasiri A. Photocatalytic degradation of Methylene Blue using ZnO nano-particles. *Iranian Journal of Health and Environment*. 2009;2(2):188-95 (in Persian).
21. Naddafi K, Nabizadeh Nodehi R, Jahangiri rad M. Removal of Reactive Blue 29 dye from Water by single-Wall carbon nanotubes. *Iranian Journal of Health and Environment*. 2011;3(4):359-68 (in Persian).
22. Maleki A. Comparison of photolysis and sonolysis processes for degradation of Reactive Red 198. *Iranian Journal of Health and Environment*. 2010;3(2):153-64 (in Persian).
23. Mehrali SH, Alavi moghaddam MR, Hashemi SH. Removal of Reactive Blue 19 by adding polyaluminum chloride to sequencing batch reactor System. *Iranian Journal of Environmental Health Science & Engineering*. 2010;7(1):63-70.
24. APHA, AWWA, WEF. *Standard Methods for the Examination of Waters and Wastewaters*. 21st ed. Washington, DC: American Public Health Association (APHA); 2005.

Evaluation of Electro-Fenton Process Performance for COD and Reactive Blue 19 Removal from Aqueous Solution

***Mohammad Malakootian¹, Mahdi Asadi¹, Amir Hossein Mahvi²**

¹Department of Environmental Health Engineering, School of public Health and Environmental Research Center, Kerman University of Medical Science, Kerman, Iran

²Department of Environmental Health Engineering, School of public Health, Tehran University of Medical Science, Tehran, Iran

Received: 06 April 2011 ; Accepted: 18 June 2012

ABSTRACT

Background and Objectives: Synthetic dyes represent one of the largest groups of pollutants in wastewater of dyeing industries. Discharging these wastewaters into receiving streams not only affects the aesthetic but also reduces photosynthetic activity. Electrochemical advanced oxidation processes such as Electro-Fenton process are low operational and have high mineralization degree of pollutants. In this study, we investigated affective factors in this process to determine the optimum conditions for dye and COD removal from aqueous solutions containing Reactive Blue 19 dye.

Materials and Methods: Synthetic samples containing Reactive Blue 19 dye were prepared by dissolving dye powder in double distilled water. and the the solution prepared was transferred into pilot electrochemical cell having two anode and cathode electrode made of iron and carbon. Electro-Fenton process was began by adding of Fe²⁺ ions and establishing electrical potential difference. After testing and at specified time intervals, each sample was collected from the pilot cell, and process performance was evaluated through measuring dye concentration and COD.

Results: Based on the results obtained, optimum conditions of Electro-Fenton process for dye and COD removal was determined. Accordingly, potential difference of 20 volt for dye concentration up to 100 mg/L and potential difference of 30 volt for dye concentration of more than 200 mg/L, reaction time 60 minutes, 0.5 mg/L of Fe²⁺ concentration and suitable pH for the maximum dye removal efficiency equaled 4 respectively. Under such conditions, the dye and COD removal was 100 and 95% respectively.

Conclusion: Based on the results obtained, it was revealed that Electro-Fenton process has significant ability in not only dye removal but also in COD removal. Accordingly, it was found that the effective parameters in Electro-Fenton process for removal Reactive Blue19 dye are electric potential difference, concentration of iron ions and electrolysis time.

Keywords: Electro-Fenton process, Avanced oxidation, Reactive Blue19 dye, Electrical Potential difference

*Corresponding Author: m.malakootian@yahoo.com

Tel: +98 341 3205074 , Fax: +98 341 3205128