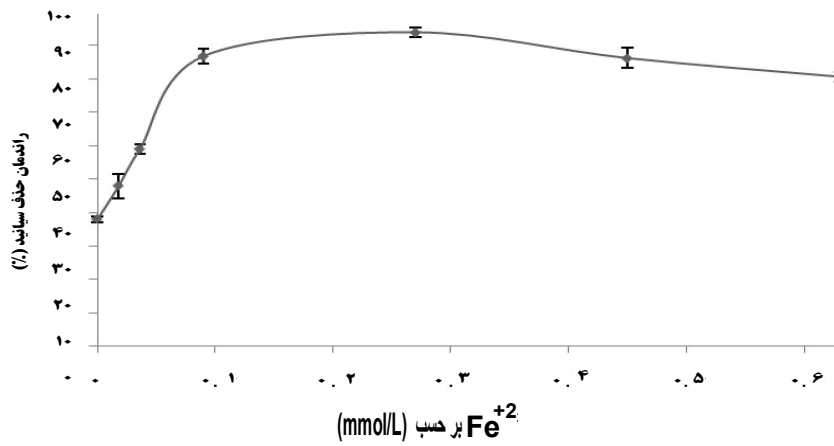






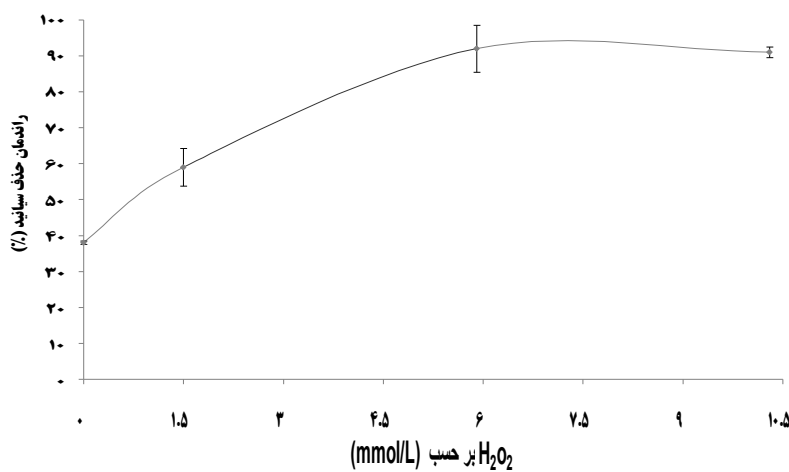
$\text{Fe}^{2+} = \frac{\text{mmol}}{\text{L}}$   $\text{Fe}^{2+} / \text{H}_2\text{O}_2 = \frac{\text{mmol}}{\text{L}}$   
 pH  
 Fe<sup>2+</sup> one factor at a time  
 mmol H<sub>2</sub>O<sub>2</sub> - mmol  
 min  
 (CECIL-model 7100) vis-uv  
 nm  
 4500-E - CN  
 ( L  
 Merck  
 Excel  
 Fe<sup>2+</sup> / H<sub>2</sub>O<sub>2</sub> pH  
 pH  
 mg/L  
 mg/L  
 mmol/L  
 L  
 mmol  
 pH  
 pH  
 pH =  
 ! N





( $\text{H}_2\text{O}_2 = 1 \text{ mmol/L}$  |  $\text{pH} = 5$  |  $\text{Fe}^{2+} = 1 \text{ mmol}$ )

در این مطالعه، درصد حذف یون  $\text{Fe}^{2+}$  با تغییر غلظت آن در محلول بررسی شد. نتایج نشان داد که درصد حذف با افزایش غلظت  $\text{Fe}^{2+}$  تا حدی افزایش می‌یابد و سپس کمی کاهش می‌یابد. این رفتار می‌تواند به دلیل اشباع شدن سایت‌های فعال یا تغییر در دینامیک واکنش باشد. همچنین، در این شرایط، غلظت  $\text{H}_2\text{O}_2$  برابر با  $1 \text{ mmol/L}$  و pH برابر با  $5$  در نظر گرفته شد. این نتایج نشان می‌دهد که در این شرایط، درصد حذف  $\text{Fe}^{2+}$  به طور قابل توجهی افزایش یافته است.



( $\text{Fe}^{2+} = 1 \text{ mM/L}$  |  $\text{pH} = 5$  |  $\text{Fe}^{2+} = 1 \text{ mmol}$ )



ی/ی ی فل )ی/ ( ) ی/ی ( ) ی/ ( ) ی/ ی/ ( ) ی/

" Fe<sup>2+</sup> /H<sub>2</sub>O<sub>2</sub> < i ymin

ñ y

yy Lipczynska fl )

Kavitha " mmol

fl L ymin

" H<sub>2</sub>O<sub>2</sub> ç

ñ ç ðé ç/ mM H<sub>2</sub>O<sub>2</sub> :CN

mmol/L (H<sub>2</sub>O<sub>2</sub>:CN) = è mg/L çmin (Fe<sup>2+</sup>L y/

Masahafi " (H<sub>2</sub>O<sub>2</sub>:CN) =

mg/L èçmin éç mg/L (é L

= y/ mmol/L pH= ç/ mmol/L Fe<sup>2+</sup> / H<sub>2</sub>O<sub>2</sub> = y/ y ) H<sub>2</sub>O<sub>2</sub> = / mmol/L iFe<sup>2+</sup>

ñ çmin

ç/ mmol ñ ç ðé ç/

Fe<sup>2+</sup> pH = L pH fl L

pH ( L Fe<sup>2+</sup> pH

OH<sup>0</sup> H<sup>+</sup> H<sub>2</sub>O<sub>2</sub> fl L OH<sup>0</sup>

Fe<sup>2+</sup> / H<sub>2</sub>O<sub>2</sub> = y/ y

H<sub>2</sub>O<sub>2</sub> Fe<sup>2+</sup> "

( L Fe<sup>2+</sup> + H<sub>2</sub>O<sub>2</sub> → Fe<sup>3+</sup> + OH<sup>0</sup> + OH<sup>-</sup> ( )

Ly/ y Fe<sup>2+</sup> /H<sub>2</sub>O<sub>2</sub> " fl

:( L Fe<sup>2+</sup> + OH<sup>0</sup> → Fe<sup>3+</sup> + OH<sup>-</sup> ( )

Fe<sup>2+</sup> / H<sub>2</sub>O<sub>2</sub> < Neyens

y/ mmolL fl L fl

" y/ mmol

Fe<sup>2+</sup> /H<sub>2</sub>O<sub>2</sub> y/ / mmol/L y/ y

H<sub>2</sub>O<sub>2</sub> ( L

2H<sub>2</sub>O<sub>2</sub> → 2H<sub>2</sub>O + O<sub>2</sub> ( )

H<sub>2</sub>O<sub>2</sub> + OH<sup>0</sup> → H<sub>2</sub>O + HO<sub>2</sub><sup>0</sup> ( ) Fe<sup>2+</sup> /H<sub>2</sub>O<sub>2</sub>





- Fenton's oxidation, ozone and coagulation-flocculation processes. *Water Research*. 2005;39(6):1147-53.
11. Farrokhi M, Kouti M, Mousavi GR, Takdastan A. The study on Biodegradability Enhancement of landfill leachate by Fenton oxidation. *Iranian Journal of Health and Environment*. 2009;2(2):114-23.
  12. Neyens E, Baeyens J. A review of classic Fenton's peroxidation as an advanced oxidation technique. *Journal of Hazardous Materials*. 2003;98(1-3):33-50.
  13. Lipczynska-Kochany E, Kochany J. Effect of humic substances on the Fenton treatment of wastewater at acidic and neutral pH. *Chemosphere*. 2008;73(5):745-50.
  14. Kavitha V, Palanivelu K. The role of ferrous ion in Fenton and photo-Fenton processes for the degradation of phenol. *Chemosphere*. 2004;55(9):1235-43.
  15. Shayegan J, Nodel T, Shams Natri N, editors. Using Fenton in hazardous industrial wastewater treatment. Proceedings of the 4th Conference of Industries and Mines R&D Centers; 2003; Tehran, Iran.
  16. Chen S, Sun D, Chung J. Treatment of pesticide wastewater by moving-bed biofilm reactor combined with Fenton-coagulation pretreatment. *Journal of Hazardous Materials*. 2007;144(1-2):577-84.
  17. Papadimitriou CA, Samaras P, Sakellariopoulos GP. Comparative study of phenol and cyanide containing wastewater in CSTR and SBR activated sludge reactors. *Bioresource technology*. 2009;100(1):31-7.
  18. APHA, AWWA, WEF. Standard Methods for the Examination of Water and Wastewater, 21st ed. Washington DC: American Public Health Association (APHA); 2005.
  19. Kušić H, Koprivanac N, Božić AL, Selanec I. Photo-assisted Fenton type processes for the degradation of phenol: A kinetic study. *Journal of Hazardous Materials*. 2006;136(3):632-44.
  20. Logsdon MJ, Hagelstein K, Mudder T. The management of cyanide in gold extraction. Pennsylvania: International Council on Metals and the Environment; 1999.
  21. Young CA, Jordan TS. Cyanide remediation: current and past technologies. Proceedings of the 10th Annual Conference on Hazardous Waste Research; 1995; Manhattan, United State.
  22. Rodrigues C, Madeira L, Boaventura R. Optimization of the azo dye Procion Red H-EXL degradation by Fenton's reagent using experimental design. *Journal of Hazardous Materials*. 2009;164(2-3):987-94.
  23. Barbusiński K, Majewski J. Discoloration of Azo Dye Acid Red 18 by Fenton reagent in the presence of iron powder. *Polish Journal of Environmental Studies*. 2003;12(2):151-5.
  24. Jozwiak WK, Mitros M, Kaluzna-Czaplinska J, Tosik R. Oxidative decomposition of Acid Brown 159 Dye in aqueous solution by H<sub>2</sub>O<sub>2</sub>/Fe<sup>2+</sup> and ozone with GC/MS analysis. *Dyes and Pigments*. 2007;74(1):9-16.
  25. Yoo KW, Seo H. Chemical oxidation of Cu - and CN- Contained Wastewater. *Clean Technolgy*. 1999;5(1):20-9.
  26. Masahafi Z, Akbari M, Khoei M, etal. Cyanide oxidation in heat processing units effluent using hydrogen peroxide and catalyst. *Journal of Amirkabir*. 2006;65:79-82.

## **The Study of Fenton Performance in Removal of Cyanide from Aqueous Solution**

**Somayeh Golbaz<sup>1</sup>, \*Ahmad Jonidi Jafari<sup>2</sup>, Roshanak Rezaei Kalantari<sup>3</sup>**

<sup>1</sup>Department of Environmental Health, Faculty of Health, Alborz University of Medical Sciences, Alborz, Iran

<sup>2</sup>Department of Environmental health Engineering, School of Medical Sciences, Tarbiat Modares University, Tehran, Iran

<sup>3</sup>Department of Environmental Health, Faculty of Health, Tehran University of Medical Sciences, Tehran, Iran

Received; 18 July 2011 Accepted; 16 October 2011

### **ABSTRACT**

**Background and Objectives:** Cyanide is a toxic pollutant existing in the various industrial effluents such as iron and steel, coal mining, non-ferrous metals manufacturing and metal plating. Its presence in water resources and wastewater, as serious hazardous substances leads to undesirable effects on both the environment and human. Thus, its concentration control is essential for human health. The main goal of this study was to evaluate Fenton process efficiency in cyanide removal from aqueous solution.

**Materials and Methods:** This is an experimental study Conducted at Lab scale in a batch system. We investigated effect of different variables including; pH, mole ratio of  $\text{Fe}^{2+}/\text{H}_2\text{O}_2$ , contact time, and initial concentration of cyanide. Data were analyzed using Excel software.

**Results:** We found that cyanide with initial concentrations of 0.4 mM/L was reduced by 92 %. This removal result was related to oxidizing agent of hydroxyl radicals under optimum conditions including; pH = 4, molar ratio  $\text{Fe}^{2+}/\text{H}_2\text{O}_2 = 0.046$  ( $\text{Fe}^{2+} = 0.27$  mM/L) after 60 min reaction time. An increase in reaction time was not improved cyanide removal efficiency. Moreover, the Fenton process efficiency in cyanide removal decreased from 92 to 60 %, by increasing the initial cyanide concentration from 0.4 to 0.6 mM/L.

**Conclusion:** It can be concluded that Fenton oxidation Process can be considered as a suitable alternative for cyanide removal to achieve environmental standards.

**Keywords:** Advanced oxidation, Hydrogen peroxide, Fenton, Wastewater treatment, Cyanide

---

\*Corresponding Author: [a.jonidi@modares.ac.ir](mailto:a.jonidi@modares.ac.ir)

Tel: +98 21 883563 Fax: +98 21 82883825