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NaCl

min cm g/L

min cm g/L

COD

$$R+XH_2O \rightarrow RO_x + 2XH^+ + 2Xe^-$$

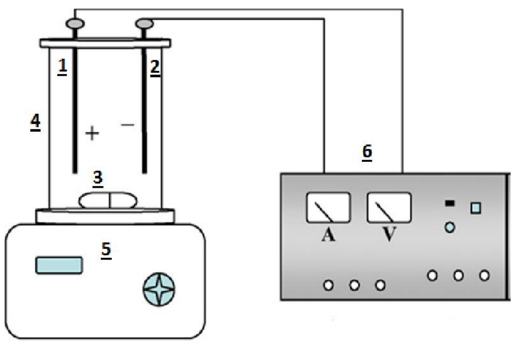
$$R+XH_2O \rightarrow RO_x+1/2CO_2+2XH^++2Xe^-$$

$$Co_x\,(OH^0) \rightarrow CO_x+1/2\,O_2 + H^+$$

$$CO_{x+1} \rightarrow CO_x+1/2\,O_2$$

$$2R+Co_x\,(OH^0) \rightarrow \tfrac{1}{2}\,ROO + H^+ + e^- + CO_x$$

$$CO_x + R \rightarrow CO_x + RO$$



[illegible]

[illegible]

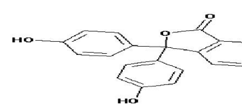
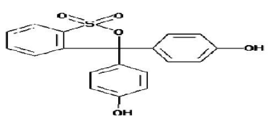
[illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

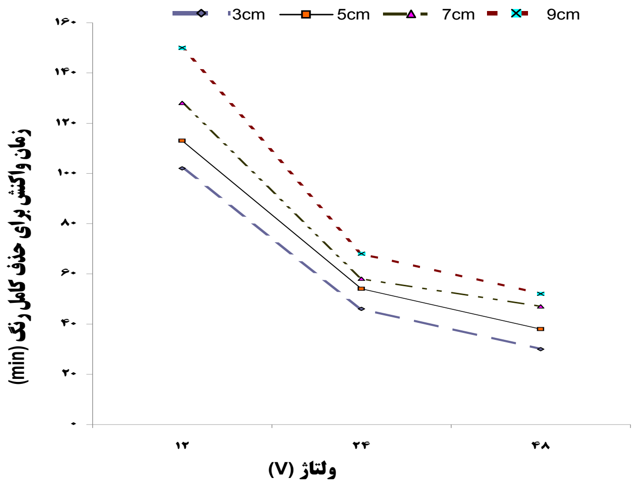
[illegible]

[illegible] [illegible] (Phenolphthalein) [illegible] g) [illegible] $C_{20}H_{14}O_4$ [illegible] mL [illegible] (Phenol red) [illegible] g [illegible] $C_{19}H_{14}O_5S$ [illegible]

[illegible] cm [illegible] cm [illegible] pH [illegible] NaOH [illegible] mL [illegible] V) [illegible] cm) [illegible] g/L) NaCl [illegible]

[illegible]

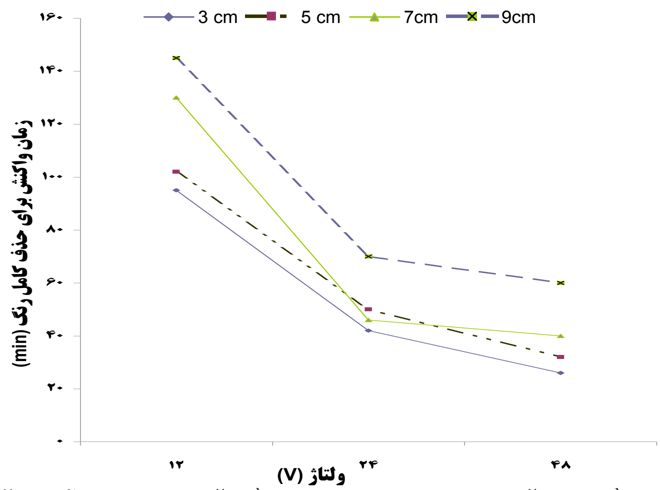
وزن مولکولی (g/mol)	ماکزیمم طول موج (nm)	گروه شیمیایی	ساختمان شیمیایی	ماده رنگ‌زا
۳۱۸/۳۲	۵۵۲	هیدروکسیل تری آریل متان		فنل فتالئین
۳۵۴/۳۹	۴۳۱	تری آریل متان		فنل رد



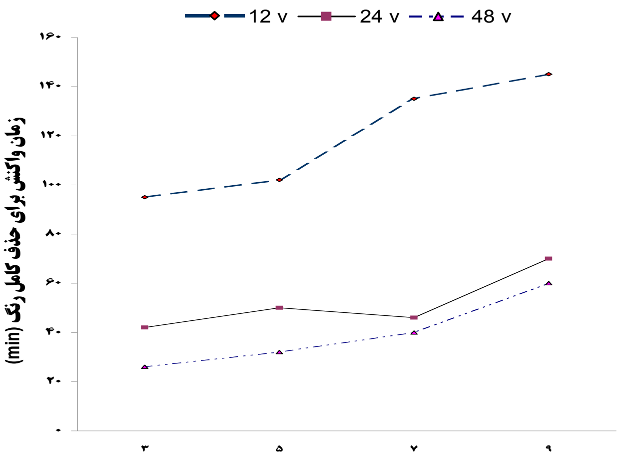
[illegible] cm [illegible]

[illegible] pH) [illegible] COD [illegible] Corning 120 [illegible] pH [illegible] Open Reflux-Colorimetric-5220B [illegible] nm [illegible] DR5000 [illegible] SPSS (Version18) [illegible] Excel [illegible].

[illegible] NaCl [illegible]



[illegible] cm [illegible]

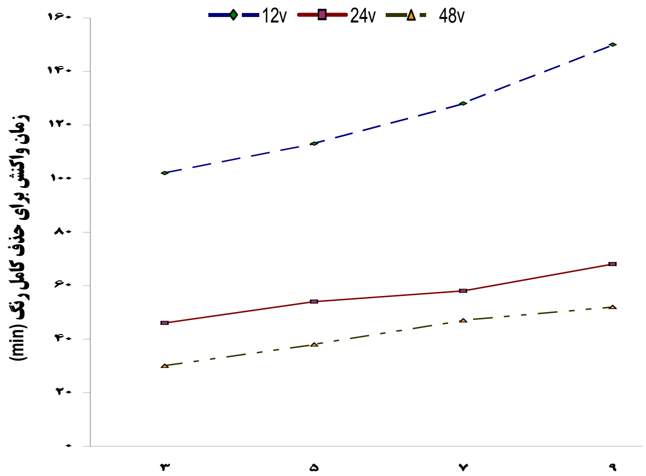


شکل ٤: تاثیر فاصله بین الکترودها بر حذف رنگ فنل فتالئین بر اساس زمان واکنش در ولتاژهای مختلف V ١٢، ٢٤ و ٤٨

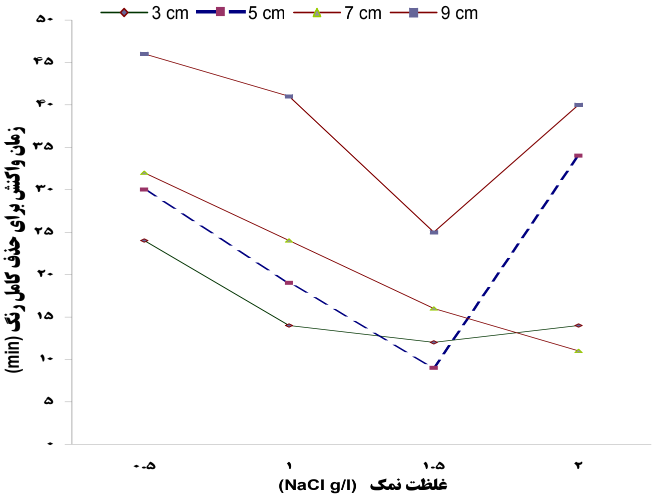
ĠǪĎžǨǝ ȜƳ Ů ǰ ǿǕǨǪǝ Ǩǚǝ Ūȝ ǻȀƩ Ǵg ǻȜǸǍ Ǵ .ƴğƳǼǭ ! ǨdžǪǬǀ ǨǛ ĠǪĎžǨǝ ǰ ǿȝg ȜƳ Ƿ ĥĩ min ǀ ǀȶƥ ȝǨǭƺ Ůħĩ vţǨǪƥ ǨǛ Ħ cm .ƠȘǀ ĠǪǝǨǽ ǀ ǽǀȝǝǀ ǏĨ min Ǵ ǀ ǀȶƥ ȝǨǭƺ Ů Ĥĥ V ţǨǪƥ Ħ cm ĠǪĎžǨǝ ȜƳ ŮƳȜ Ǩǚǝ Ūȝ ǻȀƩ ǴǨǂǭ ȜǸǍ Ǵ ǰ ǿǫšǬǵ ǨǛ ĠǪĎžǨǝ ǰ ǿȝg ȜƳ Ƿ Ħg min ǀ ǀȶƥ ȝǨǭƺ Ůħĩ V ţǨǪƥ ǨǛ .ƠȘǀ ĠǪǝǨǽ ǀ ǽǀȝǝǀ Ĥġĥ min Ǵ ǀ ǀȶƥ ȝǨǭƺ Ĥĥ V ţǨǪƥ ȝǨǭƴȝ Ħcm ĠǪĎžǨǝ ȜƳ Ƿ ħĩ V ţǨǪƥ ȜƳ ƩŮǽƳ ѲȝǨǕ Ǵ ǴĤĥ VţǨǪƥ Ǵ ƠǪšǀ ƳȜ Ǩǚǝ Ƿ ǰ ǿǕǨǪǝ Ǩǚǝ ǻǨǵŪȝ Ǜzf ȝǿǨǓ Ʃǀ ǲƳǨǍǪȘǀ ǨǛ ŮƠȘǀ ĠǪǝǨǽ ǀ ǽǀȝǝǀ ě Ĩǵƥ ě ĩĥ ǀ ǿǾƩǽ ƳȜǸǪ ȝǨǭƺ ƩǨǵƳƥƩǪŨǀ ĠǪĎžǨǝ Ƿ ţǨǪƥ Ʃǀ Ǩǚ ȜǸǪǂǨǝ 5 ǨǽȝƗƥ ǵ/ǵĨTǎȘ ȜƳ ƳȜ Ǩǚǝ Ƿ ǰ ǿǕǨǪǝ Ǩǚǝ Ūȝ Ǩǭǂ Ǜzf ǻȀƩ ǥǨǭ Ĩ- Ĩ cm ĠǪĎžǨǝ Ƿ ħĥ VţǨǪƥ ǨǛǨǽǭǵ Ʃǀ ǰ ǿǫšǬǵ .ƠȘȜǀƳǼǭ

ǼǭŨǭ ǰ ǿǕǨǪǝ Ǩǚǝ Ūȝ Ǩǭǂ Ǜzf ǻȀƩ ȝǨǓ ƳȜǸǪ ȝǨǭƺ Ʃǀ Ǜzf Ʃǀ ǨǵƳƥƩǪŨǀ ǰ ǿǭ ĠǪĎžǨǝ ƩǾǰǨǕ Ĩ Ƿ ħ ǻǨǵǨǛ .ƠȘȜǀ Ǵǂ ǴǸūȝǨǭȝǵ ŮƴğƳǼǭ ȝǨǀǀ ȝ ǜƜŪǭ ǻǨǵţǨǪƥ ȜƳ Ūȝ Ǩǭǂ ǨǼ Ħ cm Ʃǀ ǨǵƳƥƩǪŨǀ ǰ ǿǭ ĠǪĎžǨǝ Ǵǂ ǼǭǨǓǴǵ ŮƳǸǀǼǭ ǴƴǵǨǀǀ ǀ ǽǀȝǝǀ ȝǿǨ ǀ ǀȶƥ ȝǨǭƺ ŮţǨǪƥ Ǵ ǴƩȜǸǍǨ ǨǛ ŮƳǨǂǼǭ ǀ ǽǀȝǝǀ Ĩ ǀ ǽǀȝǝǀ ǨǛ Ǵǂ ǻȜǸǍ Ǵ ŮƳǨǂǼǭ ǀ ǵǨǂ Ūȝ Ǜzf ȝǨǭƴĦȝ Ƿ ǀ ǀȶƥ ȝǨǭƺ ħĥ V ţǨǪƥ ȜƳ Ĩ Ǩǚ Ħ cm Ʃǀ ǨǵƳƥƩǪŨǀ ǰ ǿǭ ĠǪĎžǨǝ ĩĩ Ǵ ħĩ min Ʃǀ Ƿ ǰ ǿǕǨǪǝ Ǩǚǝ Ūȝ ǻȀƩ Ĩǵ min Ǵ ħĥ Ʃǀ ǻȀƩ .ƠǝǨǽ ǀ ǽǀȝǝǀ ƳȜ Ǩǚǝ

Ūȝ Ǩǭǂ Ǜzf ǻȀƩ ǀ ǀȶƥ ȝǨǭƺ Ʃǀ NaCl ǶȝȜ ƠǿǭǸ Ʃǀ .ƠȘǀ ǴƳǀ ǴƳƳ ȝǨǂǀ ǜƜŪǭ ǨǵǨǛ ȜƳ Ƿ ĩ ǻǨǵţǨǪƥ ȜƳ ǸǵǶǏǭ ƳǨǴ ǀ ǽǀȝǝǀ ǳƳǨǸǀ ǴƳǨǂǼǭ ǨǵǨǛ ȜƳ Ǵǂ ȜǸǍ ȝǨǭȝǵ



شکل ٥: تاثیر فاصله بین الکترودها بر حذف رنگ فنل رد بر اساس زمان واکنش در ولتاژهای مختلف v ١٢، ٢٤ و٤٨



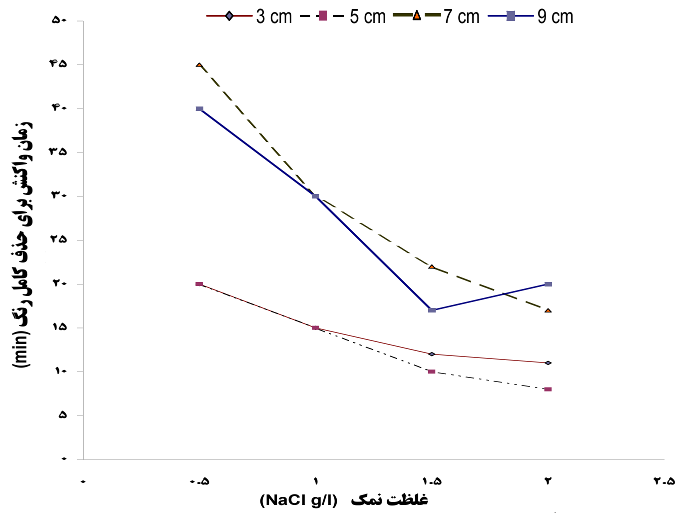
شکل ٦: تاثیر غلظت نمک NaCl بر حذف رنگ فنل فتالئین بر اساس زمان واکنش در فواصل مختلف cm ۳، ۵، ۷ و ۹ با ولتاژ ثابت ٤٨ v

Ǵǩ ǗƴğYÆǭ Ι ģǩģ ǜ ǪǪŪǭ ǨDžĦŇǝ ʒY ʒ Ι ǅŧĦƿ ǯǨǭƹ Ǘ ƙ ƌ ʒY ¡ĥ Ǩ ģ/Ĩ g/Lƹ NaCl Ŧ ǯ Ơǒǫǚ Ι ǻʒǝ Ǩ Ǵg ắʒŇǍ Ħ cm ǴǪDžǨǝ ʒY ʒ Ǩǝ Ūʒ Ǩǭŧ Ǜz ƒ ắƹ Ι ǅŧĦƿ ǯǨǭƹ Ūʒ Ǩǭŧ Ǜz ƒ ắƹ ǴǨŧǭ ʒŇǍ Ǵ ƿ ěħĨ ǗǨģYƿƹǪŨ ǰǻ Ūʒ Ǜz ƒ ǯǨǭƴʒ ǰǻƹǨ ƿ ƴǨÆǭ Ι ģǨŧ ěħĥ Ǘ ǰǻǨǪǝ Ǩǝ Ǩǝ Ūʒ Ǩǭŧ Ǜz ƒ ắƹ ǌǻƹ ǰǻƹǪǨ .ƴǨÆǭ Ι ǻʒǝ Ǵŧ ƴ ǨDžǨ ƒ ĥ g/L Ŧ ǯ Ơǒǫǚ Ǩ ƿ Ĩ cm ǴǪDžǨǝ ʒY ʒ g/L Ŧ ǯ Ơǒǫǚ Ǵ Ơŧ ƿ YŇ ī min ǯ ʒY Ι ǅŧĦƿ ǯǨǭƹ ¡ģ/Ĩ ǯǨǭƴʒ ěĩģ ắƹǪǨ ǯǨǭƴʒ .YĦY ǌǻƹ Ǵ ǨǪ Ǜz ƒ ắƹ ƿ Ĥ/Ĩ g/L Ŧ ǯ Ơǒǫǚ ǌǻƹ ʒY ǰǻǨǪǝ Ǩǝ Ūʒ Ǩǭŧ ƿ YŇ Ĩ min Ι ǅŧĦƿ ǯǨǭƹ ǯ ʒY Ǵŧ ƴ ǨDžǨ ƒ Ĩ cm ǴǪDžǨǝ ǯǨǭƴʒ ěĨģ ¡ģ/Ĩ g/L Ŧ ǯ Ơǒǫǚ Ǩ ǴǨŧǭ ǌǻƹ Ǵ Ơŧ

ƹĦ ǗǨʒŇǪŧǨǝ 5 ǨʒĦƿ ʒǻǨ ƹ ƴǨÅǭ .YĦY ǯǨ ʒ ắƹǪǨ Ǜz ƒ ắƹ ƹǨǻ YʒŇǭ ǯǨǭƹ ƹ ǨģYƿƹǪǚ ǴǪDžǨǝ ƿ Ŧ ǯ Ơǒǫǚ .Ơʒ ʒY Æǻǭ ģ/ģĨ Tǎʒ ʒY ʒ Ǩǝ ƿ ǰǻǨǪǝ Ǩǝ Ūʒ Ǩǭŧ Ĩ Ǩ Ħ cm ǴǪDžǨǝ ʒY Ĥ/Ĩ g/L Ŧ ǯ Ơǒǫǚ ǨǨÆǭ ƹĦ ǰǻšǬģ YʒŇǭ ǯǨǭƹ ƹ Ǩ Ħ cm ǴǪDžǨǝ ʒY ĥ g/L Ŧ ǯ Ơǒǫǚ ʒǻ ƿ ĥ g/L Ŧ ǯ Ơǒǫǚ ƿ ǰǻǨǪǝ Ǩǝ Ūʒ Ǩǭŧ Ǜz ƒ ắƹ ǌǻƹ Ūʒ Ǩǭŧ Ǜz ƒ ắƹ ǌǻƹ YʒŇǭ ǯǨǭƹ ƹ Ĩ Ǩ Ĩ cm ǴǪDžǨǝ ʒY Ǩǝ ʒY ʒ Ǩǝ .Ơʒ ʒY Æǻǭ ģ/ģĨTǎʒ

ƤƮǻ

ł ǻƹǗǨ Ǵ ƴŇǨÆǭ ţǨǩƿ Ι ǻʒǝ Ǩ ƴǻƹǝ ǯǨǭƴʒ Ι ǻʒǝ Æǻǭǯǻ ƿƹǪŨ ʒŇǻƨǻƨŧ ƹĦ ʒY ƙƙšř ʒY Æǻ ắǨģǻƴǻèǻ



شکل ۷: تاثیر غلظت نمک NaCl بر حذف رنگ فنل رد بر اساس زمان واکنش در فواصل مختلف cm ۳، ۵، ۷ و ۹ با ولتاژ ثابت ٤٨ v

$$Cl^- + 2OH^- \rightarrow OCl^- + H_2O + 2e^-$$

$$6\,ClO^- + 3H_2O \rightarrow ClO_3^- + 4Cl^- + 6H + 3/2\,O_2 + 6e^-$$

$$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$$

$$H_2O + 2e^- \rightarrow H_2 + 2OH^-$$

$$R \xrightarrow{\text{active-chloro species}} O_2 + H_2O + \text{Chlorinated Final product}$$

$Cl_2, ClO_2, O_3, OH^0, O^0, CLOH^0, H_2O_2, O_2, H_2, CO_2$

$OH^0, O^0, CLOH^0$

$(Cl_2, ClO_2, O_3, H_2O_2, O_2, H_2)$

(Cl_2, O_2)

(ClO_2, O_3, H_2O_2)

H_2O_2 OH°, O°, H^+

Daneshvar

Dalvand

Dalvand

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

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Investigation the Efficiency of Electrolysis Process using 3 Dimensional Graphite Electrodes for Decolonization of Phenolphthalein and Phenol red from Aqueous Environments

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ABSTRACT

Background and Objectives: The presence of chemical dyes in the water resources not only pollutes them, but also brings about death of organisms and serious indemnities to the environment through stopping oxygen production and preventing penetration of the sunlight. In this study, we investigated the efficiency of the electrolysis process for decolonization of phenolphthalein and phenol red from aqueous environment.

Materials and Methods: The experiments were conducted in an electrochemical reactor having a working volume of 1 liter equipped with 2 graphite electrodes. This study was conducted at laboratory scale. Samples were prepared by dissolving two phenol red and phenolphthalein dyes in drinking water. Then, the effect of operating parameters such as voltage, inter-electrode distance, and NaCl concentration on the complete dye removal was determined considering optimum retention time using Factorial variance analyses and the graphs were plotted using MS Excel software.

Results: the results showed that the optimum conditions for completely removal of phenolphthalein was achieved applying a voltage of 48 V, the retention time of 9 minutes, 5 cm inter-electrode distance, and the salt concentration of 1.5 g/l, whereas, complete removal of phenol red was achieved applying a voltage of 48 V, the retention time of 8 minutes, 5 cm inter-electrode distance, and the salt concentration of 2 g/l. Under these conditions, COD removal efficiency for phenol red and phenolphthalein was 85 and 80 percent respectively.

Conclusion: This study revealed that electrolysis process is an effective method to remove both phenolphthalein and phenol red dyes from effluent, because it can completely remove the dyes in a short time.

Keywords: Electrolysis, Decolonization, Phenolphthalein, Phenol red

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