massoudi@sbmu.ac.ir

NaCl

min V g/L cm

min V g/L cm

COD

Ćǫỹ₣Ẽǫ

Θy₩ Ćʌ Ū₩Ʒ ÁĕẳƬǫ Ơsźɛ ΘłɆĵł ÛɆẳƠł ĆgY yẅš ƵY ÁĮƠƘk₩ ÁźK₩ź Ơẳ̈́Ảṓt KHẅơ Ć₪ ƶđ ƵŃNJf .Ơsł Ćĵəkź ⏐ źłƶəł ƐĵH Áĺđ Q̈ĵsǿsŃ€ł Ɛʌ ĆŨQʌ Ůy₥tÁĘǫ ŘĵUǫ ł₹ ÁƬĕs ấKgķđ ΘKẅṓt€ơ ɛł Áūƶƶʌ ⏐ Uʌ .(Ĥ) yğYÁĘǫ Ɛṓṓŭơ ł₹ ƶđ p YƵłzūÁĘǫ YłŃǫ ůy₥YƐūÁĘǫ ÁüṓẅĂ ķđ ƵY ÁūYŃk̈đ YK]źł ƤP̃ŨKʌ Ćt Áĺđ YƵŃǫ ÁŨ₩KƟ p ÁĵūẁDž ΘƵŃDž Ćʌ Ćt y₥sǵ ÁźKṓƵṓ‖ ấɻɆŪ₩Ʒ njẃƬǫ Ćʌ ÁŨ₩Ʒ ấKgķkʁšř ĆṓQUơ .(ĥ) yɅƐṓūÁĘǫ ƵɻƐă ₪YKÃĵsł ƵK‖ÁŨ₩Ʒ Oṓǵķǫ ḰṓĥY Ćʌ ĸgŪ₩Ʒ ɻƐźɛ ÙƠsł t’ ₪ƐăƟ ÙƠsźɛ ĸgķđ ƵpƵY Ćʌ ƵŃ₩ ƵŃÃ₪ ɛł Û(Č) ₪YŃʌ ấƐǵķÔ ấĸǵ₪y₥ëđ ɛł ấĸǵy₥ź₹ə ƐźĸƵs p ƶ₪sŃ₪ə ấĸǵy₥ź₹ə p y₥tÁĘǫ ấƐṓūŃǫΣ ¡(ĥħpĎ) y₥źK₩ŽÆǫ ḰĵĵUǫ ł₹ ƵKźƶđ ΘKṓf Ćʌ NjŃʌƐǫ ÆŨźtẊŃʌŃṓʌ ĆÆă₪ǫ ƵY YŃΣŃǫ ƵŃQə p ƵŃə ÛƵKṓǵķǫ ấɻɆʌ y₥HŃơÁĘǫ ĵṓɹšQǵ ĵźɻƐʌK₪ʌ .(Ĩ) yʌ₩ʌ ÆƵs p ɻɛ ⏐ HΣ Ûɻɛ₹ĸĂƐs ķĸsřĆṓQUơ ấ₹pƐlj ₪yʌ₹źzř ấĸǵķđ Ćʌ ĆṓQUơ ɛł ⏐ Ṓř ĸǵ₪y₥źëđ ĵźł Ùzf .yƽ₹ÁĘǫ Ɛṓ₪ Ćʌ

ÆźKṓƵṓ‖ŃŨźɛźṓə p ÆźKṓƵṓ‖ ÛÆŨźɛźṓə Yyẅ⏐ǫ ấĸgy₥źł₹ə ɛł ƵŃ₪tKơ ÛÁ₩Ńź ğYK₪ơ Ûy₥t Á₪‖ ÁəKDž ÛÁźKṓƵṓ‖ YKźĒ₪H Û ł ṓsƐơ y₥₪Kǫ ÁźKṓƵṓ‖ Ùzf Ů(ĩ) (ÆƬăs ķzƩ) ğK₪ə ĵ₺Ɛt ấpƵ Ɛʌ ķzΣ ¡(Ī) ƶţpƵyṓǵ yṓsł₹ɆĬ Û₹ɛł ÛƐǫt y₥₪Kǫ ₪y₥tyṓsł₹ł ḰǫiŃẅ ₪ p 2 ŃŨẅǫ ɛ₹sł p ƶŃṓsł₹ƐǫṓəŃ₪K₪ y₥₪Kǫ ÁźK‡Ů ấĸgy₥źł₹ə ₪YKÃǫsł ķĸsřɛł ŪĸƵ ÙzfOHΣ ÁŨźţŃźŃŃṓʌ Ćźɛ⏐ơ y₥źł₹ə ĸǫł ůyƽ₹ÁĘǫ Ɛṓ₪ Ćʌ ɆĵŃǫ ĸǵp pƵ ĵźł ĆšƐūł .(ī) Oƽł ₪y₩ ƶłɛƵł ÁŨźţŃźŃṓʌ ấĸǵp pƵ .yẁ⏐sǵ Ć₥źǵɛɆĬ p ÆəĸtK₪ ł ǫŨł ůyƽɆĵŃǫƐṓŨ ÁŨ₩Ʒ ấĸǵķÊljĸə ł ǫŨł ấɻɆʌ ĸǫł y₥₪YKs p ấɻɆʌ ůĵźĸĸř ÁŨźţŃźŃṓʌ Ćźɛ⏐ơ OṓǪṓKă Ɇʌ ₪pÊŨ ĸǵŪ₩Ʒ ɻźźɛ Ćʌ Ɛ⏐₪ǫ p y₥⏐sǵ ÆƵs ůy₥₪Ɛə ƵY ₪YKÃǫsł YƵŃǫ ấĸǵǪsṓ₪kūƵł p ƶŃṓsł₹ṓsł ấĸgy₥źł₹ə .(Ĭ-ĤĤ) yƽYƐūÆǫ ĵ ⏐ł ƶy₩ Q̈ṓ⏐ f ÆŏṓǪŨ ĵ ⏐ł ÆźK‡Ů ấĸgy₥źł₹ə ĸǫł ůyƽ₹ĸĸKǫ ÆźK‡Ů ấĸgy₥źł₹ə ƶŃṓsł₹ṓsł p pƵ p Oƽł ŘŨ‡ǫ ƶđ ŭəY Ćt y₥tÁĘǫ y₥ŃơÆơKṓǪƵŨ ấĸǵĆźɻźǵ ł ǫŨł Ćǫə₹‡ṓř ƶŃṓsł₹ṓsł p ÆźKṓƵṓ‖ .(ĤĤ) yƽ₹ƽYƐʌ ƵY Æźèʌ

ĆṓÃdžơ OHΣ ÆźKṓƵṓ‖ƤƐǫÛĤ ấĸǵ p pƵ ɛł ƐṓƟł ấĸǵǵĸs ƵY ĸǵOźYpyƬǫ ⏐ ź₹əłʌ ƶŃǫɛǪǵ p Oƽł₪y₩ ₪YKÃǫsł ÆŨ₩Ʒ ķĸsř ĆΣŃơ ĸǵ p pƵ ĵźł ɛł ₪YKÃǫsł Ćʌ ŮnjẃƬǫ Ćʌ ķĸsř ĆṓQUơ ƵY

ĸĦ₪đ Yyẅ⏐ǫ ấĸźł₹ǫ ĆΣŃơ ĵźł ŘĆẅY .(ĤĦ) Oƽł ₪y₩ ấƐǫ⏐ł ṓʌ ÛΘĸŪźĸǫ ĆṓÃdžơ ƶĸŪǫł ÛOƽźɛ njẃƬǫ ĸʌ ấƵĸūɛĸƽs ĆQƵΣ ɛł p pƵ ƶĸǫɛ ÛđYKƽ Θł₹ṓĥ⏐ơ Ûấɛ₹yĦđƵ OĬŃĤƽ ÛΘłyǫĸΣ p ĸǵɛĸū Oƽƽǫèĸʌ Ćǫṓsɯ Y p ƐǫƵƫt Q̈⏐ f ĸʌ Ámʌ⏐ẳ yẅŃơÛ(Ĥĥ) ₪ĸoŃt yẅĸǫ ÆźKṓƵṓ‖pƐǫŨĬ ấĸǵấţŃĬŃ₪Ũơ ấpƵ Ɛʌ ΘĸÉṓÉƬơ ĵźłƐʌK₪đ .(Ćċ) ĆūƽŃơ Ɛʌ Ɛ⏐‡ṓʌ Ćt Ćǫəkź ⏐ ź₹əł Áĺđ ấĸǵ₪yẅź₪ëđ Ćźɛ⏐ơ ấɻƐʌ ĸǫĩŃŪ p ĸÊljĸə ĆṓÃdžơ ấɻƐʌ Ćǫə₹‡ṓř ấĸǵấţŃĬŃ₪Ũơ (ƵɛɻÛOźƐǫtŃŠṓǵ ÛĬḰṓsŧpƵyṓǵ ấĸǵğĸŪźYł₹ƵǴ) ấŃã ₪yẅ₪tyṓsŧł YŃ‖Æǫ ₪yṓǫK₪ ƶŃṓsłyṓsŧł₪pƐǫŨĬ Ûp pƵ ĵźł .Oƽł₪y₩ ɛtƐƵǫ ƵY YŃΣŃǫ ÁƵs ấĸǵ₪yẅź₪ëđ ⏐ ǵĸt ĸź Ćźɛ⏐ơ ấɻƐʌ yĦŃơÆǫ Ćt ₪YƐǫsū ƵŃĂ Ćʌ yẅź₹ə ĵźł Ćt ấƵŃĂ Ćʌ ÛYpƵ ƵĸtĆʌ ĸĒljĸə ĸÊljĸə Û(ČĬ)ÆŨĸY Û(ČčpČċ)ÆΣĸsǁ ĸÊljĸə ĆṓÃdžơ ƵY p (Čē)ŪʁƐ ğĸŨƶ ĆǁĸƟƵĸt Û(ČĒ) ĆǁĸƟấŃ⏐qƟƵ Û(ČĩƵĸṓtĸǫ Ćt y₩ ₪YƐʌ ƵĸtĆʌ (ČĚ) ĵəY ŘŢǫ ĆĦƐṓ‖ ĆṓÃdžơ ɻɛʌ ĵṓɯšQǵ ŘʌĸÃ ƵłyÆǫ Ćʌ ł₹ ₪y₩źëđ YłŃǫ Oƽ₩Ńơ y₩źƐə ĵźł ĸHẅđ ĆƵǵ ƵY Oƽł ĸǵƵpƐ⏐ŨĬ ĆṓÃdžơ ÆǪDžł ŘǫĸŨ p pƵ ĵźł ƵY Ûy₥ĸsƐʌ ÁĺŃ₩ã pƐə ấĸǵYpƐ⏐ŨĬ ĵṓʌ Q̈ṓÆ⏐sǫ ãƐʌ ƵĸźƐΣ ű₩ǫ Ŧź ɛł ƶđ ƵY Ćt ÆŨźƐ⏐ŨĬ ƵĸźƐΣ ấƵɻƐãƐʌ ĸʌ .YŃ‖Æǫ ₪YKÃǫsł ₪YŃĸđ ķđ ƵY Ćǫə₹ ğĸṓs ƵY YŃΣŃǫ ấĸǵOźpƐ⏐ŨĬ Ûĵṓūǫ ŘṓsĸĸǪř ÙÊ⏐ƟƟ Ŧź ĸʌ ĸṓf‡p y₩đ ƵY ƶŃṓsłyṓsŧł ấĸǵ ⏐ ₪t₺p p ₪y₩ Ćźɛ⏐ơ ĸǵƶŃź ĆʌĸǵY₪źëđ ÙzfĸʌłƵ COD ĸźp ŪʁƵ ÆźKṓƵṓ‖pƐ⏐ŨĬ Ćźɛ⏐ơ ấƐźřźĸŨǫł ĵṓÊÆƬǫ ¡(ĥĤ) 2ĸƵĬ ấĸǵYpƐ⏐ŨĬ y₩ĸǫ y₩đ YpƐ⏐ŨĬ ΘpĸÃǫǫ ấĸǵOźǵĸǫ ĵ⏐ƐtƐĦ₪ə (ACF:Active Carbon Fiber) ¡(ĥĤpĤĥ) Oźə₺Ɛū (ĥħ) Ti/TiRuO$_2$.(ĥĦ) Oźə₺ƐūP Ti/Pt ¡ACF ¡(ĥġ) ğĸũə ¡(ĥĬ) (PbO$_2$) ĸƐs yṓsŧł ấY p (BDD) YpyźǫƐʌ 2ĸƵĬ ĸÊljĸə ĆṓÃdžơ ấɻƐʌ (Ĭ) ĵ⏐Ɛt p Ti/Pt, Ti- Ru- Sn-SbO$_2$ ấĸǵƐ⏐ǫł₹ĸĬ ɛł YpƐ⏐ŨĬ ŨŃĦ Ćt yẅ⏐‖ĦY ƵĸHỎł p yĦYŃƵ Ćũ₩ĸāǫ ŭ₺p ƵY .Oƽł ƶŃṓsłyṓsŧłpƐ⏐ŨĬ y₩ź₹ə ƐʌƵłzūƐṓṓơ p Ɛ₥Ńǫ ấĸǵQṓł ğĸÃ⏐ĦĦ ĆǪṓsP Ćʌ Ćt Oƽł ÆĦĸṓǫ ⏐ ₪t₺p Ŧź p pƵ ĵźł ₪YKǫ ĸơ yğYÁǫ UƵ Æźđ YłŃǫ Ćʌ ğŃǪṓǫ ɛĸə ƵY ĸđ ɛł ƶŤṓsŧł

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

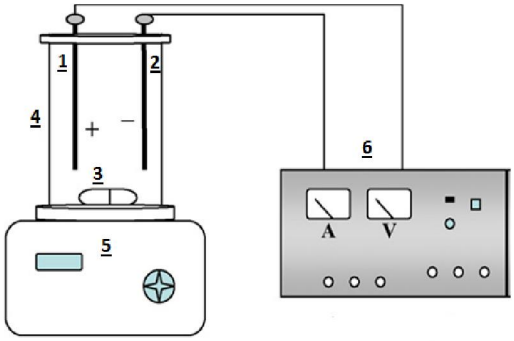
$$R+XH_2O \rightarrow ROx+1/2CO_2+2XH^++2Xe^-$$

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

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

$$2R+Co_x\,(OH^0) \rightarrow ½\ ROO +H^+ + e^- + CO_x$$

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



ÛOℏÛǫ ǴǫǪǫ -Ħ Ûyʘʞ-ĥ Ûyʞd -Ĥ) Ǵûĭǩăǫ ȝY ʤYʞÅǫѕł YȝÑǫ ÆźʞǾȝǪǁpȻǫÛĭł ȝÑǫgłȝ åʞȝǫ :Ĥ ǨÛǁ
(ǪǪÉǫѕǫ ãȻʎ ûɯɯǫ -ī ÛÆѕǪÅʞɯǔǫ ȝƶȝğ -Ĩ ÛȝÑǫgłȝ -ħ

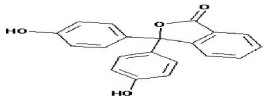
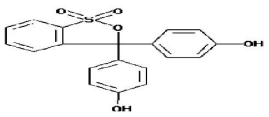
ʤYʞÅǫѕł Æĭd Ūɯȝ åʞǵDŽʊʞǁ ȝĦÑɯǔ Ǵʎ Yȝ Ǩℓə p ĵǪǪĭʞǪǫə Ǩℓə .Ơѕł ʤyǁ

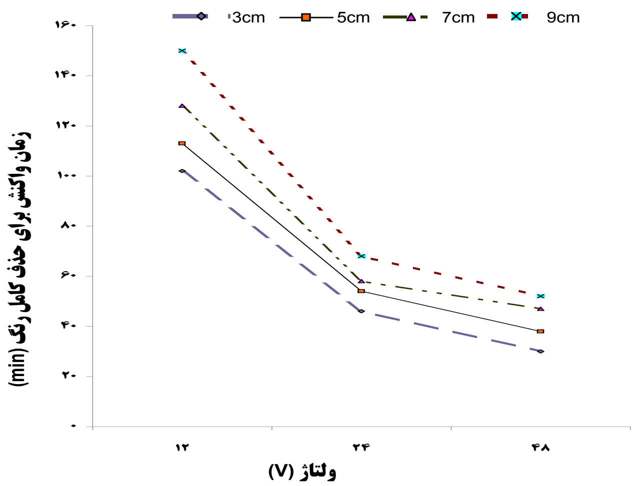
ʞǵ p pȝ p YĦÑǫ

ȝY p ÁǾȻǫơ ΘȝÑDž Ǵʎ ČĎēē ȝʞǪѕλʞơ ȝY Ǵūĭǩăǫ ĵźł ʤyŨǂǁY ǩÊljʞə p ǩd ʤǨŨǂźʞǪǫƷd ȝY ÆǵʞŨǂźʞǪǫƷd 2 ʞǪÆǫ ÆźʞǾȝǪǁpȻǫÛĭł ȝÑǫgłȝ ȝpȝY p ÁǪǂĦʎ yǪĦǁ ʤʞŨǂǁY Ơǁłyʀʎ ĵźł ȝY ʤYʞÅǫѕł YȝÑǫ ǩʞѕř .yǣYȻū ǫʞǀłĦ ǴǫѕÑǪřʞɯ ΘȝÑDž Ǵʎ Ǩℓə ğÑǪǪǫ ċ/čĨ mL ğÊǪĦ ɛł ҂ǪǪǫѕ ȝÑĂ Ǵʎ Ǵūĭǩăǫ ȝY DŽĭʞʊ ĵǪĭʞǪǫə Ǩℓə ċ/Ĩ g) ¡(Phenolphthalein) ĵǪĭʞǪǫə p $C_{20}H_{14}O_4$ ÆźʞǾȝǪǁ ğÑǫȻə ʞʎ (ěĚĒ ҂ǪǪǪǂł ǨÛĦ Čċċ mL ÆźʞǾȝǪǁ ğÑǫȻə ʞʎ (Phenol red) DŽĭʞʊ ȝY Ǩℓə Ĩ g ğÊǪĦ ʞǵŪɯȝ ĵźł .yǣYȻū ǴǪĦơ ÆǁyǪǫǩǁd ǩd ȻǪǪǩ ҂źʎ ȝY $C_{19}H_{14}O_5S$ .yɯÑǁÆǫ ʤYʞÅǫѕł Ȼūʞѕʞɯǁ ȝĦÑɯǔ Ǵʎ Ǵt yǪǫsǵ ÆǁdΘʞɯǪǫƷơ ɛł ûåyʘѕł åʞǵnjǾȝǫ ȝY Ǵt Ơѕł ǪĦǫ åʞǵÙȻüǫ ɛł ĵǪĭʞǪǫə Ǩℓə Ơѕł ŪɯȝÆʎ p ÆɯÑŮȝł ûŪɯȝÆʎ ł ǪǪơ Ǵʎ yǣyǁ åȻʞ p åȻʞ

ȝY Ǵt ʤYÑʎ ĵǪĭʞǪǫə ȝÑÅĭÑѕ åʞǵȻūʞѕʞɯǁ ǴǫѕY ɛł Yȝ Ǩℓə p ÆǫʞŽơ .Ơѕł ȝǫȻǎ p YȝƐ ł ǪǪȻơ Ǵʎ ÆźʞǪǪǎ p åyʘѕł njǾȚǫ .YÑʎ ȝʞŽǎd t’Ȼǫ Ơt Ȼǁ ǴǫǴʞѕ ʤYʞÅǫѕł YȝÑǫ ÆźʞǾȝǪǁ ΘʞɯǾtȻơ .Ơѕł ʤyǫd Č ğpyΣ ȝY ʤYʞÅǫѕł YȝÑǫ åłȻŪɯȝ YĦÑǫ ΘʞdžU ł ǫ åłǴ ł ǪǁǴ ǪðÅȚǫ Ҭź Ǩǫʞǁǩ ȝǾĭpȻǫÛĭł yƒtp Ǵʎ NjÑʎȻǫ ΘłȝǪ́Hʊ ǁơ ʞʎ Čh×ČČ/Ĩ×ČČ/Ĩ cm ʤȝłyʞĦ ȝY ǨǪăǫѕǫ ł üŨǫ ǨŨǁ Ǵʎ ɛł yʘʞt p yd YpȻǫÛĭł YyŨ č ȝd ȝY Ǵt YÑʎ Č LȻǫÑǫ Ǫǫƒ Ǵʎ p yɯəȻū ȝłȻă Č ×Č×ČĎ/Ĩ cm YʞüĭĦ Ǵʎ ƠǁəłȻū 5 ɯΣ ǪǾÆǫѕǫ Ǵʎ ǩpʞɯǫ ãȻʎ ğyɯǫ 5 ĦȻơ Ҭź Ǵʎ åţȻĦ ĵǪǫǨơ ȝÑǁɯǫ ɛʎ NjÊǫƲł YʞƐǫ ȝÑǁɯǫ Ǵʎ ȝÑǫgłȝ Ǩt 5 Śѕ .yɯyǣYȻū Ǩdžǫǫ NjÑʎȻǫ pH .(Ĥ ǨŨǁ) ƠəȻū ȝłȻă ÆѕǾĂʞǪǪǎ ȝƐǪǵ Ҭź åpȝ NaOH ğÑǪȚǫ ɛł ʤYʞÅǫѕł ʞʎ ĵǪĭʞǪǫə Ǩℓə Ūɯȝ åpʞf ǩʞѕř Ǵʎ ǪǾǁơ ĩ/Ĩ ʤYpƳȚǫ ȝY Yȝ Ǩℓə p Ĭ ʤYpƳȚǫ ȝY ğʞǪȻɯ Ҭź ǩʞѕř ɛł Ěċċ mL ʞʎ ȝƐUǫ ǀ ǽʞǪƐd ɛł ǴǪfȻǫ Ȼǵ ȝY .yǁ ¡(ħē p Čč¡čhV) ţʞǫĭp åʞǵȻǫǫłȝʞř ȻǾʞơ p yǣYȻū Ɛř ÆǓɯȝ (ěĬĬ) Ơǫ́pȻǫÛĭł Ơǁǫǔ p (Ě p Ē¡Ĩ¡Ħcm) YpȻǫÛĭł ĵǪʎ ǴǪDžǩə Ǵăǽɯ ɛł Ūɯȝ Ǩǫʞt Ùƶf Ɛʎ (ĥp Ĥ/Ĩ ¡ǵǔĤ/Ĩ g/L) NaCl

ÆəȻdžǫ åłȻŪɯȝ YĦÑǫ ΘʞdžU ł ǫ :Ĥ ğpyΣ

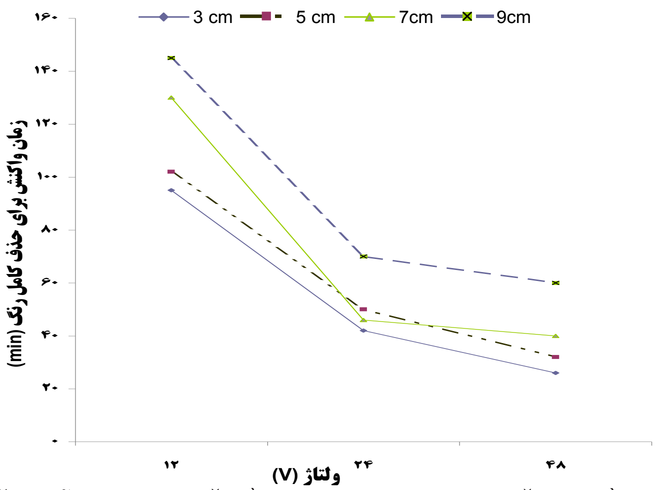
وزن مولکولی (g/mol)	ماکزیمم طول موج (nm)	گروه شیمیایی	ساختمان شیمیایی	ماده رنگزا
۳۱۸/۳۲	۵۵۲	هیدروکسیل تری آریل متان		فنل فتالئین
۳۵۴/۳۹	۴۳۱	تری آریل متان		فنل رد



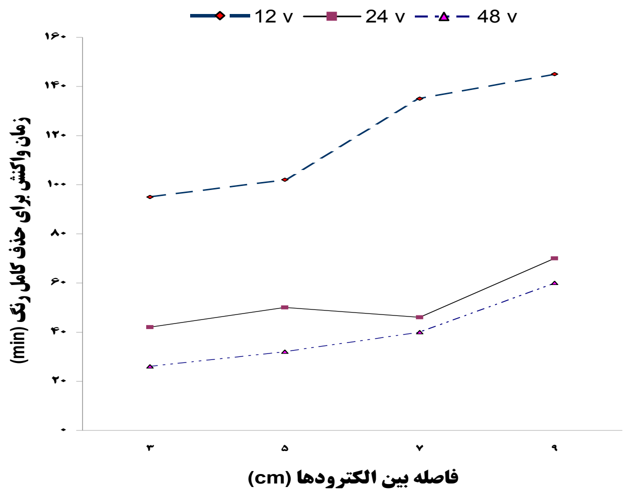
[illegible] cm [illegible]

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

[illegible] NaCl [illegible]



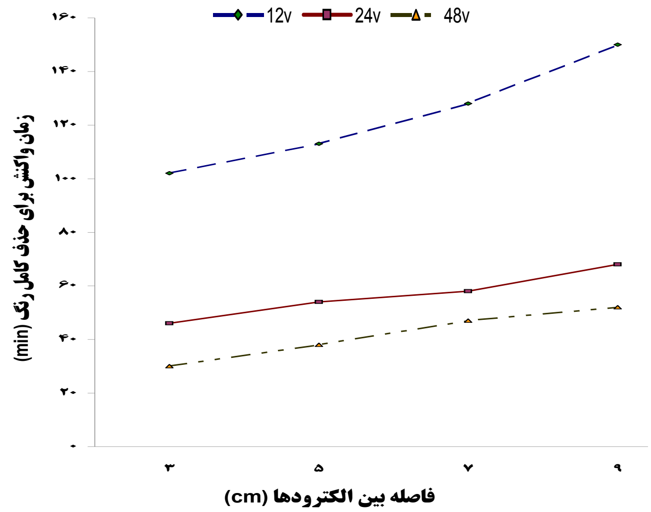
[illegible] cm [illegible]



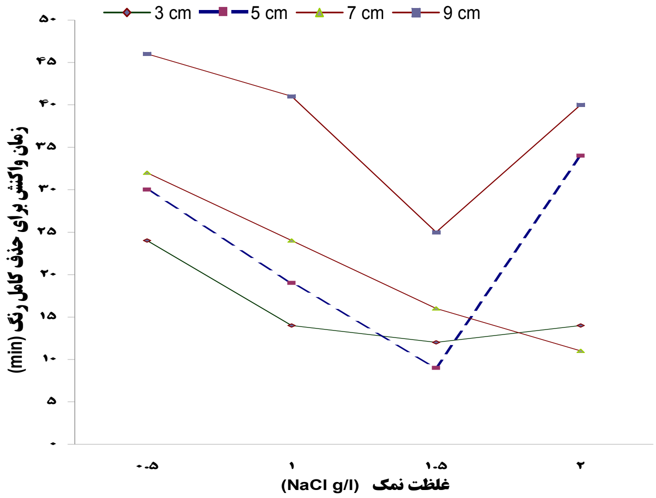
شکل ٤: تاثیر فاصله بین الکترودها بر حذف رنگ فنل فتالئین بر اساس زمان واکنش در ولتاژهای مختلف V ۱۲، ۲٤ و ٤٨

[illegible]

[illegible]



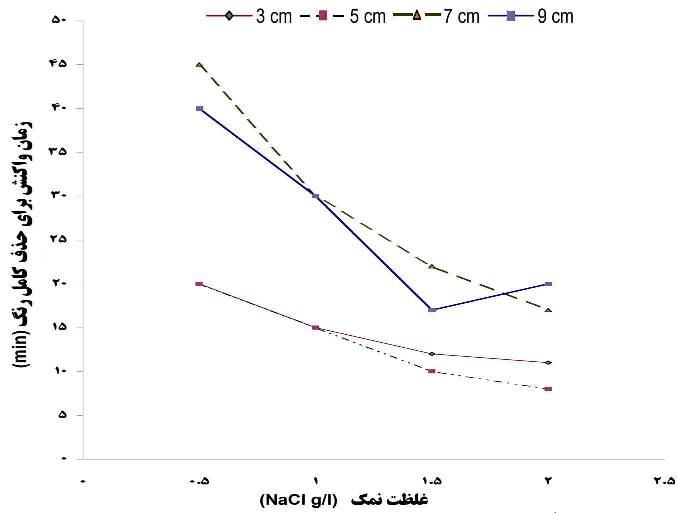
شکل ٥: تاثیر فاصله بین الکترودها بر حذف رنگ فنل رد بر اساس زمان واکنش در ولتاژهای مختلف v ۱۲، ۲٤ و٤٨



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

[illegible]

[illegible]



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

[illegible]

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

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

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

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

[illegible]

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

[illegible]

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

[illegible]

ÆIIHYƷyå p ƐÕ ǂơ

ÛÆ fŁƐĂ" ƷŁÌÑÕ ĸ Æ ǂ gpŤř ţƐĂ ɛŀ Æ ǂ UĸĶDžĶf ĠĺĶĖę ǰ ał "ƹŐĶpƐ¶ÕĬł p pƷ Ġĸ ķd ÆałYɛy¶ū ȣĶÕ¶ѕY ÆĸĶåɛƩł p ƠƟĶѕ ǫÌǪÕ ȣĶÕ ǂ IIHY ķ Ìdžǫ̂ĤĦīĩ/Ī/Ĥ UƷÌǪ ĤīĦ ĠѕǫΣ ĠĺÌdžǫ pƐŐř Ġg ȣYÌĸ ÆǪ ǂ Hĸ yØHǁ ÆIIĶǫƷY p ÆǪ ǁ łyFĸ ΘĶǫyƟ p ÆÕ ǁ ƹř Ķ fŁƐǫ ĠŐǫŧ ƷY p Ơѕł ȣyÌ łƐΣł ƷÌŧƶǫ ȣĶÕ ǂ IIHY ƠałĶƷ f ĸ ȣyÕ ǂ IIHY ķ Êljĸa p ķd ȣĶÕ ǂ ĸĶǫƐd ΘĶIIĶÕ̃ǫł ɛł ƷƋ ÆgĶÕ ǂ ĸĶǫƐd ÛȣyăYƐū ȣYĶÅ¶ѕł ÆǪ ǂ Hĸ yØHǁ ÆÕ ǁ ƹř ǫÌǪÕ ȣĶÕ ǂ IIHY Ơ ǁ łyFĸ ÆÕ ǁ ƹř ǫÌǪÕ ȣĶÕ ǂ IIHY Æ ǂ gpŤř ǫƐ¶Ţǫ ƠIIpĶūǫ ɛł ĠǪØѕp ǰ ƶyʎ Ơ ǁ łyFĸ ȣyÕ ǂ IIHY ȣĶÕ ǂ ĸĶǫƐd ǫƐ¶Ţǫ ĶIIѕƐř p ÆǪ ǂ Hĸ yØHǁ .ǪÓƶĸĶƷIIÆǫ ÆIIHYƷyå p ƐÕ ǂơ

yØĺÌÌơ ĶgȣyIIƶèd Ùzf åłƐʌ łƷ ÆIIĶÓǫ åĶgƠIIHyØѕtł yIIÌÌơÆǫ ɛł ŪIIƷ Ùzf åèĶʌ ÆƶłƷĶt ÛĠüĺĶăǫ ǰ ał ƷY 5 ř Û(ĥĩ) yƶĶƷI .YÌǁÆǫ ȣYFY ƠIIѕI ãÌÌə ȣyIIt yØѕtł ĶǫłÌÑÕ yØĺÌÌơ Ġʌ ķĶѕř åĶgŪIIƷ Ġʌ NjÌÌʌƐǫ COD ÛŪIIƷ Ùzf åƐÓūȣɛłyFH Ɛʌ ȣpÊÕ ĠIIØHʌ njałƐǁ ƷY p ΘĶ ƶĶǫƐd ǫĶ ƛIH ɛł ĶIIã YƷ ĶIIə p ǰ ØĺĺĶǫə ĶIIə Ŧ Ž I åĶgƠŏǫÛ ƷY Ĩ cm YpƐ¶ÕĺĦ ǰ Ø ĠǪDžĶə Ûħī V ţĶǫ̈́p ĶʌÃĶăǫ ǰ ØĺĺĶǫə ĶIIə åłƐʌ Ĥ/Ĩ g/L p YƷ ĶIIə åłƐʌ ĥ g/L Ī ĶĞǁ ƷY Ġt ƷÌĂŽĶƷg Ůyǁ åƐÓūȣɛłyFH ÛYƷłyIIĶ¶ѕł åĶg p pƷ p ěĨĨ YƷ ĶIIə åłƐʌ COD ǀ gĶt ƷłƷÓǫ ÛƠѕł ȣyǁ ȣYFY ƷĶǂ ʌ .yǁ ĶDžĶf ěīī ǰ ØĺĺĶǫə ĶIIə åłƐʌ yğYÆǫ ƷĶǂ ʌ ĠʌĶǂ ǀ gĶg ǀ gpŤř p ĠüĺĶăǫ ǰ ał ɛł ĶDžĶf ɾźĶ¶ū Ūƶf åłƐʌ ÆźĶÓŽØǁ pƐ¶ÕĺĦ åĶg p pƷ ɛł ȣYKÅ¶ѕł ƷĶÕǫt Ġt ƷĶǫƐ Qg åYĶdžŪãł åĶgÆѕƷƐʌ YƷÌÑǫ ł QÛł ƷY ĶǫłÛYƷHY YÑΣp YĶHȣǂÓř ǰ ałƐʌĶȣ ÜƠѕł ĠǪəƐźƶŚ ΘƷÑDž ÆÕÛȣÕư åĶgÆѕƷƐʌ ĶʌNjÌÌʌƐǫ åĶgĠȣźgĶ YƷpdƐʌ ƠHΣ åƐ¶ǂÓʌ ΘĶūĺĶăǫ Ġt YYƐūÆǫ .YYƐū ǫĶ ǁ p pƷ ǰ ał Ġʌ

åƐÓūĠ ǁ Ó¶

ɛł ǰ ØĺĺĶǫə ĶIIə p YƷ ĶIIə ÆźHYɛŪIIƷ ƠHΣ ƹÓĺpƐ¶ÕĺĦ yIIźłƐə ÆøĶÓǫŽÕ åĶgƐ¶ǫłƷĶř ƐH ƷȣÆĂ p yăYƐū ǫĶ ǁ ÆłȣåĶgğÑǫŢǫ Ŧ Ž Ơŏǫ̈Û p YpƐ¶ÕĺĦ ǰ Ø ĠǪDžĶə ÛţĶǫ̈́p ĠǪŽΣ ɛł ù ǫ¶Uǫ ɛĶÓ YƷÑǫ ƷĶǫɛ ƐŏI ĠăÆI ɛł ŪIIƷ Ùzf ÆźłƷĶt Ɛʌ ÛNaCl ĶǫĶt Ùzf ƠHΣ ǀ łtłp ƷĶǫɛ Ġt YFY ƷĶʌ ʌ ɾźĶ¶ū .yǁ ĠüĺĶăǫ ĠăIIƷ NaCl Ŧ Ž Ơŏǫ̈Û p ţĶǫ̈́p Ɛ¶ǫłƷĶř Ķ ķĶѕř ɛł ŪIIƷ .YƷHY ǪÓƶ¶ѕǫ ĠăIIƷ ĶgYpƐ¶ÕĺĦ ǰ Ø ĠǪDžĶə Ķ p 2 ÑÛūǫ ɛł ǰ ØĺĺĶǫə ĶIIə ŪIIƷ ĶǫĶt Ùzf ƷY ÆøĶÓǫŽÛ njałƐǁ ǰ ałƐ¶Ø YpƐ¶ÕĺĦ ǰ Ø ĠǪDžĶə Û Ĩ min yIIĶǫ ƷĶǫɛ Ûħī V ţĶǫ̈́p ķĶѕř ¡ħī V ţĶǫ̈́p YƷ ĶIIə åłƐʌ p Ĥ/Ĩ g/L Ŧ Ž Ơŏǫ̈Û p Ĩ cm Ơŏǫ̈Û Ķ p Ĩ cm YpƐ¶ÕĺĦ ǰ Ø ĠǪDžĶə Ûī min yIIĶǫ ƷĶǫɛ Ùzf ƷĶǫyIIƷ njałƐǁ ǰ ał Ơ Ţ .yǫd Ơѕ Ġ Ĥ g/L Ŧ Ž Ġʌ ěīǵ p īĨ ł Øƶư Ġʌ YƷ ĶIIə p ǰ ØĺĺĶǫə ĶIIə åłƐʌ COD .yǫd Ơѕ

1- Zin, NSB. Decolorization of dye solution containing azo acid orange 7 by electricity [dissertation]. Malaysia: Faculty of Civil Engineering University Technology Malaysia; 2005:7-10.

2- Daneshvar N, Vatanpour V, Khataee AR, Rasoulifard MH, Rastegar M. Decolorization of mixture of dyes containing malachite green and orange II by fenton-like reagent .Journal of Color Science and Technology. 2008;1:83-89.

3- Chen X, Chen G, Yue PL. Investigation on the electrolysis voltage of electrocoagulation. Journal of Chemical Engineering Science. 2002;57:2449-2455.

4- Daneshvar N, Ashassi-Sorkhabi H, Tizpar A. Decolorization of orange II by electrocoagulation method. Journal of Separation and Purification Technology. 2003;31:153-62.

5- Dalvand A, Jonidi jafari A, Gholami M, Ameri A, Mahmoodi NM. Treatment of Synthetic Wastewater Containing Reactive Red 198 by Electrocoagulation Process. Iranian Journal of Health and Environment. 2011;4(1):11-22 (in Persian).

6- Diez MC, Mora ML,Videla S. Adsorption of phenolic compounds and color from bleached Kraft mill effluent allophonic compounds. Journal of Water Research. 1999;33(1):125-30.

7- Clark T, Bruce M, Anderson S. Decolorization of extraction stage bleach plant effluent by combined hypochlorite oxidation and anaerobic treatment. Journal of Water Science Technology. 1994;29(5-6):421-32.

8- Kobya M, Can OT, Bayramoglu M. Treatment of textile wastewaters by electrocoagulation using iron and aluminum electrodes. Journal of Hazardous materials. 2003;100:163-78.

9- 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).

10- Panizza M, Bocca C, Giacomo C. Electrochemical treatment of wastewater containing polyaromatic organic pollutants. Journal of Water Research. 2000;34(9):2601-605.

11- Radha KV, Sridevi V, Kalaivani K. Electrochemical oxidation for the treatment of textile industry wastewater. Journal of Bioresource Technology. 2009;100:987-90.

12- Vlysside AG, Papaioannou D, Loizidoy M, Karlis PK, Zorpas AA. Testing an electrochemical method for treatment of textile dye wastewater. Journal of Waste Management. 2000;20:569-57.

13- Zaroual Z, Azzi M, Saib N, Chaint E. Contribution to the study of electrocoagulation mechanism in basic textile effluent. Journal of Hazardous materials. 2005;131:73-78.

14- Rajeshwar K, Ibanez J G, Swain G M. Electrochemistry and environment. Journal of applied electrochemistry .1994;24:1077-91.

15- Jia J, Yang J, Liao J, Wang W, Wang Z. Treatment of dying wastewater with ACF electrodes. Journal of Water Research. 1999;33(3):881-84.

16- Chandra mouli P, Venkata Mohn S, Jayarama Reedy S. Electrochemical processes for remediation of wastewater and contaminated soil: emerging technology. Journal of Scientific & Industrial research. 2004;63:11-19.

17- Daneshvar N, jafarzadeh N. Treatment of textile wastewater containing basic dyes by electrocoagulation process. Journal of Water and wastewater. 2009;57:22-29.(in Persian).

18- Ahmadi Moghadam M, Amiri H. Investigation of TOC Removal from Industrial Wastewaters using Electrocoagulation Process. Iranian Journal of Health and Environment. 2010;3(2):185-94 (in Persian).

19- Eaton, AD, Clesceri L.S, Greenberg A.E. Standard Methods for the Examination of water and wastewater. 20th ed. American public Health Association; 1998.

20- Ugurlu M, Karaoglu M H, Kula I. Experimental investigation of chemical oxygen demand, lignin and phenol removal from paper mill effluents using three-phase three-dimensional electrode reactor. Journal of Environ.Stud. 2006;15(4):647-54.

21- Li Xu , Wei Wang, Mingyu Wang, Yongyi Cai. Electrochemical degradation of tridecane dicarboxylic acid wastewater with tantalum-based diamond film electrode. Journal of Desalination. 2008;222:388–93.

22- Dalvand A, Gholami M, Joneidi A, Mahmoodi NM. Investigation of electrochemical coagulation process efficiency for removal of reactive red 198 from colored wastewater. Journal of Color science and technology. 2009; 3:97-105.(in Persian)

23-Malekotian M, Mansourian H J, Mousazadeh M. Performance evaluation of electrocoagulation process using rod iron electrodes for removal of hardness from drinking water. Proceeding of the 12th national Environmental Health Conference;2009 Nov; Iran, Kerman. (in Persian)

24- Sengil I A, Ozacar M. The Decolorization of C.I reactive blak 5 in aqueous solution by electrocoagulation using sacrificial iron electrodes. Journal of Hazardous Materials.2009 ; 161: 1369-76.

25- Vlyssides A G, Papaioannou D, Loizidoy M, Karlis P, Zorpas A A. Testing an electrochemical method for treatment of textile dye wastewater. Journal of Waste Management. 2000; 20: 569-74.

26- Mohana N, Balasubramanian N, Basha C A. Electrochemical oxidation of textile wastewater and its reuse. Journal of Hazardous Materials. 2007;147:644–51.

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

[*]Mohmmad Reza Massoudinejad[1], Hajar Sharifi[1], Ashraf Mazaheri Tehrani[2]

[1]Department of Environmental Health Engineering, Faculty of Health, Shahid Beheshti University of Medical Sciences, Tehran, Iran

[2]Department of Environmental Health Engineering, School of Health, Kashan University of Medical Sciences, Isfahan, Iran

Received; 02 April 2012 Accepted; 01 July 2012

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

***Corresponding Author**: *massoudi@sbmu.ac.ir*

***Tel:** +98 21 22332040, **Fax:** +98 21 22432037*