Æ ł gpŤř ÆŽQŰ å ĆęĸŁQdža Ůnjǿ Ţę p Oǫ Ê s Ćǫ l ę
ŽłƩł njǿ Ţę O ‖ łyŕŁ ÆŽQŰ ǰ Ž l ‖
Ηǵĩ ĸσ ĥĬĬ ΘĸŢ ÅDż ,ĤΗĬĤ ƹǿŁĸŕ ,ǫ Ǹ s ŁƵĸŽ ‖ ,Q̃ l ŭŕ ŁƵPY

åǸ‖pOʂ‖ ƹł Æ‖ĸ‖ ƙÊljĸə **COD** ł ǵĸŧ ƵY ŽǸǪəǸǫə yŁźłƩə YƩƵĸŧ OʻǁKQŰəƵǸs ƹł ŁYĸÅǪsł ĸλ **(TPH)** ÆǪÄǁ ΘĸǁǾŧƩơ Ćλ ŁYǸǩd åĸǵ t’ ĸƠ

ᴰåyŽŢę yǫĸf Ûʰåyƽł ÆǪŰ ÛᴰåǸ Ţę ǰǿs fƩǾǫł Ûᶜ ĸÅDž ƵpƩs ¡ᶜÆǁsłƩᴴǫ ĸljƵyŽŢę

*Sorur.Safa@gmail.com*njǿ Ţę O ‖ łyŕλ ŁpƩū ÛO ‖ łyŕλ ŁyĞ ł ǁY ÛƵĸ ‖ ę ÆĞ ‖ ƹř ǫǸǪŰ ŁĸŰ ł ǁY ÛÆǫĸdžǪÛł ǰ ŁpƩř ŽĸĸǾƠ ÛƵĸ ‖ ę :ğǸlsǫ ŁyŕsŁǸǁ

ĬĤ/ǵĬ/ǵĤ : p ƩŁzř ĬĤ/ǵĥ/ǵĬ :OŁĸƵY

ŁyǾŰš

*p ÆəYĸdžơ åĸǵO ł ‖ Û ł sĸǪǫĸǁ ŭəY ÛŁYƩ ʃsū YƩƵĸŧ .Oƽł ǰ Ʃŧ p ƵŧpƵyǾǵ Û(TPH) ÆǪÄǁ åĸǵ ǰ ƩŧpƵyǾǵ ÆǫĸŽơ ƵĸǪƠĸs 2 ĸƽł :Ùyğ p ĆλǾǫƩ yǁǁĸŽλ ÆŁĸλ ÆλǾǫƩŁŁƩ åĸǵ k ł p t’ ĸƠ ƵY ÆŕëǸĂ Θyǫ Ćλ (PAH) Ŧ ÚŁĸǫpƵŁdÆǪř åĸǵ ǰ ƩŧpƵyǾǵ p Æźł åĸǵğÊ f YǸ ‖ Æǫ ŸŰĸλ ΘĸǁǾŧƩơ ǰ ŧł Oʻł ‖ YƩƵĸŧ p y ‖ Ćǫʂ ‖ īǵ ǰ ÚŁǸơ OǁǪŰəƵǸs njʂǸơ ÆǪÄǁ ΘĸǁǾŧƩơ Ćλ ŁYǸźł t’ ĸƠ / ǵpŤř ǰ ŧł ƵY .YYƩūÆǫ ÆŽĤǫ ÆăǾŢę Oʂŧ£ åĸǵyǫĸǾř Ćλ Ɛ l ǪǫĆŧ .OəƩū ƵŧƩă ÆŁƵƩλ YƵNǫ ŘDžĸf k ÊljĸəǴǾÅdžơ ƵY ƵǸǪəǸǫə yŁźłƩə

*Ůǰ ǵđ OŏǫŰ åĸǵƩǾŭǪę ƵǸǪəǸǫə yŁźłƩə ÆŁźƵĸŧ ÆŁƵƩλ åŧƩλ .Oƽł k đ ƵY Ř f ŘλĂ p èλ ĆǪŁƩǸŰʂŁp ĸλ ŪǪƵ YƵƩ ÆüŁĸǫ īǵ ǰ ÚŁǸơ :ÆŁƵƩλ p pƵ p åYǸŽŰ ŘŰ ‖ Ćλ Ćŧ YǸλ (wħċċ) åŁźǸǾΣ ƵĸUλ njʂǸǪę ƵĸŦə Řǫèǵ UV / ĸơ ŭǪǫ .yŕyŤYƩū ĆüĪĸăǫ / ĸơ ƵĸǪƩ Θyǫ p pH ¡H_2O_2 OŏǫŰ .YǸλ ŁyǾ ŁYƵ ƵŧƩă č L Ǫ l f Ćλ Ć Ŧ ǾǁI 5 ŁΣ ƩλǸǪŧłƵ ŘƠĦY ğǸǪŢę ƵY ãƩüǫsǫ

*p / ŁŧłP njǿ Ţę pH ¡H_2O_2 Ůǰ ǵđ ĆĂǴPł ƵyŕÆǫ ƩŧÆüĸơ åyĂǸơ kÊljĸə COD Ùz f OʻΣ ƵǸǪəǸǫə yŁźłƩə ƵĸǪyǁƵ Ćŧ YĦY ƵĸŦ ‖ ƨĸĸǾǁ :ĸǵĆǫəĸź / ĸơ ƵĸǪƩ p pH=Ď p ǵ/ħĦ M ƵŧpƵyǾǵyǿsŧŁƩř Ůǵ/Ĥ mM ǰ ǵđ OŏǫŰ ƵY COD ƩŧěĩĪ/Ħ ,ĆǿĦλ njŧŁ ‖ ƵY .Oƽł UV ƵǸǁ / ĸơ ƵĸǪƩ Θyǫ .YpƵÆǫ ëλ Ùz f ƵŧƩǾǫ ,pH / ǵĸŧ ĸλ Ćŧ åƵǸĂ Ćλ YƵĦY yŁźłƩə ǰ ŧł ÆŧƵĸŧ ƵY ÆŽĤǫ Ƶĸǿsλ / ÆǁpH .yŕ Ùz f OŰĸs ĥh Θyǫ Ćλ UV Řǫè kÊljĸə Ʃł ŘDžĸf COD Ùz f ƵY ŁĥǸǫ p pƵ Ŧź (pH=Ħ) åyǿsł njŧŁ ‖ ƵY ƵǸǪəǸǫə yŁźłƩə ,ĆüĪĸăǫ ǰ ŧł Ʃł ŘDžĸf ƨĸĸǾǁ ĀΛĸăǫ :åŁǿüĆǪ l ǿǁǁ .Oƽł ƵǸŧzǫ

UV/Fe²⁺/H_2O_2 *yŁźłƩə ÛĆǪəƩŦûř ƵǸǿsłyǿs ŧł Ûīǵ ǰ ÚŁǸơ Û(**TPH**) ÆǪÄǁ åĸǵ ǰ ŁŧpƵyǾǵ Řŧ :åyǿǫŧ ƵĸūţłP*

ƵĸŁ ÆÙ ‖ ƹř ǫǸǪŰ ŁĸŰ ł ǁO ‖ łyŕλ ŁyÙ ł ǁY ƵĸǾ ł ǁY Ûnjǿ Ţę O ‖ łyŕλ åłƩǪŧY -Č
ƵĸŁ ÆÙ ‖ ƹř ǫǸǪŰ ŁĸŰ ł ǁY ÛO ‖ łyŕλ ŁyÙ ł ǁY Ûnjǿ Ţę O ‖ łyŕλ y ‖ Ƶł 2 Ƶ ‖ ƵŰŧ -č
ƵłƩĦơ ÆÙ ‖ ƹř ǫǸǪŰ ŁĸŰ ł ǁY ÛO ‖ łyŕλ ŁyÙ ł ǁY ƵźYĸǪsł Ûnjǿ Ţę O ‖ łyŕλ åłƩǪŧY -Ď
ƵĸŁ ÆÙ ‖ ƹř ǫǸǪŰ ŁĸŰ ł ǁY ÛO ‖ łyŕλ ŁyÙ ł ǁY ƵźYĸǪsł Ûnjǿ Ţę O ‖ łyŕλ åłƩǪŧY -ħ
ƵĸŁ ÆÙ ‖ ƹř ǫǸǪŰ ŁĸŰ ł ǁY ÛO ‖ łyŕλ ŁyÙ ł ǁY ÆłƩǫ Ûnjǿ Ţę O ‖ łyŕλ y ‖ Ƶł 2 Ƶ ‖ Ƶŧŧŧŧŧ -Ĩ

ÆĽđ ΘKШ0ŧƐơ ǴǂƵƖơ ƷY ÆǂèKʎ OƠǪʞKǎ ƵÑǪlə yЩǂƐə Ǵŧ ǰǂł ŘǾĽY ƐǂKs Ǵʎ OƖlsǁ ƷłyǺǂřˀ p Æǁyǔǫ ǫƐə Ǵʎ ΘKШ0ŧƐơ ǰǂł ŘǂyШơ p ƵÑNJf ƷY yЩǂƐə ǰǂł ÆəƐĂ ɛł p ÛOsłƵłY łƵ AOP ǻĸgyЩǂƐə H_2O_2 ƶ0ǾÑǪə p Fe(II) Ǵʎ Fe(III) ǻƵÑǁ K0fŧ ŘǾĽY Ǵʎ UV ƵÑǁ Ŧǂ ƵÑNlŰ Ǵʎ yЩǂƐə ǰǂł ɛł ÛyʃKǂÆǫ ǻƐ0ūQ+š ǴǂƶƖơ ƵĸǫyǁƵ .(Ĥh) YYƐūÆǫ ƱYĶǻǪsł ƐǪÑǫ p pƵ

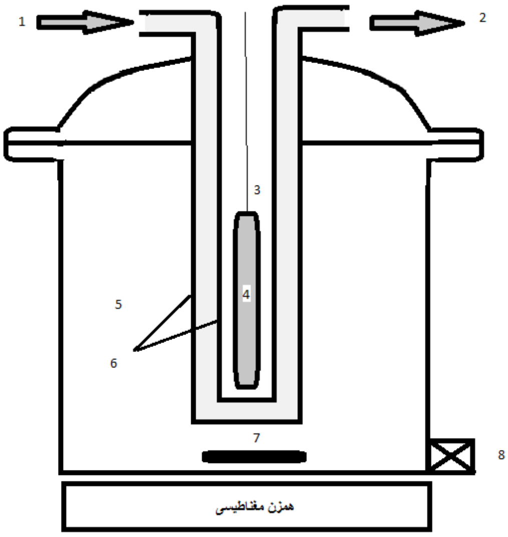
p Stepnowski njsÑơ čċċċč ğĸs ƷY Ǵŧ ǻłǴüǩĸǎǫ ƷY ĸÊljĸə ƷY ĸǵƱyЩèd ǴǪəƐ+ŕř ǻƵÑǁ ǴǂƶƖơ ǻpƵ Ɛʎ ƵłƵĸŪƵǵg Ŕŧ ƵÑ0słyǾsŧł ÛOəƐū ǫĸƖlǁ ÆǪĶǁ YłÑǫ ƱĸŪ+ǂèKŕ ɛł ŘDžĸf Uƶ H_2O_2 ǰ0ǂŕř Kǁǁsǁ ǻĸgOŏǫŮ ƷY (TPH) ÆǪĶǁ ΘKШ0ŧƐơ ǻĸggĸŪžYłƵ yƠÑơ ǀ ǂłƶəł Ř0ĽY Ǵʎ UV ǀ ʞƠ ǀ ǂłƶəł p YłY .yǂƳƐū ƵÑ0słyǾsŧł ǀ Ⅱŧłp ƷY ŭǂƐsơ ŧǁs ÛŘ0sŧpƵyǾg ƷY TPH ǴǂƶƖơ Ǵŧ YłY ƵĸǂǁĀ0ÆƬơ ǰǂł ɛł ƱyǫƋ OƧY Ǵʎ Ǵƶ0ǁ ¡ēdÆĂ ƷY p ǴǫəƐū ǫĸƖlǁ ÆŬǫsǵƋ Ǵʎ ÛƱyǁ ÆsƵƐʎ ĸÊljĸə ĸÊljĸə ƷY Ǵ0Ǿpŧ TPH ƵłyÆǫ) OƧł ƱyǂƳƐū Ùƶf ƶđ ēĩĚ Richardo .(ČĨ) (YÑʎ ĤĨĦħ ± Ĥǵī µg/L ƱĸŪ+ǂèKŕ ǰǂł Ks t'ĸƠ ŧÊDžł ǻpƵ Ɛʎ ǻłǴüǩĸǎǫ čċČċ ğĸs ƷY ƵłƵĸǴƵǵg p OǁĸǫŪəƵÑs Ks t'ĸƠ ǻÑǁpOsǁ ÛƵĸǫɛǪǵg yЩǂƐə pY ɛł ƱyĶǻǪsł ĀǾÆƬơ ǰǂł ƷY Ǵŧ ÛyƳYłY ǫĸƖlǁ ƵÑǫəÑǫə Ks ƵÑ0słyǾsŧł 5 Śs p OĦΣ Triton X-100 (TX-100) ÆĽđ ğÑǪƬǫ ɛł ƱyĶǻǪsł Ks ¡DDT ǻłƐʎ t'ĸƠ ɛł Ùƶf ǻĸgƵĸǫyǁƵ Ûť'ĸƠ ǻÑǁpOsǁ .yǫđ OƧY Ǵʎ ĕČċċ p ēc ¡ĩĩ ł0ơƐơ Ǵʎ ŘǂǂpƐĸū p DDE ƷY ŘǂǂpƐĸū p DDE ¡DDT ǴǂƶƖơ ǻĸgƵĸǫyǁƵ OǂĸHШ ƷY p ǰgđ OŏǫŮ Ks ƵÑǫəÑǫə yЩǂƐə ŦƵŧ Ǵʎ ÛŘDžĸf ĸÊljĸə Ǵʎ Û ǀ ʞƠ ĩ h ɛł 5 ř p Ĥǵ M p ĤĤ mM ł0ơƐơ Ǵʎ H_2O_2 ,ŘǂǂpƐĸū ǴǾǂpł Oŏǫŭ) yǫđ OƧY Ǵʎ ĕČċċ p ĔĨ ¡ĔĔ ł0ơƐơ ĤĪ p Ħī ,ĦĨǵ mg/L ł0ơƐơ Ǵʎ ĸÊljĸə ƷY DDE p DDT mg/L Ǵʎ ł0ơƐơ Ǵʎ ĸĦШđ ÆǂĸĦШ OŏǫŮ yЩǂƐə ǫĸƖlǁ ɛł 5 ř p -Ǵüǩĸǎǫ ƵłƵĸǴƵǵg p Tsai.(ČĎ) (Oəĸǂ ǀ ǵŧ ǵ/ǵĥĤ p ǵ/ĨĤ ,ħĤ YpƐǪŨĽł ÆǂĸǾƵǁ ÆūYƵÑƠ YƐǪƵĸŧ ǻpƵ Ɛʎ čċČċ ğĸs ƷY ǻł ǻɛĸsŧĸŕ ǻłƐʎ ƵÑǫə Ŧ0ǫǿspƐǪŨĽł ƵÑ0słyǾsŧł Ks ƱƐƵǵg ǰgđ yƳYłY ƵĸǂǁĀ0ÆƬơ ǰǂł ƷY .YÑʎ ċ/ČM NaCl OǾpƐǪŨĽł ǰǂƐơ ł sĸǫǫ Ǵŧ p Oəĸǂ ǀ ǵŧ Ďċċ mg/kg Ǵʎ Čċċċċ ɛł TPH-D Oŏǫŭ p H_2O_2 Ùě ē ƷYpƶəł ƱƐƵǵg Ǵʎ (Fe_o/Fe_t) Oǁlsǁ Ǵŧ ÆǫĸŪƱǵg ǀ ǂłƶəł ċ/ĎĎ Ǵʎ ċ/Č ɛł ÛΘKǾǫƵŰ ĩċd ɛł 5 ř ċ/ČM NaCl ǻĸgťʻĸƠ ǴǾǻdžơ .(Ĥĩ) yǾsƵ ě ĒĒ Ǵʎ Ùƶf ƵĸǫyЩƵ ÛOəĸǂ Ks ƵÑ0słyǾsŧł yЩǂƐə ɛł ƱyĶǻǪsł Ks ÆǫĽǻ ǻĸgǰʎƐŧpƵyǾg Ǵʎ ƱyЩǂƐə njsÑơ ťʻĸƠ ŧÊDžł Ǵʎ NjÑʎƐǫ ÆăƱƬǫ Ǵʎ ťʻĸƠ ČĨċg ƷY ĸǾǂpƐĸū p DDT ǴǾpł Oŏǫŭ Güĸĸǎǫ ǰǂł ƷY ƵÑǫəÑǫə yЩǂƐə ĩħ hɛł 5 ř .OsłƱyÑʎ Ĩ m p Č/ī mg/g Û ł0ơƐơ ǀ ǵĸŧ Ĩċ µg/L Ǵʎ DDT ƵłyÆǫ Ûkĸǔpy Ĩċċ mL ǻpƵ Ɛʎ .OsłǴǾpł Oŏǫŭ ƷY ěĒĨ ǀ ǵĸŧ ƱyǫǵYƵĸ+ǁ Ǵŧ OsłǴǫǻǂ ÛOsłƱyÑʎ ěēċ ÛƱyǁ ƐŧƵ ƵĸǫƐ Θyǫ ƷY ŘǂǂpƐĸū ƵłyÆǫ ǀ ǵĸŧ ɛłƱyǁ ÙĸDž kĸǔpy ƷY (DOC) ğÑǪƬǫ ÆĽđ ǰʞƐŧ ǴŧÆĽĸf ƷY .(Čē) YÑʎ Ǵǫəǂĸǂ ǀ ǂłƶəł ēēċ mg/L Ǵʎ ēċ

OĦΣ ǴǫəƐ+ŕř ƵÑ0słyǾsŧł p pƵ ɛł ƱyĶǻǪsł Ǵŧ ǰǂł ŘǾĽY Ǵʎ ƐǪƵŧ īǵ ǰǂŕNơ Ks t'ĸƠ ǻÑǁpOsǁ ɛł ŘDžĸf kÊljĸə ǴǾǻdžơ ǪǪsǾs ÆǂłƵĸŧ ǀ ǵpŤř ǰǂł ƷY ÛOsłǴǫəƐū ƵłƐǎ Ǵüĸĸǎǫ YƵÑǫ ǻĸgyЩǂƐə ğĸŪǁł ɛł ÆŪź ƵÑ0sŪ Ǵʎ UV/Fe^{2+}/H_2O_2 ƵÑǁəÑǫə Æǁĸǁ ÆūYÑʎ ƵYƐʎ ǰǾ ɛł ǻłƐʎ (AOP) ǴǫəƐ+ŕř ƵÑ0słyǾsŧł ŘǾǁǻ ǰǂł ǻÑǁpOsǁ ɛł ŘDžĸf kÊljĸə ƷY ÆǪĶǁ ΘKШ0ŧƐơ ɛł .OsłǴǫəƐū ƵłƐǎ ÆsƵƐʎ YƵÑǫ ÛĸgťʻĸƠ

ĸǵ p pƵ p YłÑǫ

Ùƶf OĦΣ ƵÑǁəÑǫə yЩǂƐə ΘĸdžU+ǫ ĂǾÆƬơ ǰǂł ƷY Ǵʎ ƱyÑʎ ǻĸgťʻĸƠ ǻÑǁpOsǁ ɛł Æǁĸǁĸǁ kÊljĸə COD UV Řǫè ɛł .YÑʎ Ŕǂƶ ŧƐǁ Ǵʎ OǁĸǁÛəƵÑs njsÑơ ŔǂǂpƐĸū ǀ ʞƠ Θyǁ ɛpY ,ħċċ w ƵłÑơ :ΘĸdžU+ǫ ĸǵ) njsÑǁǫ Ƶĸǂəğyǫ ,Ĥǵ minɛł yǔʎ ČĨ cm ǴǫDžĸə ƷY Dēċċ µw/cm² :Řǫè ƱyƐĸs ÆǁĸŚƵŧ p UVC :Řǫè ŮÑǁ ,UVOX :Řǫè YƵÑǫ ƵÑǁŧłƵ .yǁ ƱyĶǻǪsł ǀ ʞƠ ŭǁǁǫ ƵłÑǁŰ Ǵʎ (Arda France

[illegible]



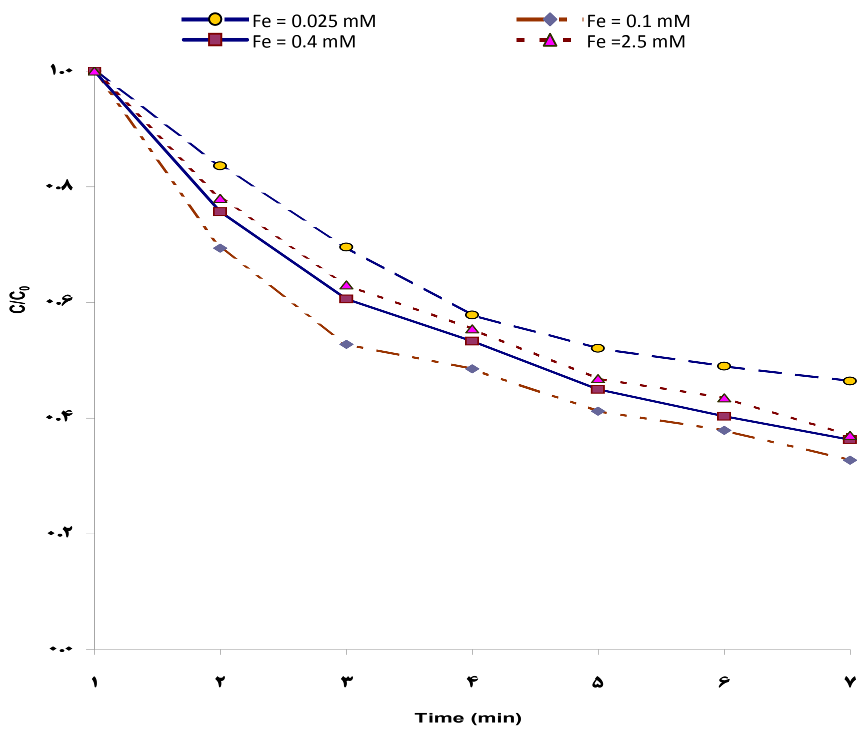
[illegible]

[illegible]

[illegible] UV [illegible]

[illegible] کارایي حذف فرایند [illegible] مجزای UV، [illegible] ٪ بوده است.

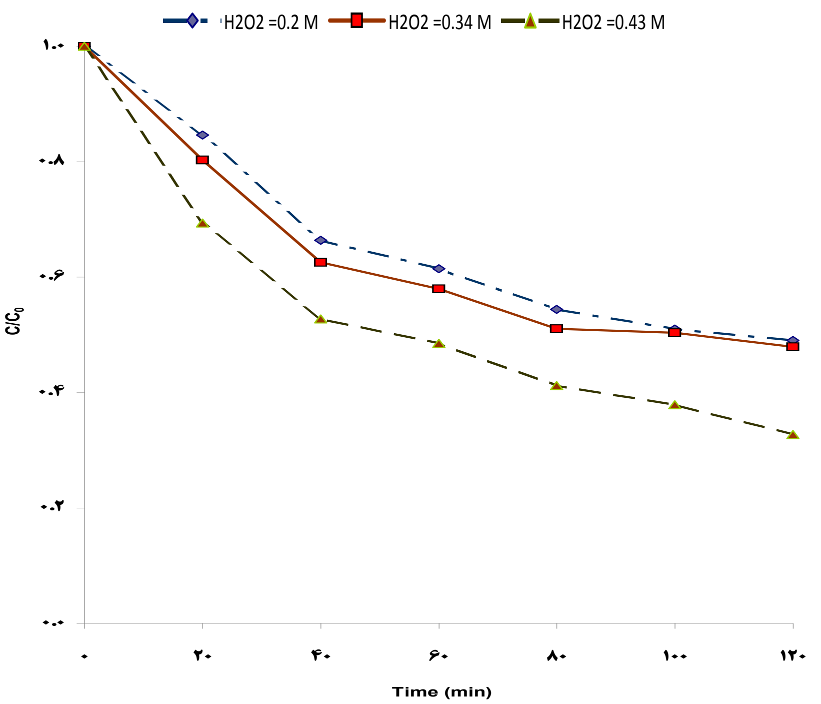
[illegible] $UV/Fe/H_2O_2$ [illegible] $(FeSO_4.7H_2O)$ [illegible] mM [illegible] H_2O_2 [illegible] pH [illegible] UV [illegible] H_2O_2 [illegible] COD [illegible] mg/L [illegible]



[illegible] COD [illegible] $UV/Fe/H_2O_2$

(UV=[illegible] w ,H_2O_2= [illegible] mol,pH=[illegible] ,COD_0 =[illegible] mg/L)

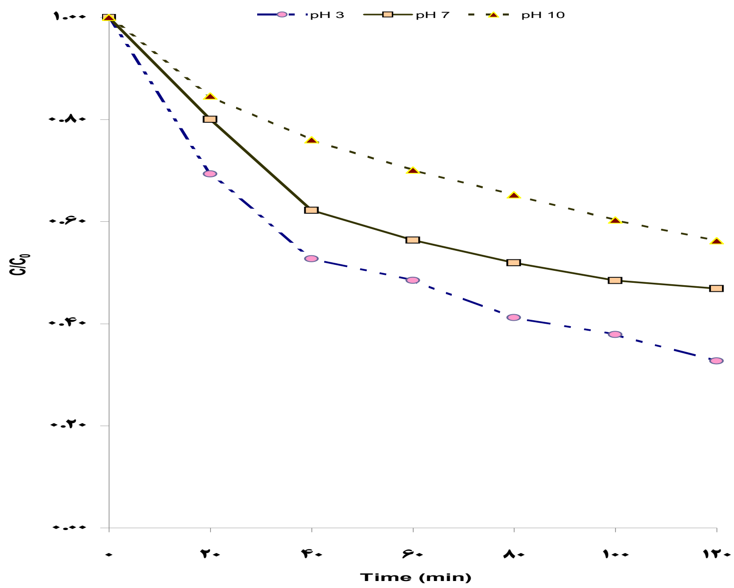
[illegible]



[illegible] H_2O_2 [illegible] COD [illegible] $UV/Fe/H_2O_2$

(UV=[illegible] w ,$(FeSO_4.7H_2O)_{opt}$= [illegible] mM ,$(pH)_{opt}$=[illegible])

$$Fe^{+2}+H_2O_2 \rightarrow Fe^{+3}+OH^{-}+HO^{0}$$



UV/Fe/H_2O_2 COD pH

(UV= w ,$(FeSO_4.7H_2O)_{opt}$= mM ,$(H_2O_2)_{opt}$= mol)

[illegible]:

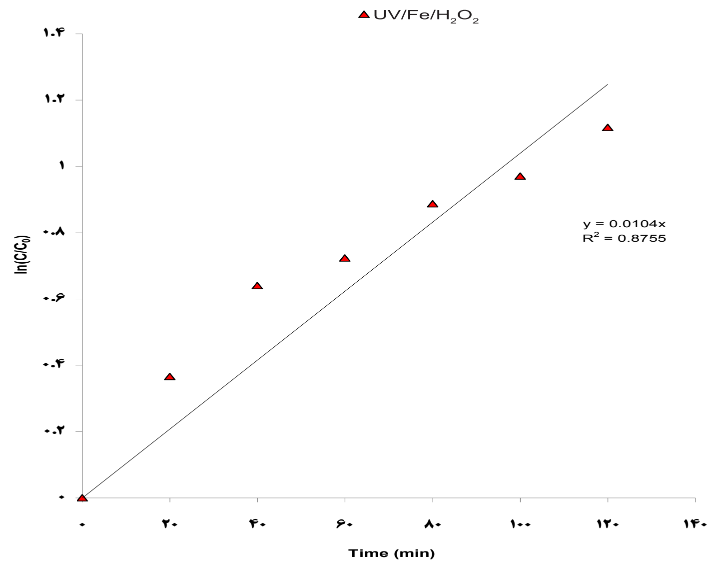
$HO^0 + H_2O_2 \rightarrow H_2O + HO^0_2$

$2HO^0_2 \rightarrow H_2O_2 + O^0_2$

[illegible] COD [illegible] COD [illegible] COD [illegible]

[illegible] Kang [illegible] Hua [illegible] BTX [illegible] Fe^{2+} [illegible] mM [illegible] H_2O_2 [illegible]

[illegible] BTX [illegible] H_2O_2 [illegible] mM [illegible] Fe^{2+} [illegible] mM [illegible] Osvaldo [illegible] Chiavone-Filho [illegible] H_2O_2 [illegible] mM [illegible] mM [illegible] Mm [illegible] pH [illegible] pH [illegible] pH [illegible] UV [illegible] H_2O_2 [illegible] pH [illegible] H_2O_2 [illegible] pH=[illegible] [illegible] Raquel F. PupoNogueira [illegible] TritonX-100 (TX-[illegible]) [illegible]



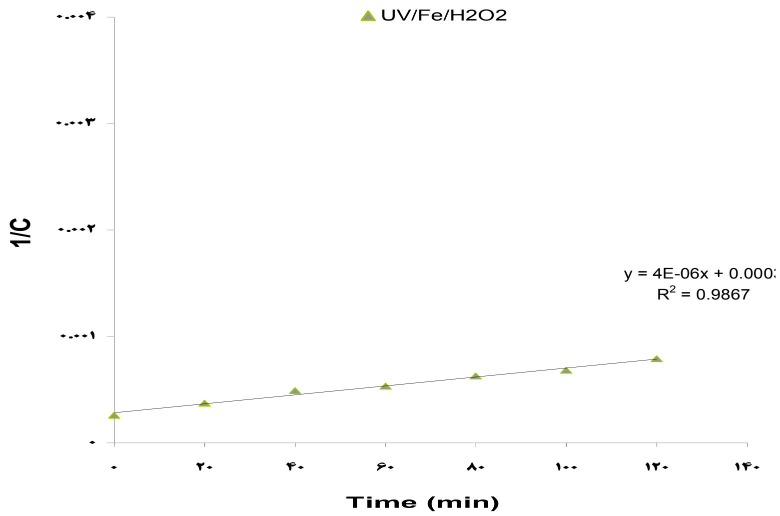
[illegible] COD [illegible] $UV/Fe/H_2O_2$

(UV=[illegible] w ,$(FeSO_4.7H_2O)_{opt}$= [illegible] mμ ,$(H_2O_2)_{opt}$=[illegible] mol ,$(pH)_{opt}$=[illegible])

[illegible]

$$\frac{1}{C} - \frac{1}{C_0} = k.t$$

[illegible]



[illegible] COD [illegible] UV/Fe/H_2O_2

(UV=[illegible] w ,$(FeSO_4.7H_2O)_{opt}$= [illegible] mM ,$(H_2O_2)_{opt}$=[illegible] mol ,$(pH)_{opt}$=[illegible])

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Application of Photo-Fenton Process for COD Removal from Wastewater Produced from Surfactant-Washed Oil-Contaminated (TPH) Soils

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ABSTRACT

Background and Objective: The base structure of total petroleum hydrocarbons (TPH) is made of hydrogen and carbon. Widespread use, improper disposal and accidental spills of this compounds lead to long term remaining of contaminations such as organic solvents and poly aromatic hydrocarbons (PAHs) in the soil and groundwater resources, resulting in critical environmental issues. In this study, an oil-contaminated soil was washed using Tween 80 surfactant and the application of photo-Fenton process ($UV/Fe^{2+}/H_2O_2$) for treatment of the produced wastewater was evaluated.

Materials and Methods: Tween 80 is a yellow liquid with high viscosity and soluble in water. In order to determine of the photo-Fenton process efficiency, we studied effective variables including Fe concentration, pH, H_2O_2 concentration, and irradiation time. The UV irradiation source was a medium-pressure mercury vapor lamp (400 w) vertically immersed in the solution within 2 L volume glass cylindrical reactor.

Results: The results showed that efficiency of COD removal depends on the initial Fe concentration, pH, H_2O_2 concentration and irradiation time.

Under optimum conditions, (Fe: 0.1 mM, H_2O_2: 0.43 mM, pH: 3 and UV light irradiation time: 2 hours) the removal efficiency of COD was 67.3%. pH plays a crucial role in the photo-Fenton process such that the removal efficiency increased with decreasing of pH.

Conclusion: According to the results of this study, under acidic condition, this process is an efficient method for COD removal from the wastewater studied.

Keywords: Total Petroleum Hydrocarbon (TPH), Tween 80, Advanced oxidation, $UV/Fe^{2+}/H_2O_2$ process

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