結合超音波程序於Photo-fenton法降解染整廢水之研究

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摘 要

本研究以紫外光(UV)/Fenton、紫外光(UV)/Fenton-like為實驗基礎，並結合超音波(Ultrasound, US)程序，對染整廢水進行降解脫色研究，以了解同相光催化處理染整廢水情形下結合超音波程序是否能增加反應速率。本研究之目標污染物為C.I. Reactive Red 2 (RR2)，探討參數包括氧化劑(Ox)和金屬離子(Me)之初始濃度效應、UV波長效應、US效應及結合UV/US的複合實驗。添加的Ox有H_2O_2和$Na_2S_2O_8$；添加的Me有硫酸亞鐵(Fe^{2+})和硫酸鐵(Fe^{3+})；UV波長有254及365 nm；US頻率為40 kHz。 從實驗結果顯示，Fenton 、Fenton-like之Ox濃度效應，Ox劑量有一恕限值；但Me則隨劑量增加，其降解效率也隨之增加。H_2O_2/Fe^{3+}之Ox濃度效應，H_2O_2濃度3 mM的k值為0.0103 min^{-1}，明顯低於2.5 mM的0.0140 min^{-1}。而$Na_2S_2O_8/Fe^{3+}$之Ox濃度效應，$Na_2S_2O_8$濃度達2 mM時的k值為0.0016 min^{-1}，明顯低於1 mM的0.0027 min^{-1}。 在UV波長效應中，UV/Fenton、UV/Fenton-like經由 UV光照後之降解效率呈現UV/Fenton＞Fenton、UV/H_2O_2/Fe^{3+}＞H_2O_2/Fe^{3+}、UV/$Na_2S_2O_8/Fe^{2+}$＞$Na_2S_2O_8/Fe^{2+}$、UV/$Na_2S_2O_8/Fe^{3+}$＞$Na_2S_2O_8/Fe^{3+}$，故得知UV光照有促進降解效果。UV波長對降解效率顯示254 nm＞365 nm。 US效應顯示US/Fenton、US/Fenton-like在 Me濃度為0.01 mM時k值呈現US/Fenton (0.0710 min^{-1})＞Fenton (0.0503 min^{-1})、US/H_2O_2/Fe^{3+} (0.0070 min^{-1})＞H_2O_2/Fe^{3+} (0.0020 min^{-1})、US/$Na_2S_2O_8/Fe^{2+}$ (0.0217 min^{-1})＞$Na_2S_2O_8/Fe^{2+}$ (0.0192 min^{-1})、US/$Na_2S_2O_8/Fe^{3+}$ (0.0049 min^{-1})＞$Na_2S_2O_8/Fe^{3+}$ (0.0005 min^{-1})，可知加入US程序有促進降解的效果。 在UV/US/Ox/Me複合實驗部分，在UV = 254 nm條件下，US程序於UV/US/Fenton及UV/US/H_2O_2/Fe^{3+}降解效果並不明顯，但在UV/US/$Na_2S_2O_8/Fe^{2+}$與UV/US/$Na_2S_2O_8/Fe^{3+}$程序上皆有促進降解的效果，可從k值得知UV/US/$Na_2S_2O_8/Fe^{2+}$ (0.0927 min^{-1})＞UV/$Na_2S_2O_8/Fe^{2+}$ (0.0661 min^{-1})、UV/US/$Na_2S_2O_8/Fe^{3+}$ (0.0314 min^{-1})＞UV/$Na_2S_2O_8/Fe^{3+}$ (0.0270 min^{-1})；在UV= 365 nm條件下，US程序於UV/US/Fenton及UV/US/$Na_2S_2O_8/Fe^{2+}$的促進效果不明顯，但在UV/US/H_2O_2/Fe^{3+}與UV/US/$Na_2S_2O_8/Fe^{3+}$程序上皆有促進降解的效果，並可從k值得知UV/US/H_2O_2/Fe^{3+} (0.0038 min^{-1}) ＞UV/H_2O_2/Fe^{3+} (0.0029 min^{-1})、UV/US/$Na_2S_2O_8/Fe^{3+}$ (0.0045 min^{-1})＞UV/$Na_2S_2O_8/Fe^{3+}$ (0.0020 min^{-1})。在抑制劑添加部分，C_2H_5OH添加均對UV/US/Fenton、UV/US/Fenton-like有明顯抑制效果，在UV/US/Fenton、UV/US/H_2O_2/Fe^{3+}程序中抑制效果最為明顯，可推估氫氧自由基為主要氧化有機物的物種；在UV/US/$Na_2S_2O_8/Fe^{2+}$及UV/US/$Na_2S_2O_8/Fe^{3+}$程序中，反應初期有明顯的降解，但降解反應並未被完全抑制，可推估氫氧自由基非系統中唯一之氧化能力的物種，硫酸根自由基亦扮演重要氧化角色。

關鍵詞 : 超音波、紫外光、過氧化氫、過硫酸鈉

目錄

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