Photochemical and Sonochemical Degradation of Halogenated Pyridines in Water

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Introduction
- Toxic, mutagenic and carcinogenic organic compounds
- Conventional biological treatment is not efficient
- Chemical treatment is necessary

Pyridines and Derivatives
- Pharmaceuticals, cosmetics, pesticides
- Toxic and biorecalcitrant
- Emphasis on 2-chloropyridine

Advanced Oxidation Processes (AOPs)
- Ultraviolet irradiation (UV)
- Ultrasound irradiation (US)
- Fenton reaction (FeSO4 + H2O2)

Research Objectives
- Comparison of efficiency of AOPs to degrade pyridines
- Optimisation of operating conditions
- Kinetics of 2-chloropyridine photodegradation

Organic Substrates
- 2-Chloropyridine (2CP), 2-Fluoropyridine (2FP), 2-Methylpyridine (2MP)
- Initial concentrations from 100 to 500 mg/L

Experimental Setup for UV Runs
- Upland Pen Ray Lamp (254 nm, 110 W, 10x200 mm) housed inside a 30 mm tubular reactor
- Continuous recirculation of the solution at 10-200 ml/min
- Liquid holdup from 140 to 500 ml and temperatures from 20 to 40°C

Experimental Setup for US Runs
- Ultrasonic 250 Labplant horn-type sonicator at 20 kHz frequency
- and 250 W electric power
- Liquid holdup of 50 ml and temperatures from 5 to 50°C

Experimental Setup for Fenton Runs
- Runs in a 2L jacketed batch vessel
- Fe2+ from 0.25 to 5 mg/L and H2O2 at 1 g/L
- Liquid holdup of 1 L and temperature at 35°C

Analytical
- HPLC coupled with UV detector at 265 nm. Separation on a Symmetry Shield RP8 column (Waters) with 20:80 acetonitrile:water at 1 ml/min
- Total organic carbon (TOC) on a Shimadzu 5050 analyser

Fig. 1. Comparison of AOPs for 2CP degradation
- UV
- US
- UV + Fenton (5 mg/L Fe2+)
- US + Fenton (5 mg/L Fe2+)

Fig. 2. Degradation of pyridines by UV or US
- UV; 2CP; 500 mg/L
- US; 2MP; 100 mg/L
- UV; 2FP; 100 mg/L
- US; 2CP; 100 mg/L
- UV + Fenton (5 mg/L Fe2+)
- US + Fenton (5 mg/L Fe2+)

Fig. 3. Effect of temperature, concentration & liquid holdup on 2CP photodegradation
- 20°C; 500 mg/L; 400 ml
- 20°C; 500 mg/L; 250 ml
- 40°C; 500 mg/L; 250 ml
- 40°C; 300 mg/L; 250 ml
- 40°C; 300 mg/L; 250 ml

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KEYWORDS
Advanced oxidation, water treatment, ultraviolet, ultrasound, pyridines