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DEGRADATION OF CHLORDECONE AND β -HCH BY PHOTOLYSIS AND PHOTO-FENTON PROCESSES

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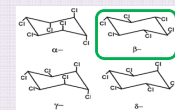
Context



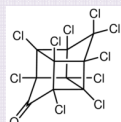
From the 1960s to the 1990s: Use of chlordecone (CLD) and beta-hexachlorocyclohexane (β -HCH) as pesticides



Intensive use of chlorinated pesticides in the banana-producing areas of Guadeloupe \rightarrow Soil and water contamination



HCH (C₆H₆Cl₆): isomeric mixtures



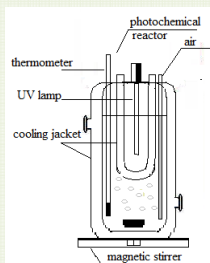
CLD (C₁₀Cl₁₀O)

Highly stable chloro-organic products
Acute toxicity (suspected as human carcinogens)

***Objective: To evaluate the degradation of CLD and β -HCH in aqueous solution by photolysis, Fenton and photo-Fenton processes.**

Materials and methods

Photochemical reactor and operating conditions:



Experimental set-up for photolysis and (photo-)Fenton oxidation (V_L = 0.7 L)

- ✓ Initial pollutant concentration: 1 mg L⁻¹
- ✓ Temperature: 30(±1)°C
- ✓ UV source: medium-pressure mercury vapor lamp (450W, Hannovia) in quartz immersion well.
- ✓ Of total energy radiated, approximately 40-48% is in the ultraviolet portion of the spectrum, 40-43% in the visible, the balance in the infrared
- ✓ Maximum absorbance of molecules: CLD= 320 nm, β -HCH= 320 nm
- ✓ Fenton's reagent: H₂O₂ (30% sol.) / FeSO₄·7H₂O as ferrous ion source
- ✓ pH: 2.6
- ✓ samples treated with a quenching solution (MeOH:sample = 1:1) and centrifuged prior to analysis when iron is used

Liquid chromatography analysis:



Chemical analysis: LC-MS/MS

Detector: Mass spectrometry (triple quadrupole MS/MS)	Followed transitions: CLD: 506.85 [M+OH] ⁻ β -HCH: 321.8 [M+O ₂] ⁻
Ionization: Atmospheric pressure chemical ionization (APCI), negative mode	Mode: MRM (Multiple Reactions Monitoring)
Column: Waters C18 Xbridge, 3.5 μ m, 3*100mm T = 50°C	*external calibration was used

Conclusions and perspectives

Photolytic degradation of chlordecone (69 %) and β -HCH (>99 %) in aqueous solution within 5 hours

\rightarrow Intermediates to be identified (by GC-MS/MS)

No apparent oxidation by free radical mechanism \rightarrow Other conditions (higher [H₂O₂]) and oxidant (O₃) to be investigated

Acknowledgements

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State of art

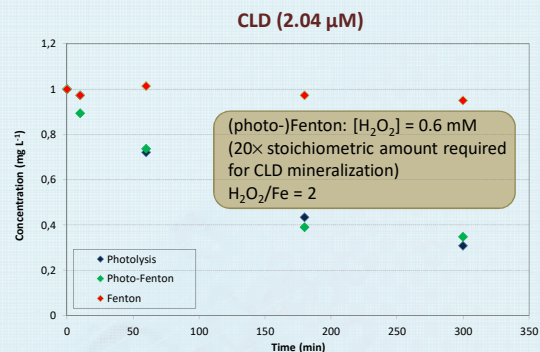
Only reports on lindane (γ -HCH) remediation

- Photolysis: promotion of γ -HCH transformation by α -Fe₂O₃ and inhibition in the presence of dissolved organic matter. (Fu et al., Langmuir, 2004)

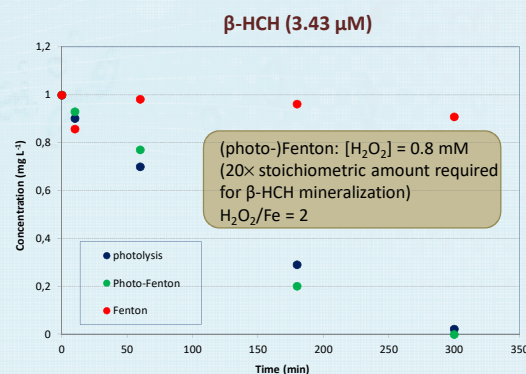
- UV/H₂O₂: 90% conversion in 4 minutes for 0.26 μ M of γ -HCH and 1 mM of H₂O₂ (Nienow et al., Chemosphere, 2008)

- Photo-Fenton: 95% conversion in 2 hours for 3.47 μ M of γ -HCH and 29.41 mM of H₂O₂ with H₂O₂/Fe=20 (Nitoi et al., J. Ind. Eng. Chem., 2013)

Results and discussion



- ✓ Degradation by photolysis only
- ✓ No (additional) effect of either Fe²⁺/H₂O₂ or UV/H₂O₂ in the investigated conditions



- ✓ Faster photolytic degradation than for CLD
- ✓ As for CLD, no appreciable oxidation by H₂O₂ based processes