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ON SITE ALKALINE HYDROLYSIS OF FLUIDS EXTRACTED IN SEAR TREATMENT IN THE LIFE SURFING PROJECT AT BAILIN – SABIÑÁNIGO (HUESCA)

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LIFE SURFING

- 
- TRACERS
 - SEAR 1 – 2 (Surfactant Enhanced Aquifer Remediation)
 - S-ISCO (Surfactant Enhanced in-situ Chemical Oxidation)
- 

FLUIDS EXTRACTED FROM SEAR TEST

EMULSION highly polluting with

Chlorinated Organic + Surfactant
Compounds - COCs E-mulse 3®



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VARIOUS TECNIQUES ARE EVALUATED

3 on-site treatments

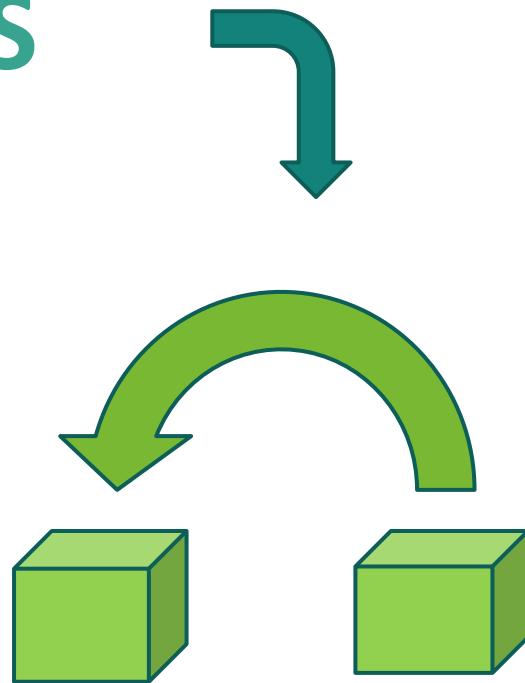
- Advanced Oxidation (Fenton Reagent)
- Activated Carbon and its Regeneration
- Thermal Alkaline Hydrolysis with Aireation

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OBJECTIVES



BAILIN'S TREATMENT PLANT

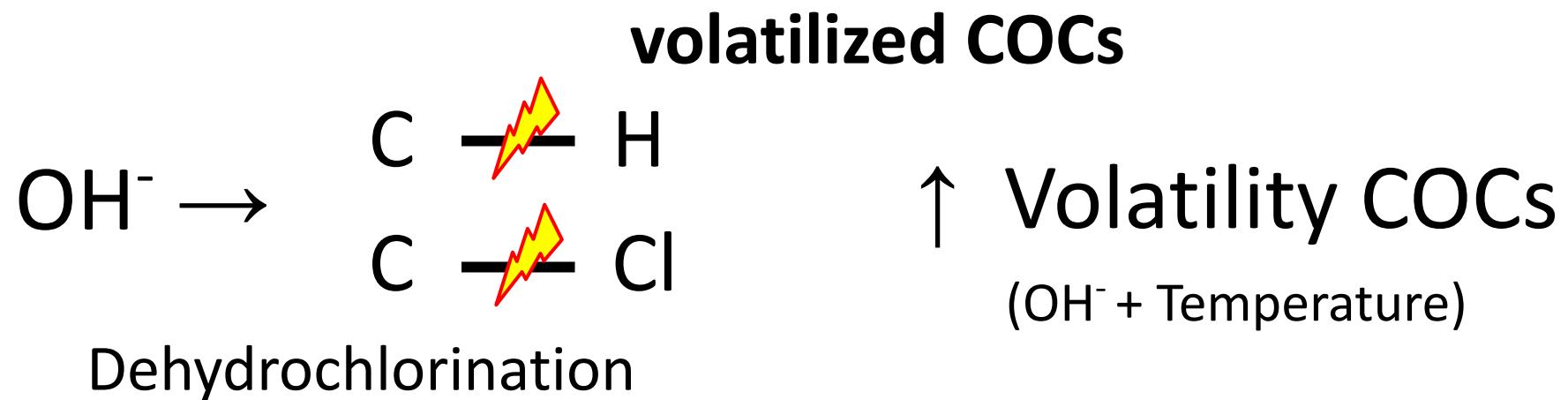


REUSE

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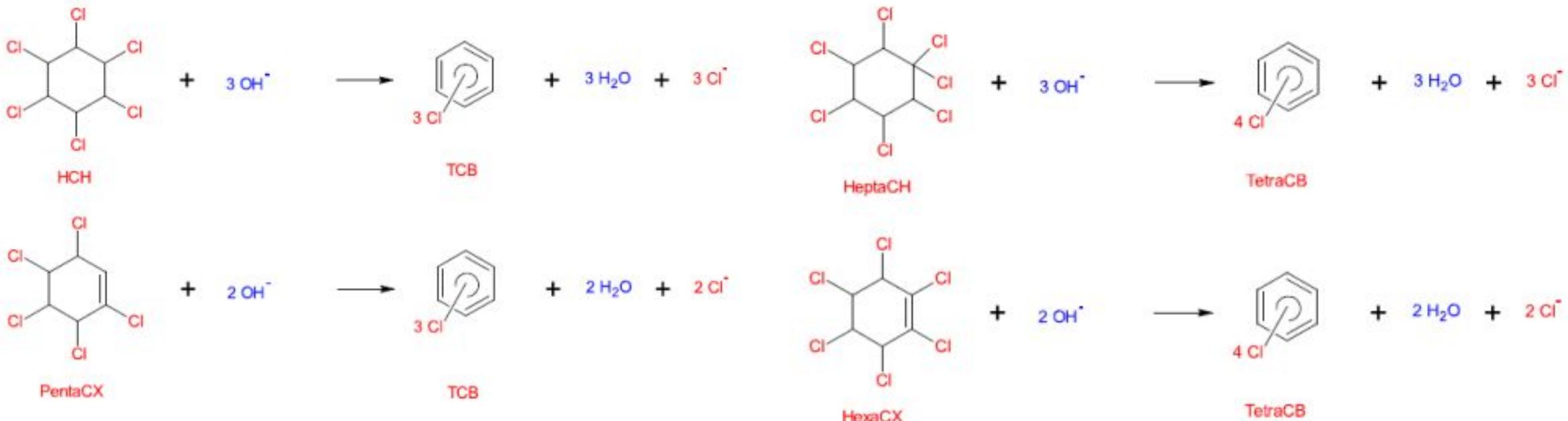
1. THERMAL ALKALINE HYDROLYSIS

Alkaline Hydrolysis with NaOH and
temperature-enhanced with air steam for dragging



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1. THERMAL ALKALINE HYDROLYSIS



Dehydrochlorination reactions at alkaline pH (A, Santos [1])



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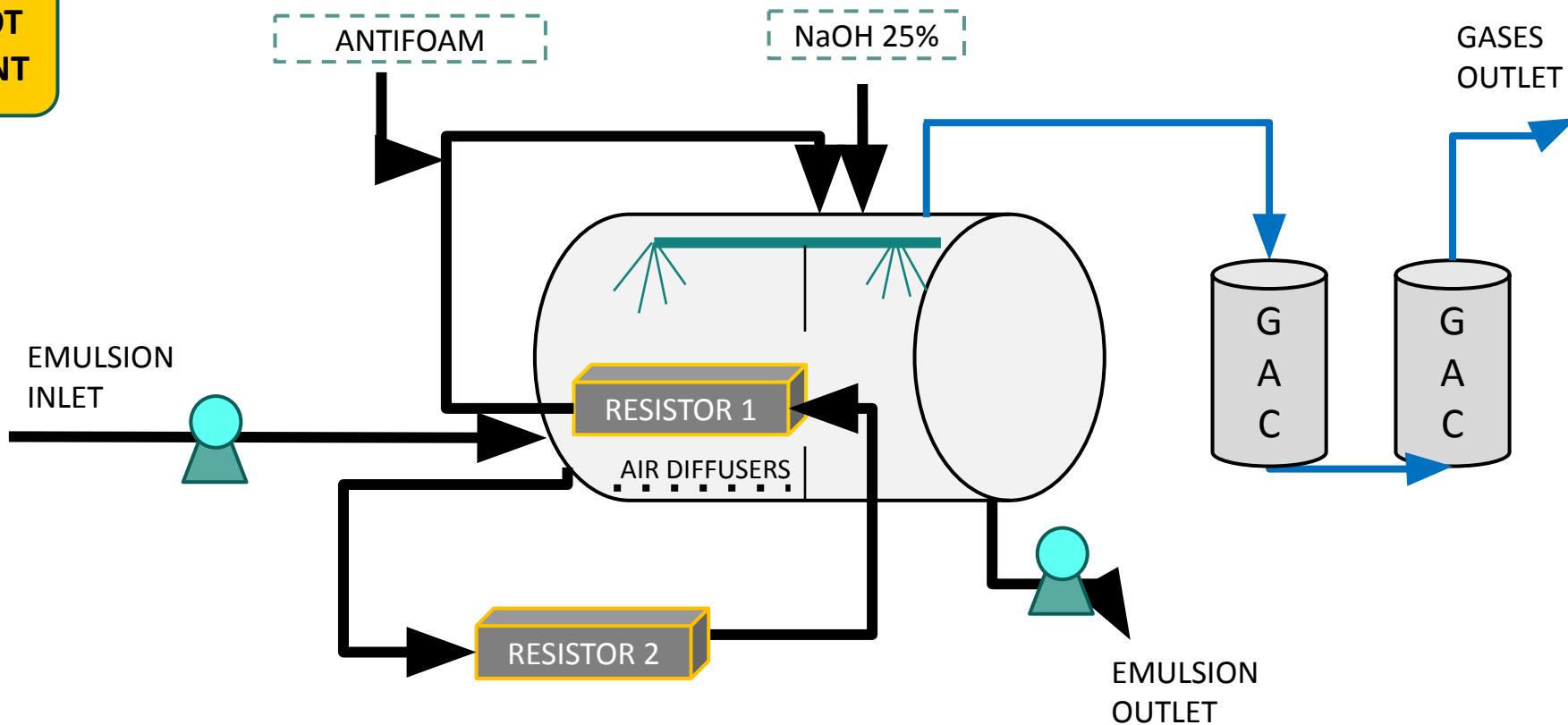
1. THERMAL ALKALINE HYDROLYSIS

- Alkaline conditions → Cl, H (TCB, DCBs...)
- Heavier compounds → Lighter compounds
 - ↑ Volatility
 - ↓ Toxicity
- Total mineralization → $\text{CO}_2 + \text{H}_2\text{O} + \text{Cl}^-$

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1. THERMAL ALKALINE HYDROLYSIS

PILOT
PLANT



- 6 m³ capacity
- Air compressor
- Double chamber
- Level Sensor
- pH measurement
- Antifoam dosage pump
- NaOH pulse pump
- 24 kW resistors (x2)
- GAC filters (x2)

1. THERMAL ALKALINE HYDROLYSIS



RESISTORS

1. THERMAL ALKALINE HYDROLYSIS



SPRAY
SISTEM

AIR
DIFFUSERS

1. THERMAL ALKALINE HYDROLYSIS





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1. THERMAL ALKALINE HYDROLYSIS

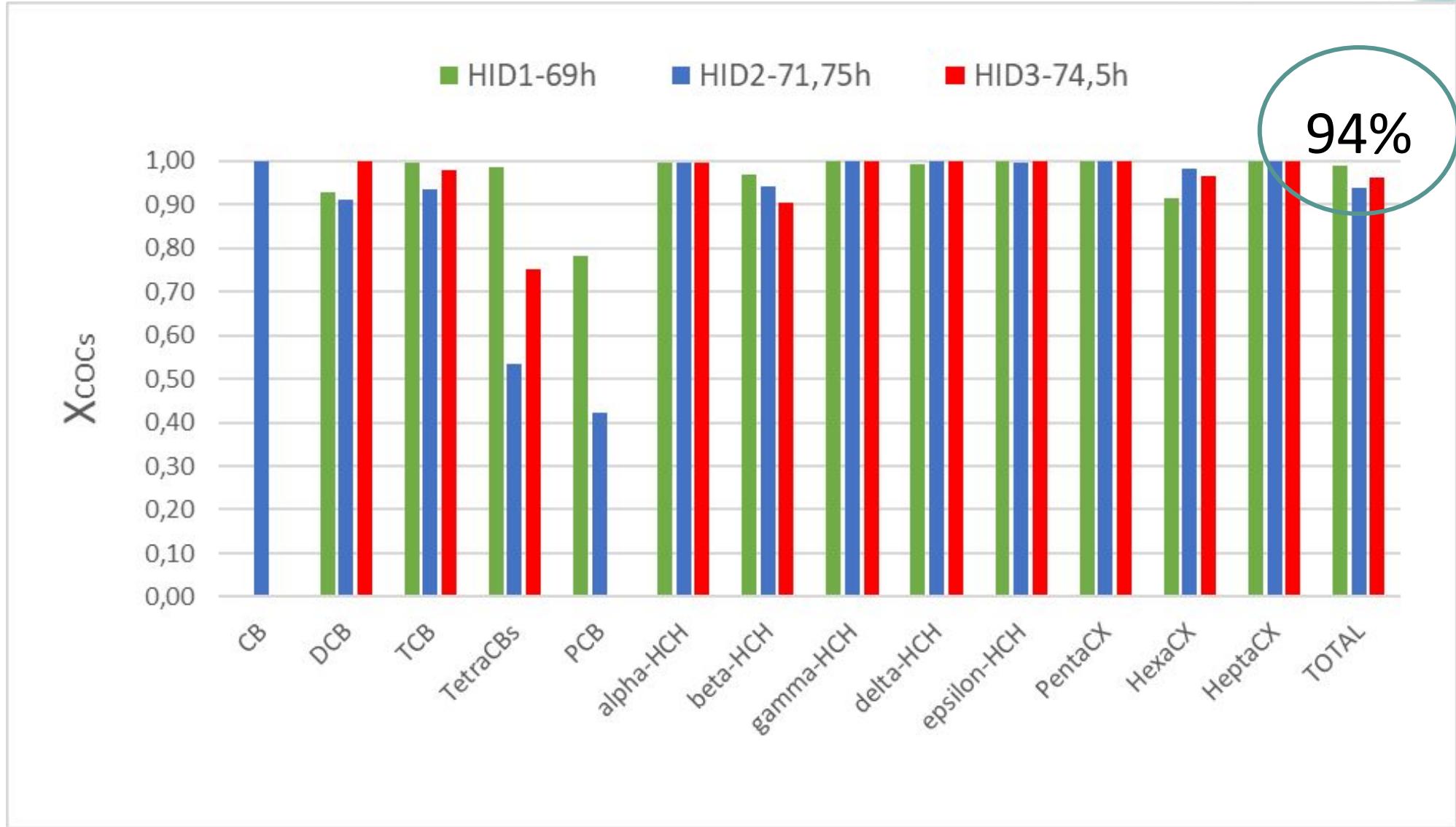
PILOT
TESTS

	HID-1 (June 2022)	HID-2 (July 2022)	HID-3 (October 2022)
V treated = 1835L	V treated = 1907L	V treated = 2122L	
118,78 ppm ΣHCHs	388,83 ppm ΣHCHs	118,76 ppm ΣHCHs	
448,75 ppm ΣCOCs	1209,84 ppm ΣCOCs	454,05 ppm ΣCOCs	
0,58 g/L E-mulse 3®	0,65 g/L E-mulse 3®	1,49 g/L E-mulse 3®	
NaOH 25% = 32,04L	NaOH 25% = 114,89L	NaOH 25% = 350,0L	
Antifoam = 6,6L	Antifoam = 3,8L	Antifoam = 6,3L	
T = 45°C-50°C			
pH set point = 12	pH set point = 11,7	pH set point = 12	
pH average = 12,56	pH average = 12,74	pH average = 12,63	
NaOH Addition = Manual	NaOH Addition = Automatic	NaOH Addition = Automatic	

1. THERMAL ALKALINE HYDROLYSIS

	HID-1				HID-2					HID-3				
	V treated = 1835L				V treated = 1907L					V treated = 2122L				
	DECONTAMINATION YIELDS													
Time (h)	0	6,75	45	69	0	21	48	71,75	186,5	0	2,5	21	74,5	217,5
α-HCH ppm	-	99,6%	99,5%	99,6%	-	98,7%	99,5%	99,7%	99,7%	-	99,5%	99,5%	99,5%	99,6%
β-HCH ppm	-	19,7%	80,3%	96,7%	-	64,3%	83,4%	94,3%	77,7%	-	-22,9%	30,1%	90,4%	100 %
γ-HCH ppm	-	100,0%	100,0%	100,0%	-	99,9%	100,0%	99,8%	100,0%	-	96,3%	100,0%	100,0%	100 %
δ-HCH ppm	-	99,7%	99,4%	99,2%	-	99,8%	99,9%	99,9%	99,8%	-	99,9%	100,0%	100,0%	100 %
ε-HCH ppm	-	100,0%	100,0%	100,0%	-	99,7%	99,9%	99,6%	99,8%	-	93,0%	100,0%	100,0%	100 %
Suma HCH ppm	-	99,5%	99,7%	99,8%	-	99,5%	99,8%	99,8%	99,7%	-	97,2%	99,6%	99,8%	99,9%
Suma COCs ppm	-	51,6%	96,5%	98,8%	-	56,8%	74,7%	93,8%	93,2%	-	38,3%	81,1%	96,2%	96,0%
E-mulse 3® g/L	-	100,0%	100,0%	100,0%	-	70,8%	100,0%	100,0%	100,0%	-	41,6%	100,0%	100,0%	100 %
ΣHCH removed from aq phase (g)	217,58				739,57					251,75				
ΣCOCs removed from aq phase (g)	813,24				2149,42					925,0				

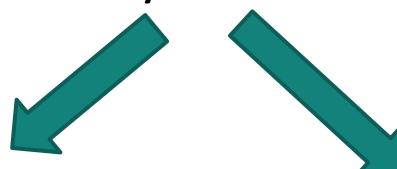
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1. THERMAL ALKALINE HYDROLYSIS

- Degradation of HCHs, COCs and E-mulse 3® at 45°C and pH 12
- Degradation of HCHs > COCs (~ 70 h - 94%)
- Reuse due to ↑pH → Dehydrochlorination on-site
- Preference generation of 1,2,4-TCB and TetraCBs
- Heat and Aireation → ↓↓↓ [CLF, VOL] of aqueous matrix
- 63-73% of total cost → electrical consumption
- Design improvement of reactor-system



Save Reagents

Isolation

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ADVANCED OXIDATION

- Selective Conv > 95% COCs – 48 hours
- Stoichiometric amount peroxide
- Fenton reactive (H_2O_2 / Fe^{2+}) = 45/1
- Treated emulsion → Surfactant capacity

ACTIVATED CARBON AND ITS REGENERATION

- Adsorption > 99% COCs
- Recovery ~ 80% adsorption capacity GAC (lab)
- Unproductive consumption of persulfate
- Treated emulsion → Surfactant capacity

THERMAL ALKALINE HYDROLISIS

- Degradation ~94% COCs at 45°C and pH 12
- Degradation HCHs (6-24h) 100% > COCs (~ 70 h - 94%)
- Heat and Aireation → ↓↓ [CLF, VOL] of aqueous matrix
- Treated emulsion → Dehydrochlorination capacity

- 3 Techniques are capable of treating the emulsion resulting from the SEAR tests
- Optimise the cost of the treatments
- Improve operating conditions



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REFERENCES

- [1] D, Lorenzo, R, Garcia-Cervilla, A, Romero, A, Santos, Partitioning of chlorinated organic compounds from dense non-aqueous phase liquids and contaminated soils from lindane production wastes to the aqueous phase, Chemosphere, 239 (2020) 124798,

THANK YOU FOR YOUR ATTENTION

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