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ON SITE REMEDIATION OF FLUIDS EXTRACTED IN SEAR TREATMENT IN THE LIFE SURFING PROJECT AT BAILIN – SABIÑÁNIGO (HUESCA): SELECTIVE POLLUTANTS OXIDATION AND ADSORPTION

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LIFE SURFING

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

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FLUIDS EXTRACTED FROM SEAR TEST

EMULSION highly polluting with

- Chlorinated Organic Compounds
  - COCs
- Surfactant
  - 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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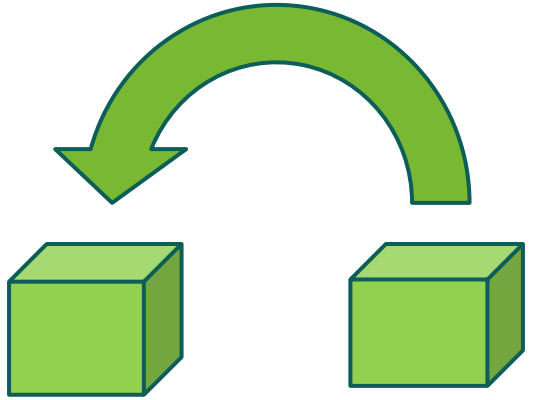
OBJECTIVES

BAILIN´S TREATMENT PLANT



REUSE

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1. ADVANCED OXIDATION

2. ACTIVATED CARBON AND ITS REGENERATION

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1. ADVANCED OXIDATION

Selective Oxidation of COCs with Fenton Reagent

$$H_2O_2 + Fe^{2+} \longrightarrow OH^{\cdot} + Fe^{3+} + OH^{-} \qquad \text{Eq.1}$$

$$Fe^{3+} + H_2O_2 \longrightarrow Fe^{2+} + HO_2^{\cdot} + H^{+} \qquad \text{Eq.2}$$

The catalyst, Fe^{2+}, is regenerated by Eq.2, producing the $HO2^{\cdot}$ radical with lower oxidizing power than $OH^{\cdot}$

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LAB

1. ADVANCED OXIDATION

3,7 g/L DNAPL solubilized + 11 g/L E-mulse 3®

- 12 mol H_2O_2 / 1 mol COC
- Ratio H_2O_2 / Fe^{2+} = 32

Stoichiometric amounts of hydrogen peroxide

50% - 100% - 200%

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1. ADVANCED OXIDATION

Selective oxidation of COCs vs Surfactant

LAB	50% stoichiometric	100% stoichiometric	200% stoichiometric
ΣCOCs	<80% - 144 h	>80% - 144 h	>80% - 48 h
Surfactant Capacity	↓20% - 144h	↓40% - 144h	↓50% - 144h

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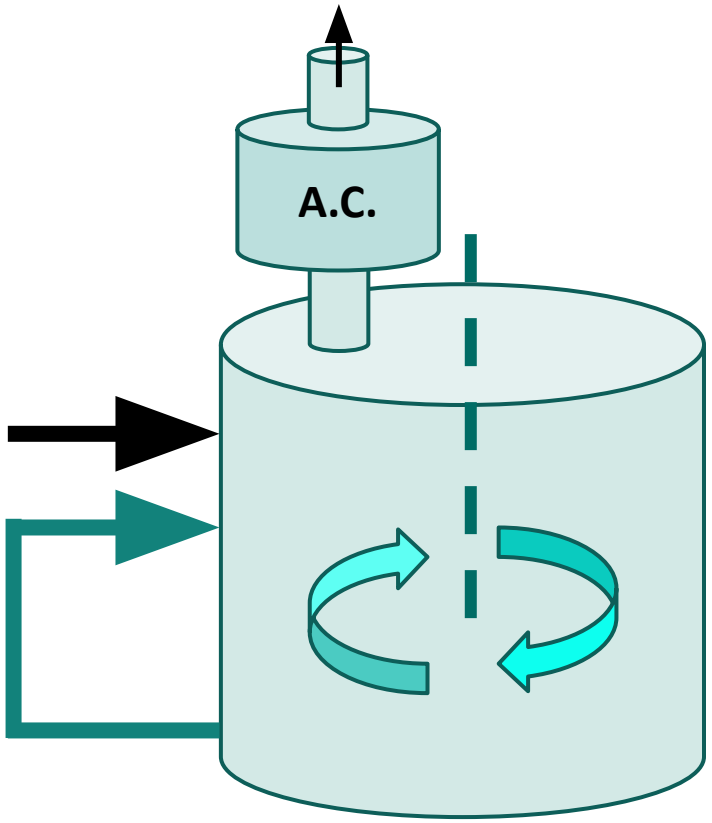
PILOT TEST

1. ADVANCED OXIDATION



- Volume 300L
- Agitation
- Recirculation
- Slow Aireation
- pH control

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PILOT TEST

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PILOT TEST

1. ADVANCED OXIDATION

200L - 5,166g/L DNAPL solubilized + 10 g/L E-mulse 3®

~ 24 mM COCs - 220 mM H_2O_2 - 5 mM Fe^{2+}

pH 5,7 $\rightarrow$ 3,3 H_2SO_4

90% Stoichiometric amount of hydrogen peroxide

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PILOT TEST

1. ADVANCED OXIDATION

- Keeping agitation and recirculation
- Samples taken at 2, 5, 10, 24, 48 and 72 hours
- Neutralization of samples before análisis FID/ECD
- COCs conv. >95% at 48h (total H_2O_2 consumption)
- Neutralization of emulsion before reuse with NaOH 25%

  pH 3,3 $\rightarrow$ 11,4 ($\downarrow Fe(OH)_3$ and $\downarrow Fe(OH)_2$)

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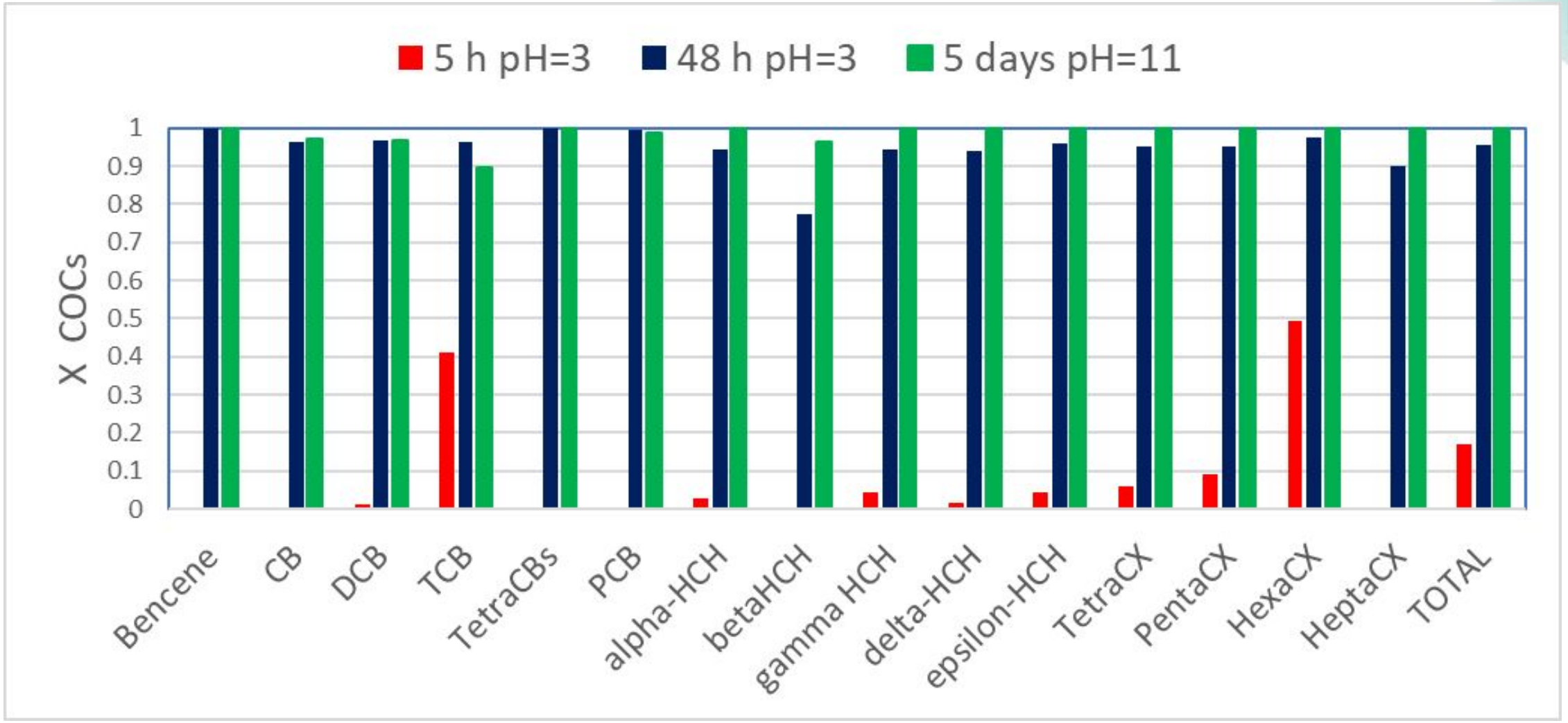

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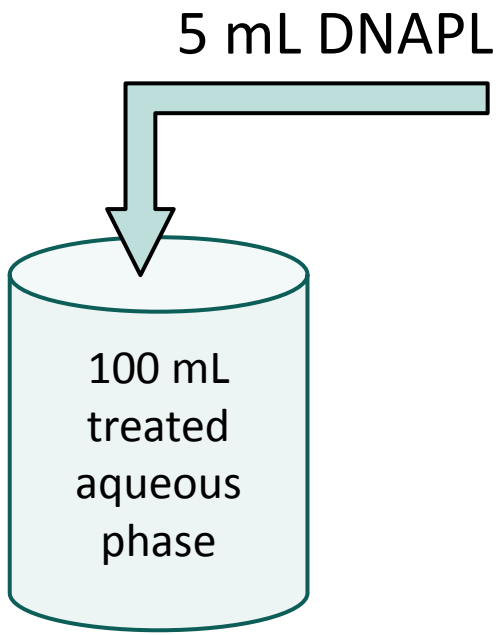
1. ADVANCED OXIDATION

PILOT TEST

Solubilization Capacity?

- 24 hours ultrasonic agitation
- Analysis 9 g/L COCs

↳ ~ 10 g/L surfactant



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1. ADVANCED OXIDATION

2. ACTIVATED CARBON AND ITS REGENERATION

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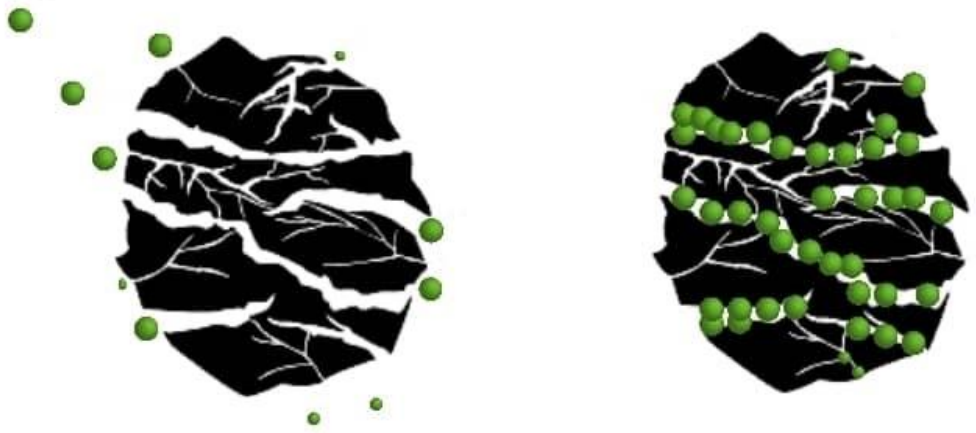
2. ACTIVATED CARBON AND ITS REGENERATION

Adsorption of COCs and Surfactant on Granular Activated Carbon (GAC) and AC regeneration with Thermal Activated Persulfate (TAP)



$$S_2O_8^{2-} \xrightarrow{Temperature} 2SO_4^{\cdot}$$

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2. ACTIVATED CARBON AND ITS REGENERATION

Granular Activated Carbon (GAC)

- 905 m^2/g BET surface area
- 0,42 cm^3/g total pore volume
- WWTP Bailin landfill

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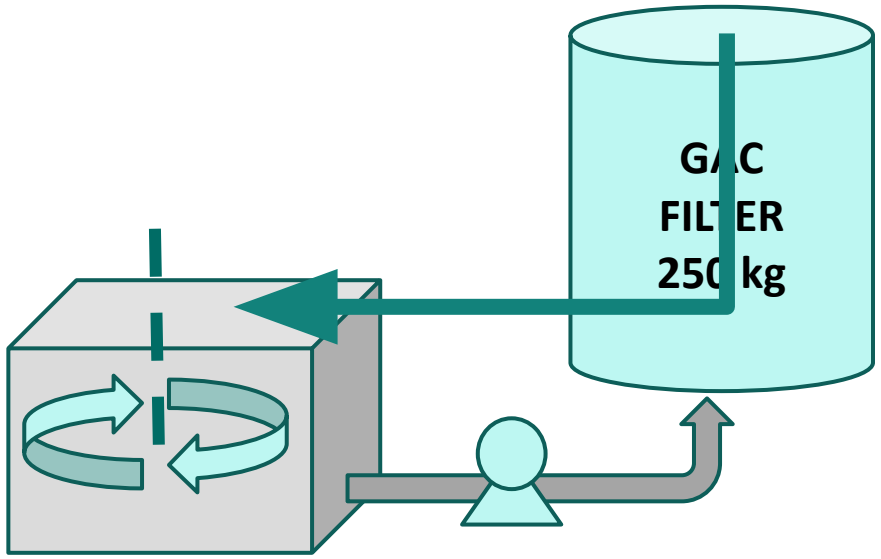
2. ACTIVATED CARBON AND ITS REGENERATION

PILOT TEST

250L - 8 g/L DNAPL solubilized + 16 g/L E-mulse 3®



- Pump 400 L/h
- TR = ~ 40 min (1 cycle)
- Bed porosity = 275 L
- Test 20 hours (30 cycles)
- Samples: 1,2,3,4,5,7,20 hours

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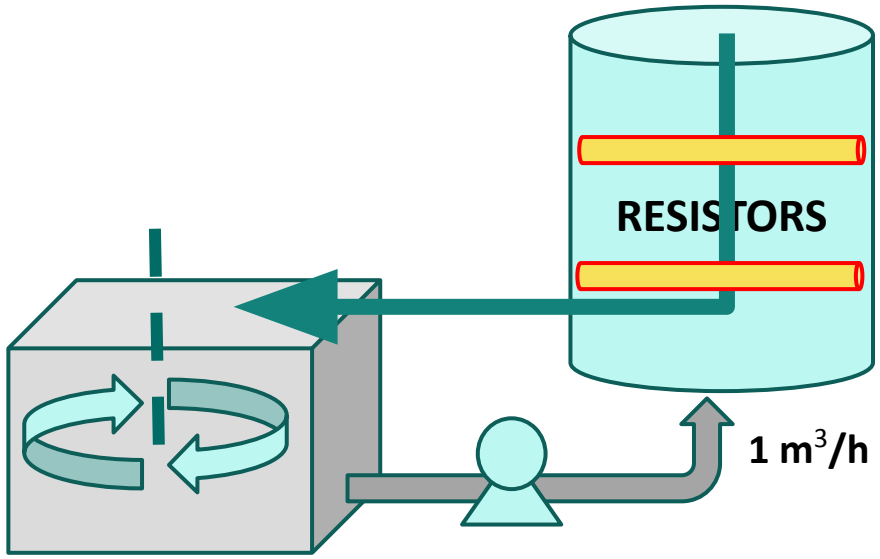
2. ACTIVATED CARBON AND ITS REGENERATION

PILOT TEST

250L - 8 g/L DNAPL solubilized + 16 g/L E-mulse 3®

45ºC



500 L
40 g/L PS

- 40 g/L $Na_2S_2O_8$
- 75% stoichiometric amount COCs
- 45 min – 42ºC-45ºC
- Test 20 hours
- Samples: 1,5,20 hours

$$S_2O_8^{2-} \xrightarrow{Temperature} 2SO_4^{\cdot}$$

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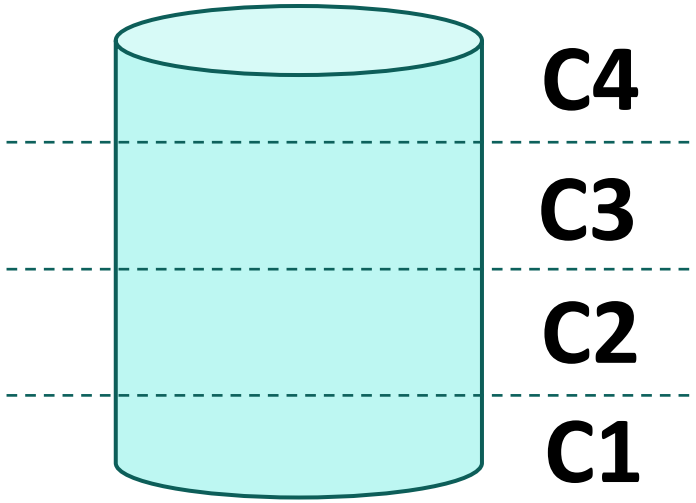
2. ACTIVATED CARBON AND ITS REGENERATION

PILOT TEST



GAC FILTER

- Drained
- Washed
- Disassembled
- Dryed
- Homogenized
- Samples extracted and analyzed

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2. ACTIVATED CARBON AND ITS REGENERATION

LAB

- $[COCs]_{SAT}$ ~ 120 mg/g carbon
- $[SURF]_{SAT}$ ~ 160 mg/g carbon
- Adsorption-regeneration cycles

⬇

Recovery 80% adsorption capacity GAC

Lower Surfactant adsorption in each cycle

PILOT TEST

- Adsorption > 99%
- [COCs] = 8 mg/g < SAT
- [SURF] = 16 mg/g < SAT

AFTER REGENERATION

COCs ~ 30%

- PS 75% stoichiometric COCs
- Surfact consumption
- GAC consumption (0,5 g PS / g carbon)

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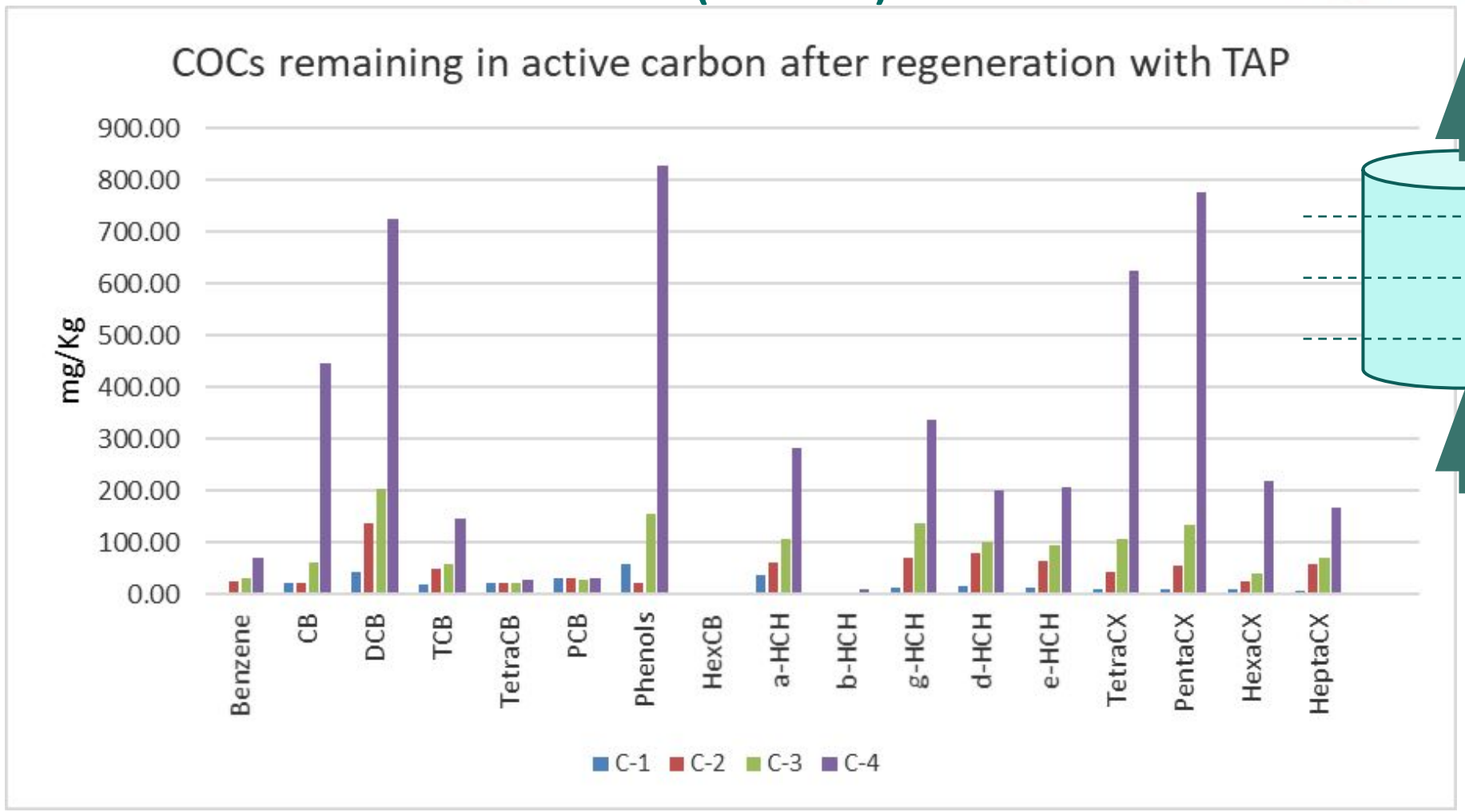

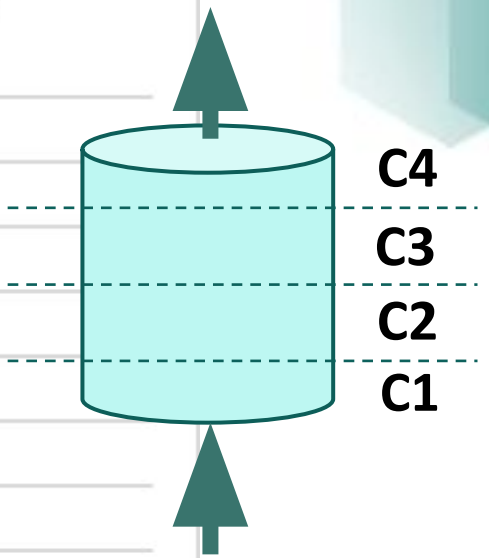

Efficiency of TAP in COCs oxidation in GAG filter

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1. ADVANCED OXIDATION

- Selective Conv. > 95% COCS – 48 hours (pH = 3, room conditions)
- Stoichometric amount peroxide
- Fenton reactive (H_2O_2 / Fe^{2+})= 45/1
- Treated emulsion → Surfactant capacity

2. ACTIVATED CARBON AND ITS REGENERATION

- Adsorption > 99% COCs
- Recovery ~ 80% adsorption capcity GAC (lab)
- Adsorption-Regeneration
- Umproductive consumption of persulfate

- Both techniques are capable of treating the emulsion resulting from the SEAR tests
- Optimice the cost of the treatments
- Improve operating conditions

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THANK YOU FOR YOUR ATTENTION

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