

Combined Electrochemical and Biological Treatment – a new approach

Industrial Wastewater Treatment

Thursday 12 May 2005

The Exchange, Express Park, Bridgwater

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Agenda

- ✓ Introduction
- ✓ Biofiltration
- ✓ EAOP
- ✓ AQUA-BIOMANT[®]-Process





Industrial wastewater

- ✓ Biological treatment
→ BOD elimination
- ✓ Biofiltration efficient step (BAT)
- ✓ Electrochemical treatment (EAOP)
- ✓ Combination of biofiltration and electrochemical oxidation as a **new** technology





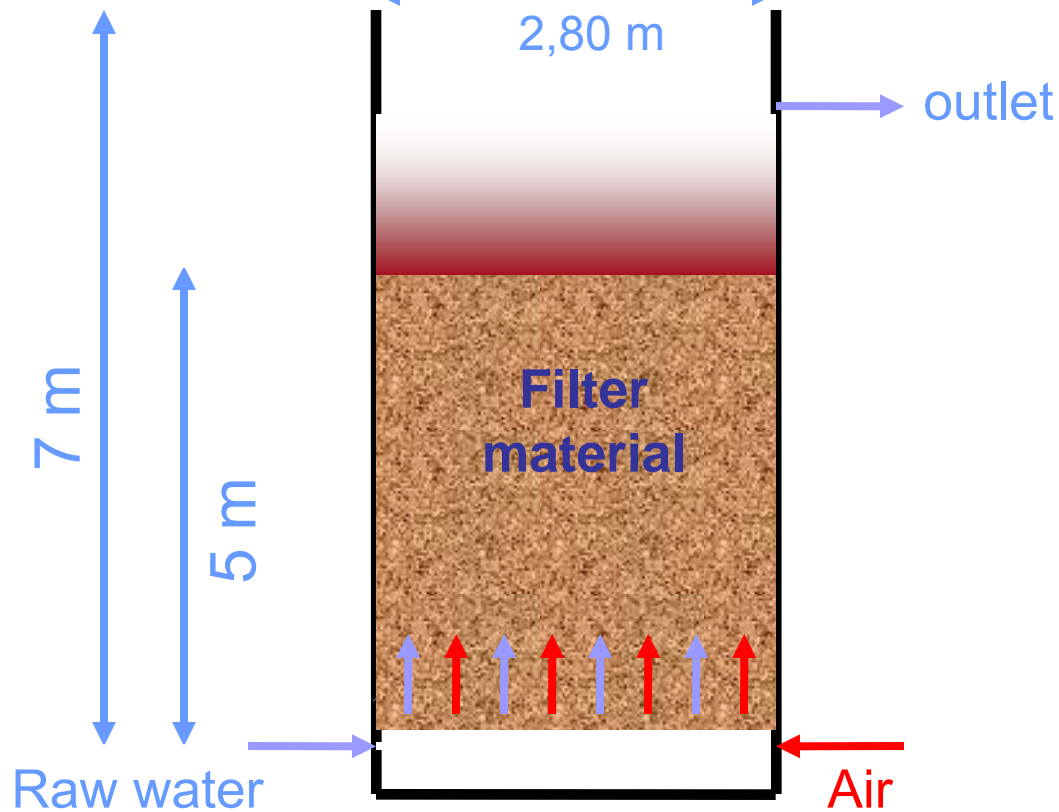
Biological Filtration

- ✓ **Best Available Technique** for wastewater treatment with low-medium organic concentration
- ✓ **Very efficient** for municipal and industrial installations
- ✓ **New generation** of biofiltration with low investment costs and full automation





Upflow biofiltration Process mechanism



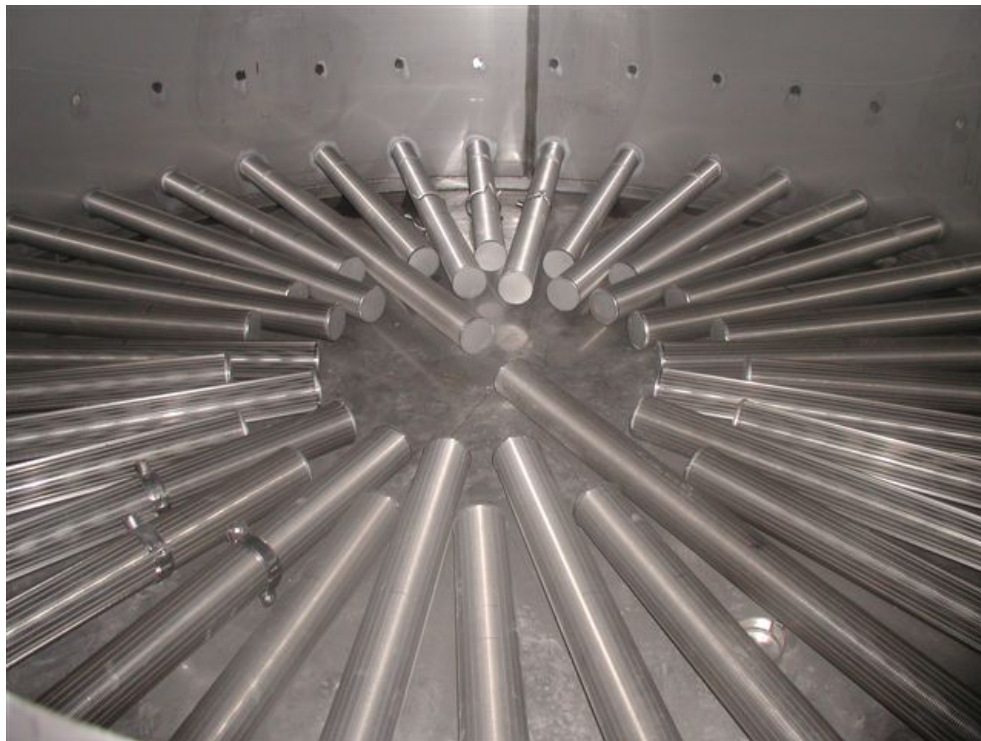


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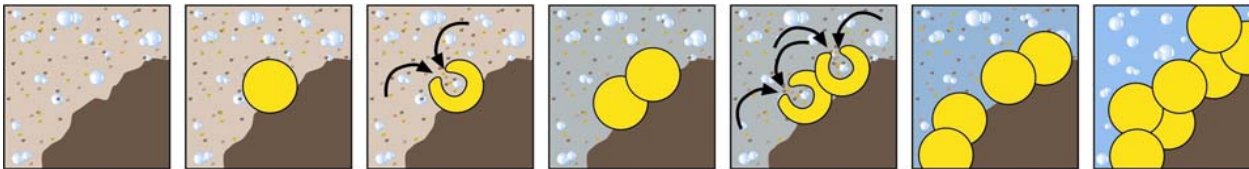
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Upflow biofiltration Bottom construction





Purification of the residual water through the bacterial growth



Wastewater flows through the filter material and is aerated additionally

Purification bacteria settle in the milieu, which they deem ideal...

..live on the contamination in the water and on oxygen

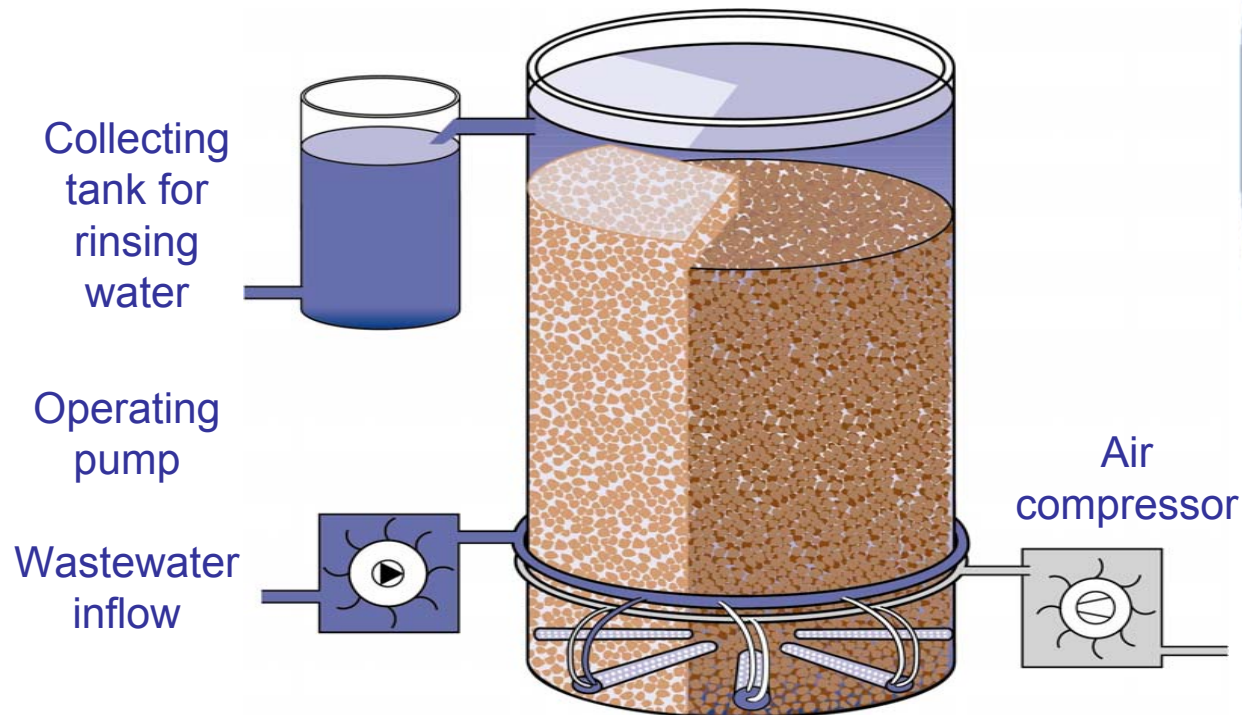
.. and multiply through cell division.

The increasing reproduction of the bacteria (biomass) gives rise to the optimum biological purification of the water.





Process mechanism





Upflow biofiltration

✓ Operation

$$V_{\text{water}} = 5 \sim 10 \text{ [m}^3\text{/m}^2\cdot\text{h]}$$

$$V_{\text{air}} = 5 \sim 10 \text{ [m}^3\text{/m}^2 \cdot\text{h]}$$

✓ Backwashing 30 to 60 min

$$V_{\text{water}} = 20 \sim 30 \text{ [m}^3\text{/m}^2 \cdot\text{h]}$$

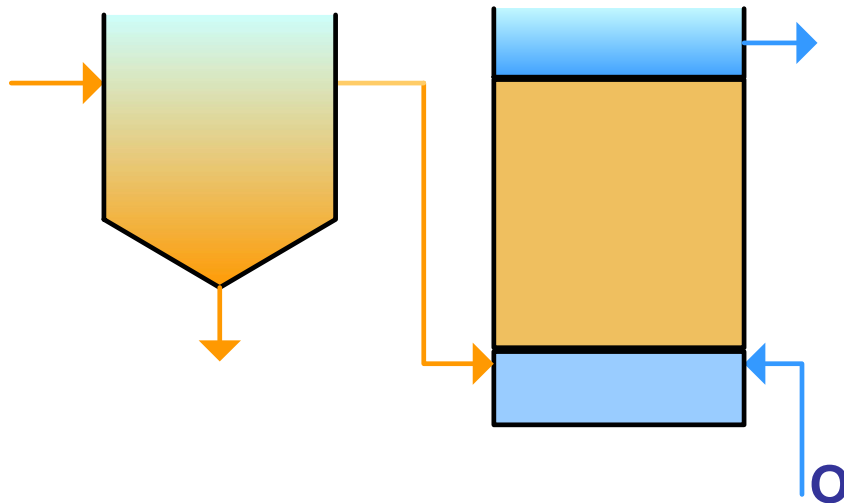
$$V_{\text{air}} = 60 \sim 120 \text{ [m}^3\text{/m}^2 \cdot\text{h]}$$





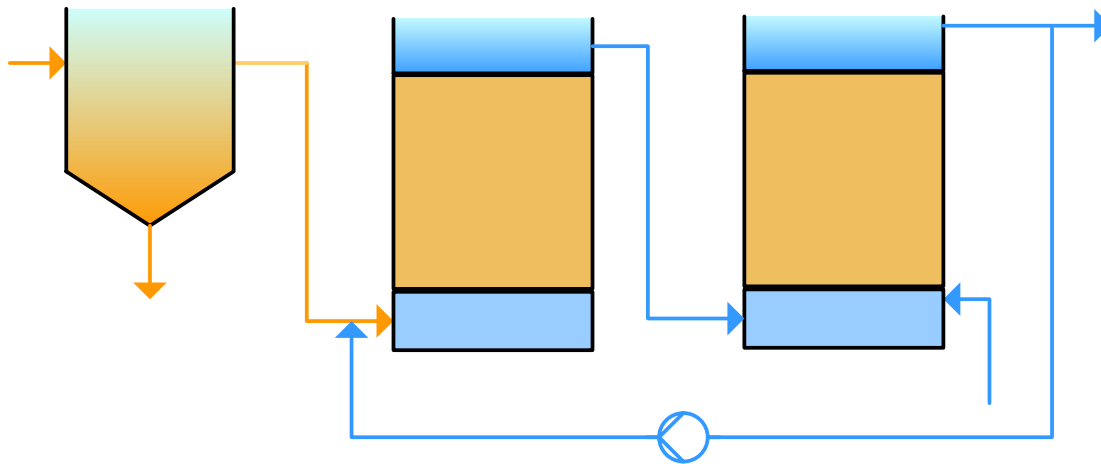
Upflow biofiltration

Application



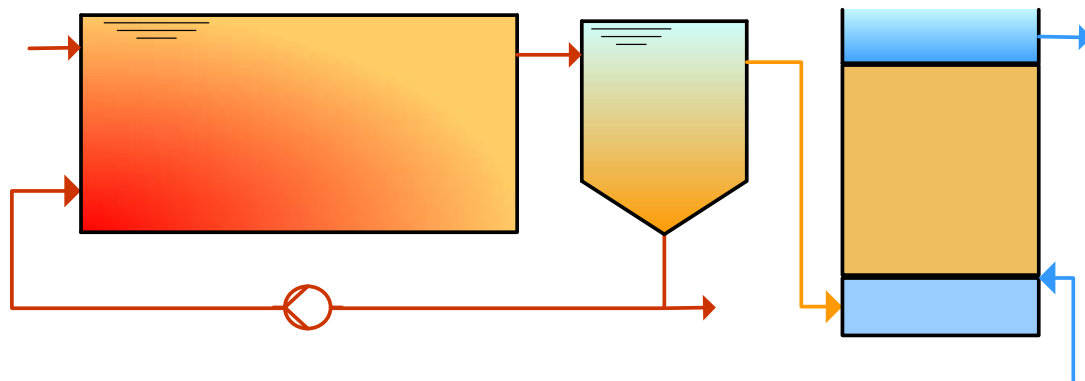


Upflow biofiltration Application





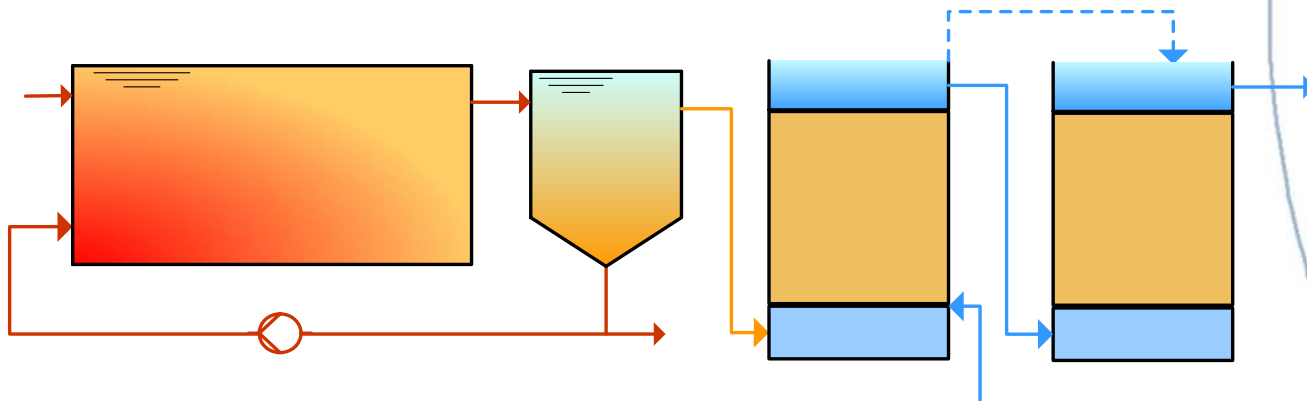
Upflow biofiltration Application





Upflow biofiltration

Application





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References of Aquabiotec





Biofiltration advantages

- ✓ Excellent purification results
- ✓ Biofiltration is a BAT in industrial wastewater treatment
- ✓ Space savings
- ✓ Full automation
- ✓ Low operation costs
- ✓ Low investment costs





EAOP

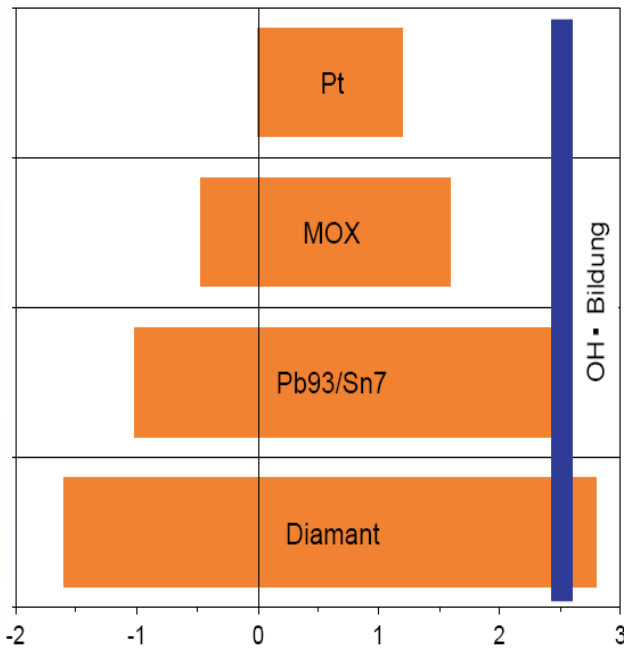
Fabrication of Diamond electrodes

- ✓ HF CVD
- ✓ Electrode base material
Nb, Si, Ta, Ti
- ✓ Boron doping increases conductivity
- ✓ BDD
- ✓ Electrode areas up to 1m²





BDD Electrodes



- ✓ High electrochemical stability
- ✓ **Highest overpotential**
- ✓ $\text{H}_2\text{O} \rightarrow \bullet\text{OH} + \text{H}^+ + \text{e}^-$





Oxidation potential of several oxidants

Oxidant	Reactions	Oxidation potential (volt)
Hydroxyl-radical	$\text{OH} + \text{H}^+ + \text{e} = \text{H}_2\text{O}$	2,80
Ozone	$\text{O}_3 + 2\text{H}^+ + 2\text{e} = \text{H}_2\text{O} + \text{O}_2$	2,07
Hydrogen peroxide	$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e} = 2\text{H}_2\text{O}$	1,77
Permanganate	$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e} = \text{Mn}^{2+} + 4\text{H}_2\text{O}$	1,52
Chlorine dioxide	$\text{ClO}_2 + \text{e} = \text{Cl}^{\cdot} + \text{O}_2$	1,50
Chlorine gas	$\text{Cl}_2 + 2\text{e} = 2 \text{Cl}^-$	1,36



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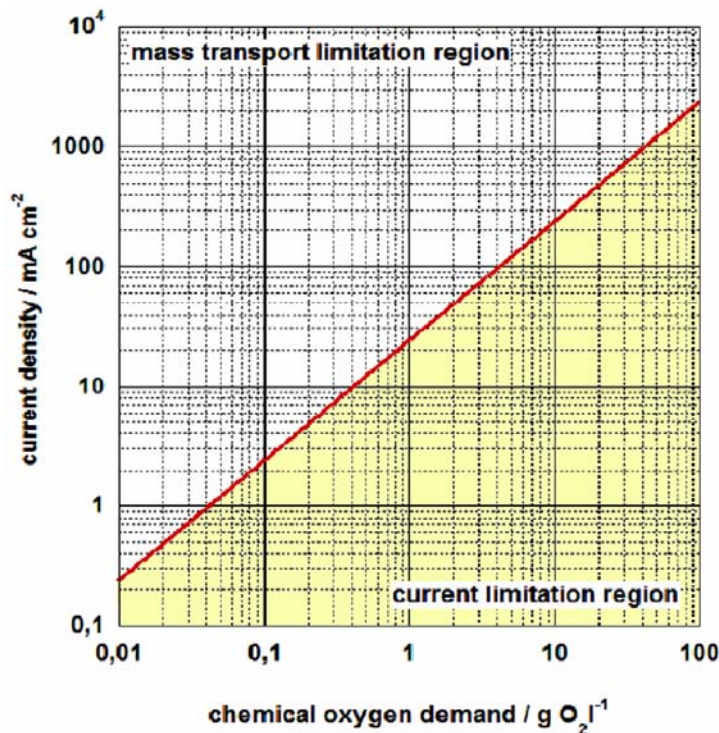
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Electrochemical cell





Calculation of the COD destruction with EAOP

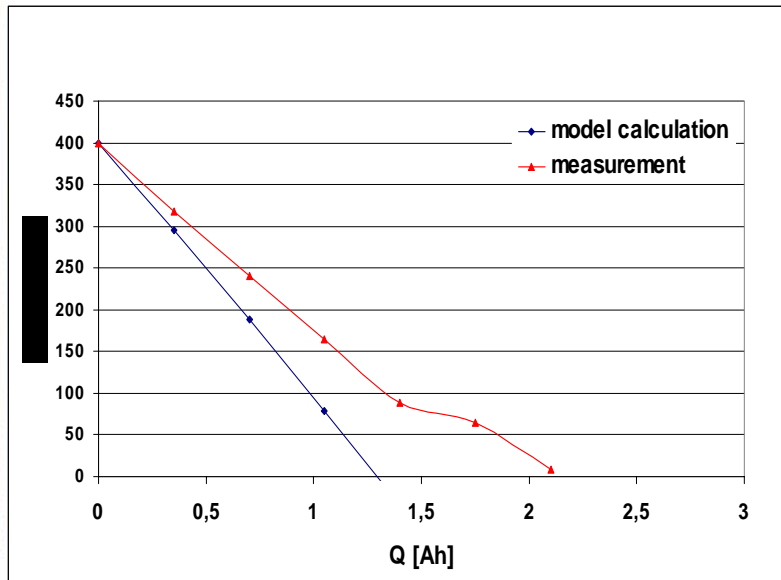


- ✓ $Q = 0,298 \cdot \text{COD}$
- ✓ **1Ah = 0,298g COD**
- ✓ Optimal current:
 $I = \text{COD} \cdot 0,024$
- ✓ Calculations according to Comninellis-Michaud:
 $\text{COD} = \text{COD}_{\text{Start}} \cdot \exp(-A \cdot K \cdot t/V)$





Treatment with EAOP Wastewater from Pulp and Paper production

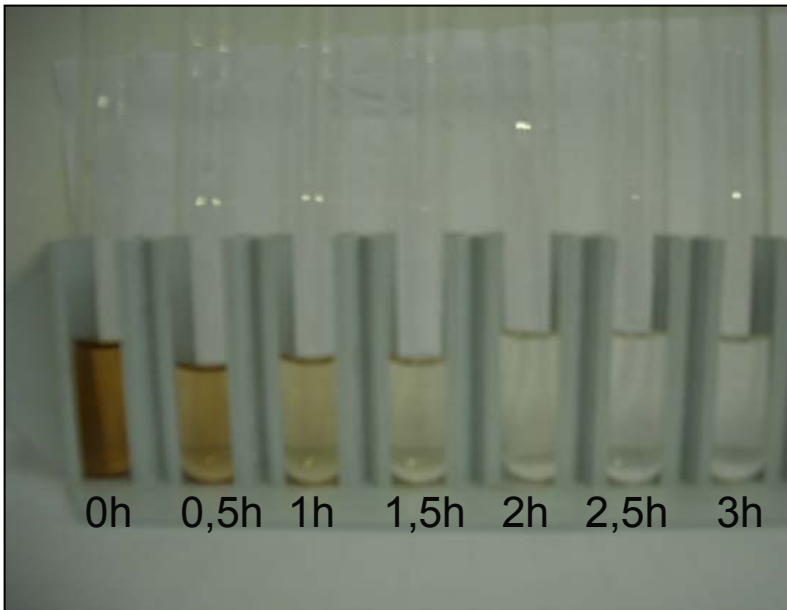


- ✓ Highly efficient COD reduction with constant current density
- ✓ Current density: $5\text{mA}/\text{cm}^2$





Treatment with EAOP Wastewater from Pulp and Paper production



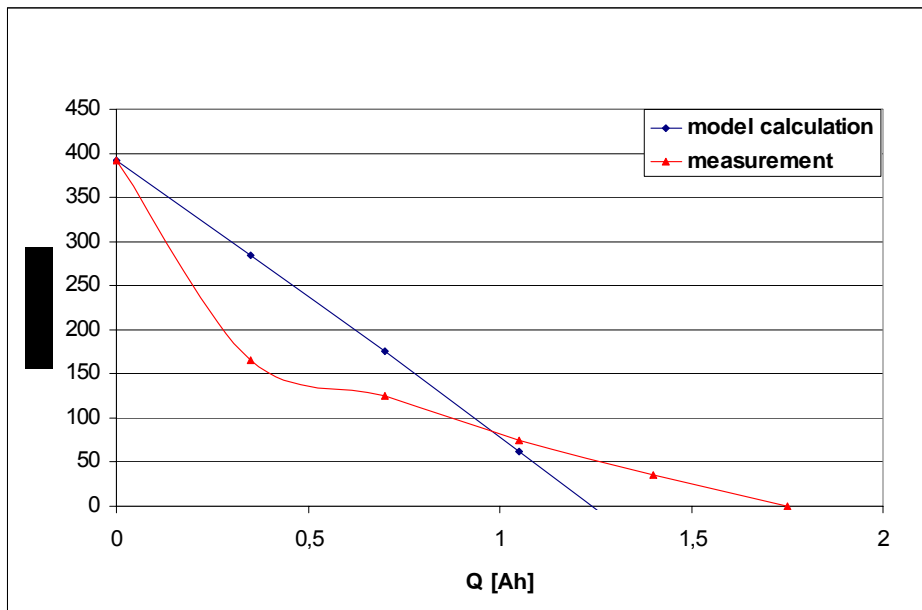
✓ Complete
Decolourisation





Treatment with EAOP

Wastewater from textile production

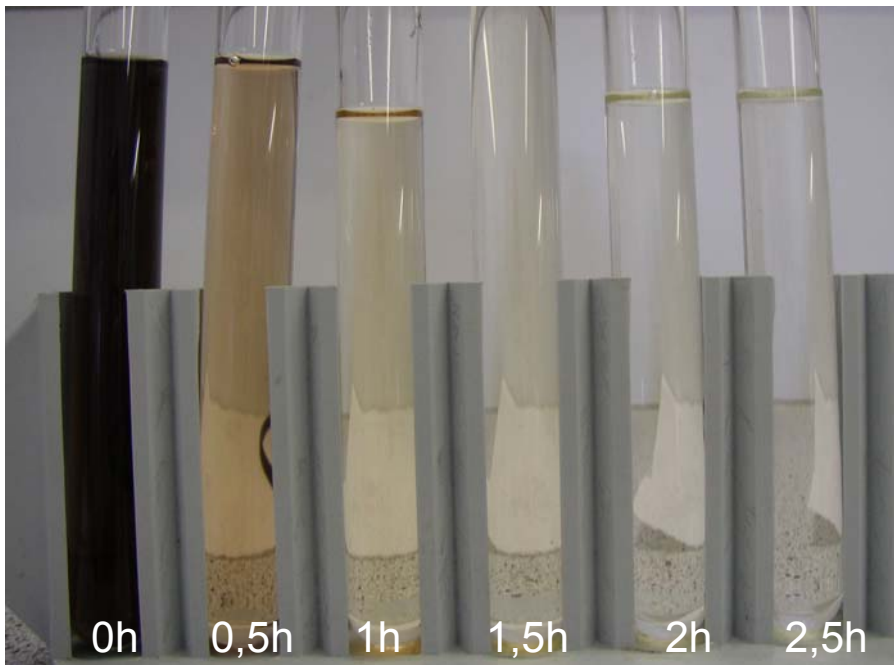


✓ Current density
 $7\text{mA}/\text{cm}^2$





Treatment with EAOP Wastewater from textile production



✓ Decolourisation
after 1,5h





EAOP advantages

- ✓ Total oxidation of refractory COD
- ✓ High effectiveness
- ✓ Ease in operation
- ✓ No disposal costs
- ✓ Low energy consumption





AQUA-BIOMANT®

- ✓ New patented technology
- ✓ Combined electrochemical + biological treatment
- ✓ Involves advantages of a biological upflow filtration and electrochemical oxidation on BDD





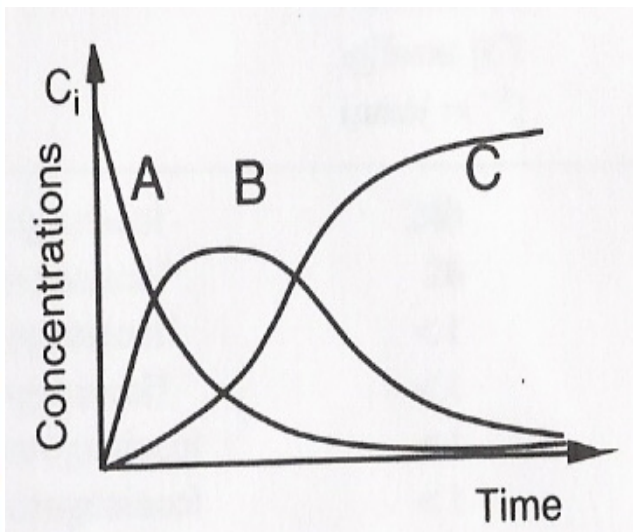
Range of application

- ✓ Pharmaceutical industry
- ✓ Chemical industry
- ✓ Oil industry
- ✓ Textile industry
- ✓ Pulp and paper industry





Oxidation process

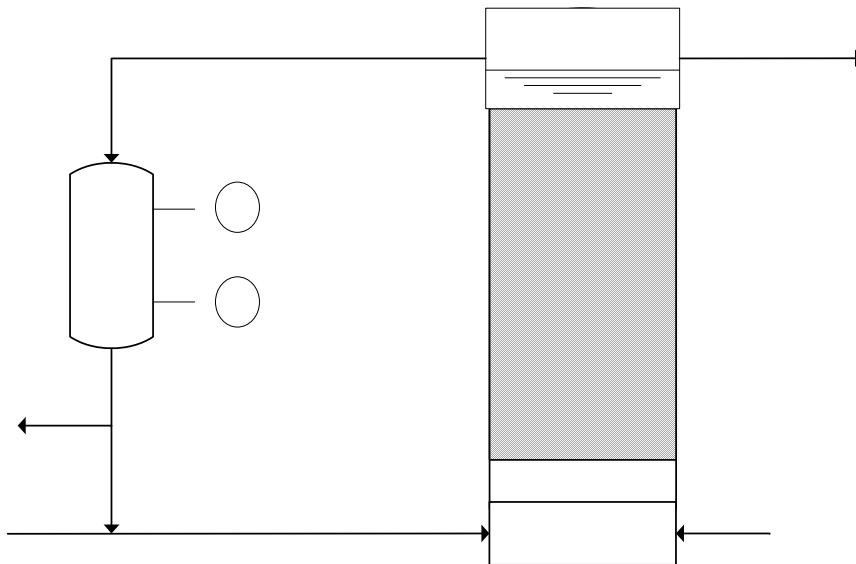


- ✓ A = refractory COD
- ✓ B = BOD
- ✓ C = CO_2





AQUA-BIOMANT[®]-Process



✓ Scheme of the AQUA-BIOMANT[®]- Process





AQUA-BIOMANT[®] advantages

- ✓ Efficient and high purification
- ✓ Complete destruction of organic substances
- ✓ Decolourisation
- ✓ Cost-effective process
- ✓ No addition of chemicals
- ✓ Up to 80% space saving
- ✓ Low operational costs
- ✓ Low investment costs





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Thank you for your attention

