



UNIVERSITY OF
PATRAS
ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ



UNIVERSITY OF PATRAS
Department
Of Chemical
Engineering



FORTH
FOUNDATION FOR RESEARCH AND TECHNOLOGY – HELLAS
INSTITUTE OF CHEMICAL ENGINEERING SCIENCES



Environmental Systems Laboratory (ESL)

Prof. Dimitrios Vayenas

Water and Wastewater Treatment Processes



➤ Water and Wastewater Treatment Processes



Biological pollutants removal



Lab- scale

Pilot- scale

Full- scale



Electrochemical pollutants removal



Lab- scale

Pilot- scale

➤ Post-treatment of effluents (constructed wetlands, lagoons)

➤ Nutrients recovery from wastewaters using zeolite and microalgae

Water and Wastewater Treatment Processes



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➤ Post-treatment of effluents (constructed wetlands, lagoons)

➤ Nutrients recovery from wastewaters using zeolite and microalgae

Simultaneous removal of H_2S , NH_3 , Fe & Mn

Basic laboratory research

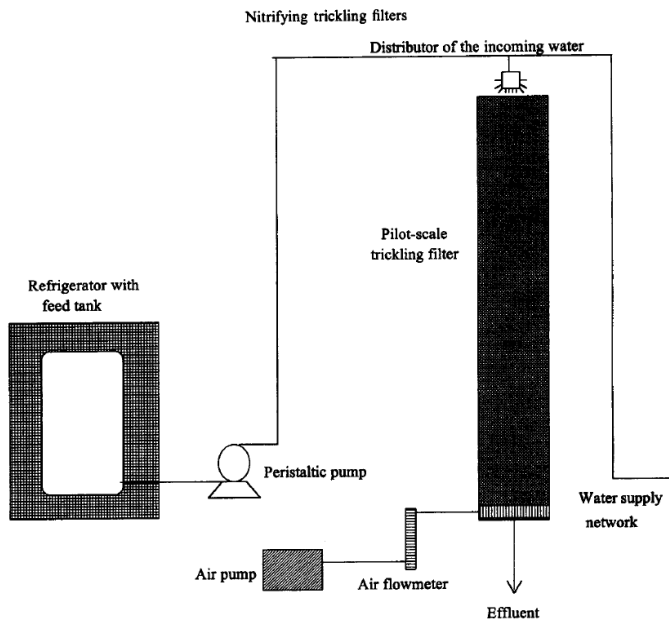


Fig. 1. Schematic drawing of the pilot-scale trickling filter.

D. Vayenas & G. Lyberatos, 1994

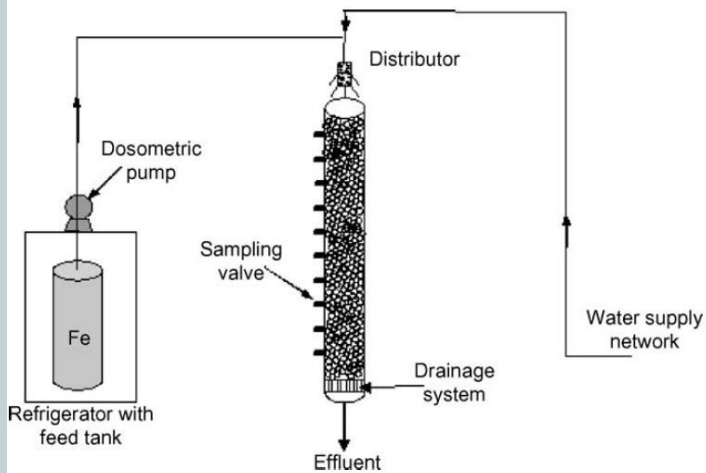
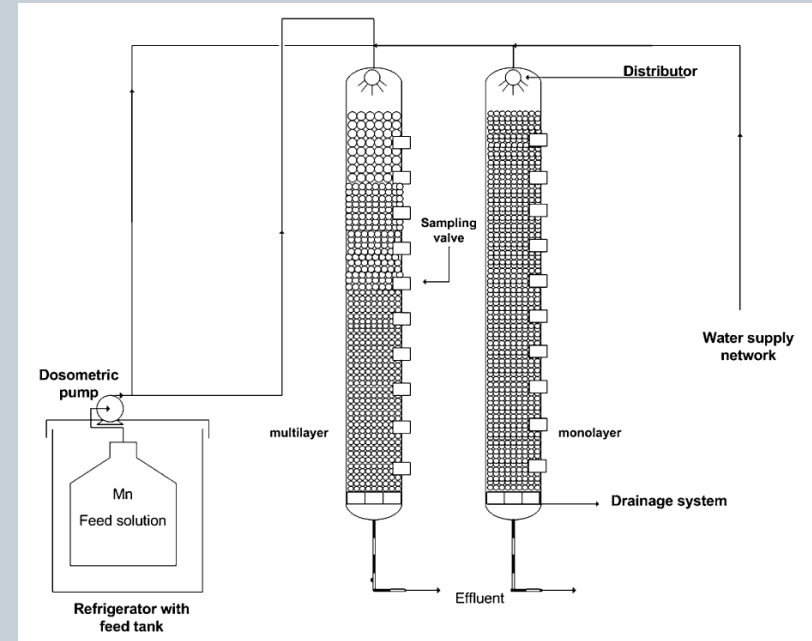


Fig. 1. Schematic drawing of the pilot-scale trickling filters arrangement.

A. G. Tekerlekopoulou et al., 2006

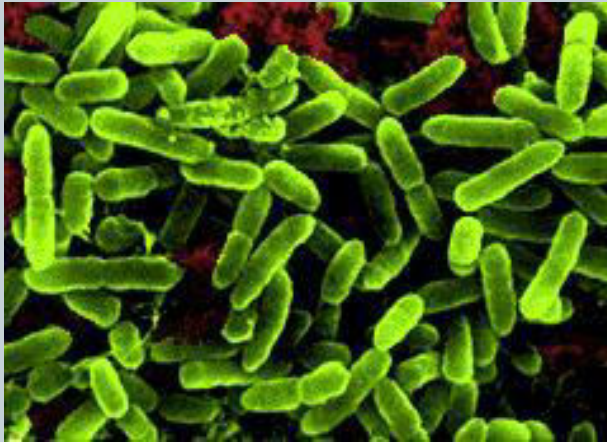


A. G. Tekerlekopoulou et al., 2008

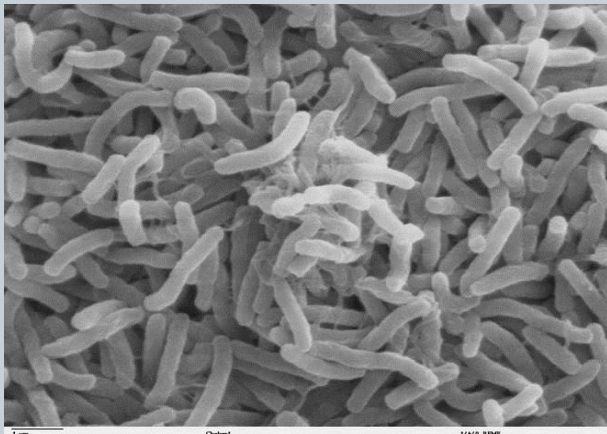
Lab scale trickling filters



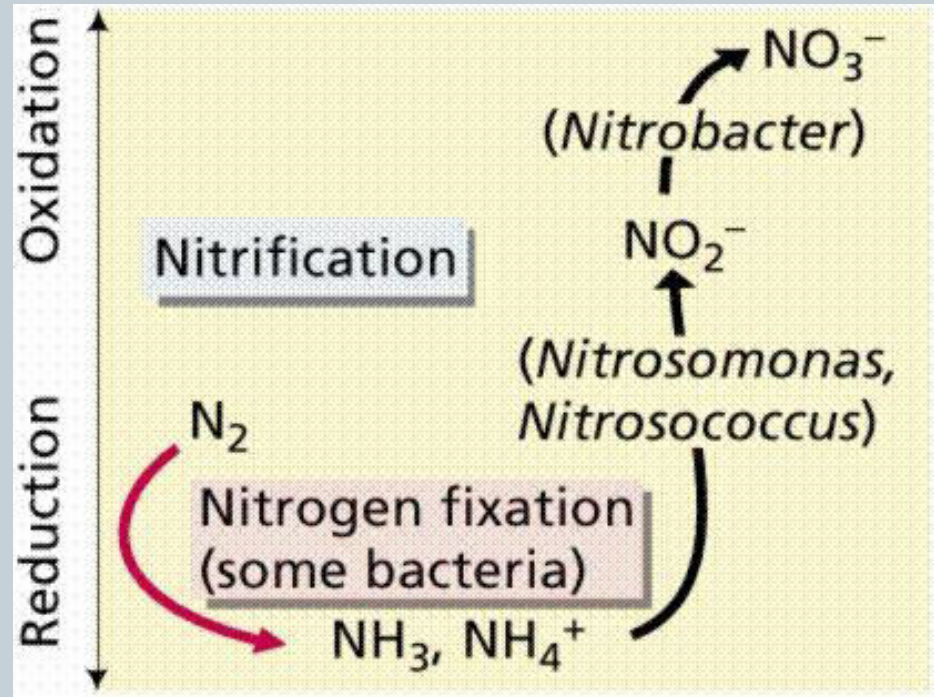
Nitrifying bacteria



Nitrosomonas

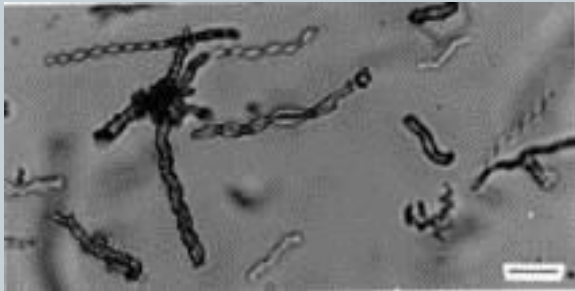


Nitrobacter

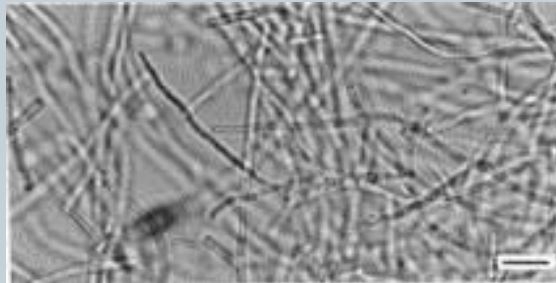


Indigenous microorganisms were used

Iron/Manganese oxidizing bacteria



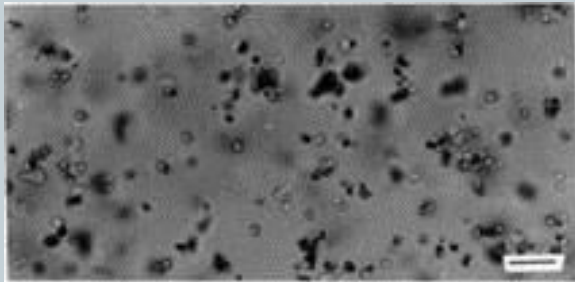
Gallionella ferruginea



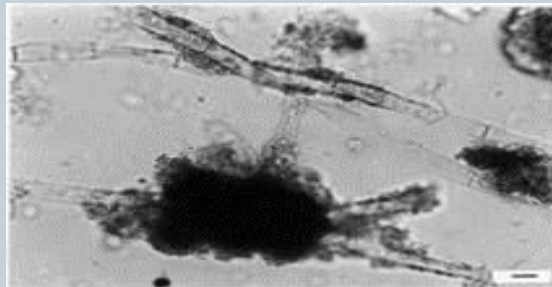
Leptothrix ochracea



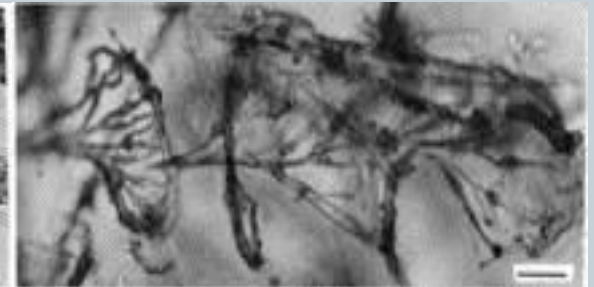
Siderocapsa sp.



Siderococcus sp.



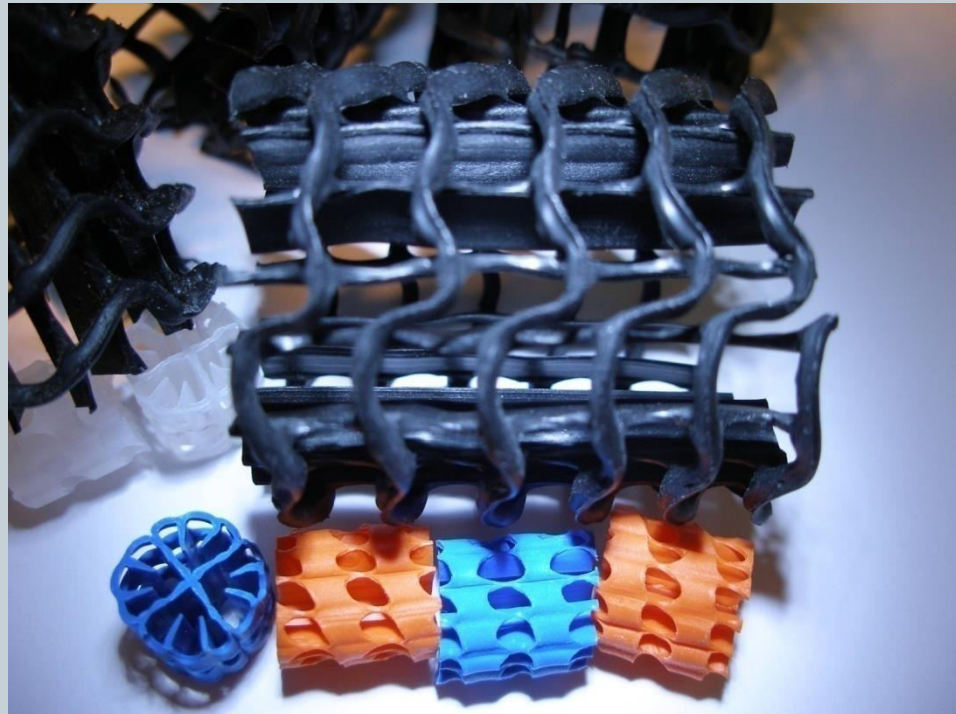
Siderocystis sp.



Toxothrix trichogenes

Indigenous microorganisms were used

Support media



Silicic gravel 5mm

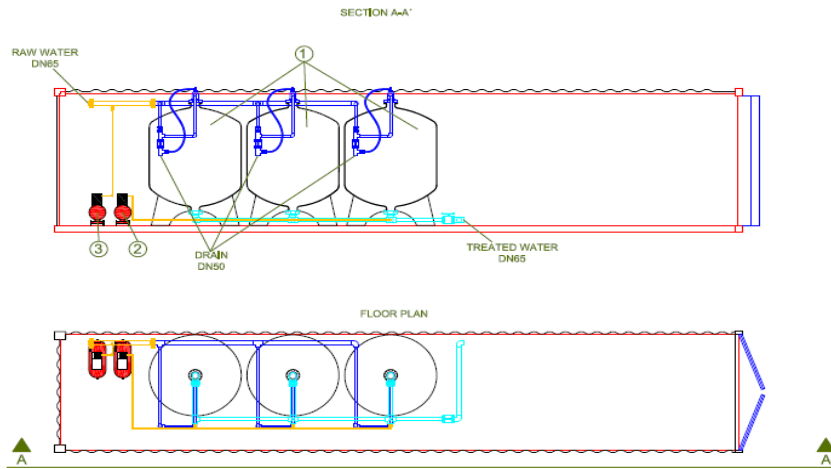


Before..

After 2 years



Full scale...



DESCRIPTION	
1	FILTER 63X86
2	WASHING AIR COMPRESSOR
3	VENTILATION AIR COMPRESSOR

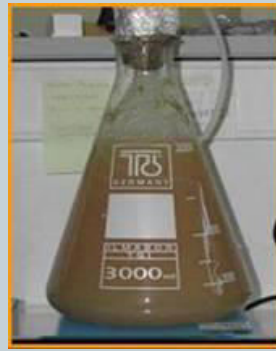
SCALE:	1:50
PAPER SIZE:	A3
TITLE:	FLOOR PLAN V FILTRA
PROJECT:	VA
<small>© 2010 WATER-BIOFILTER S.R.L.</small>	



Full scale...

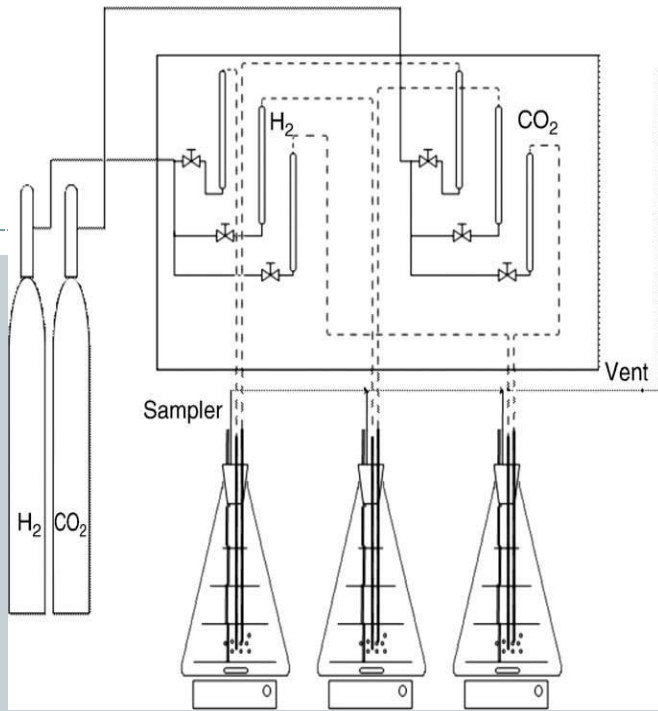


From basic knowledge to full-scale application



Removal of NO_3^- - Hydrogenotrophic denitrification

Basic laboratory research



I. A. Vaisliadou et al., 2006

K.A. Karanasios et al., 2011

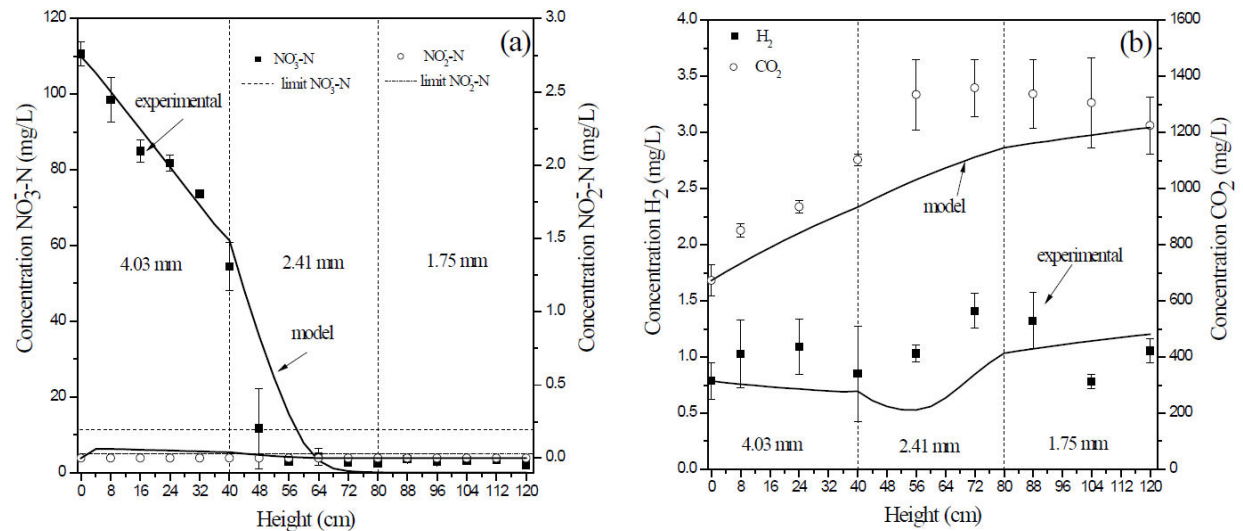


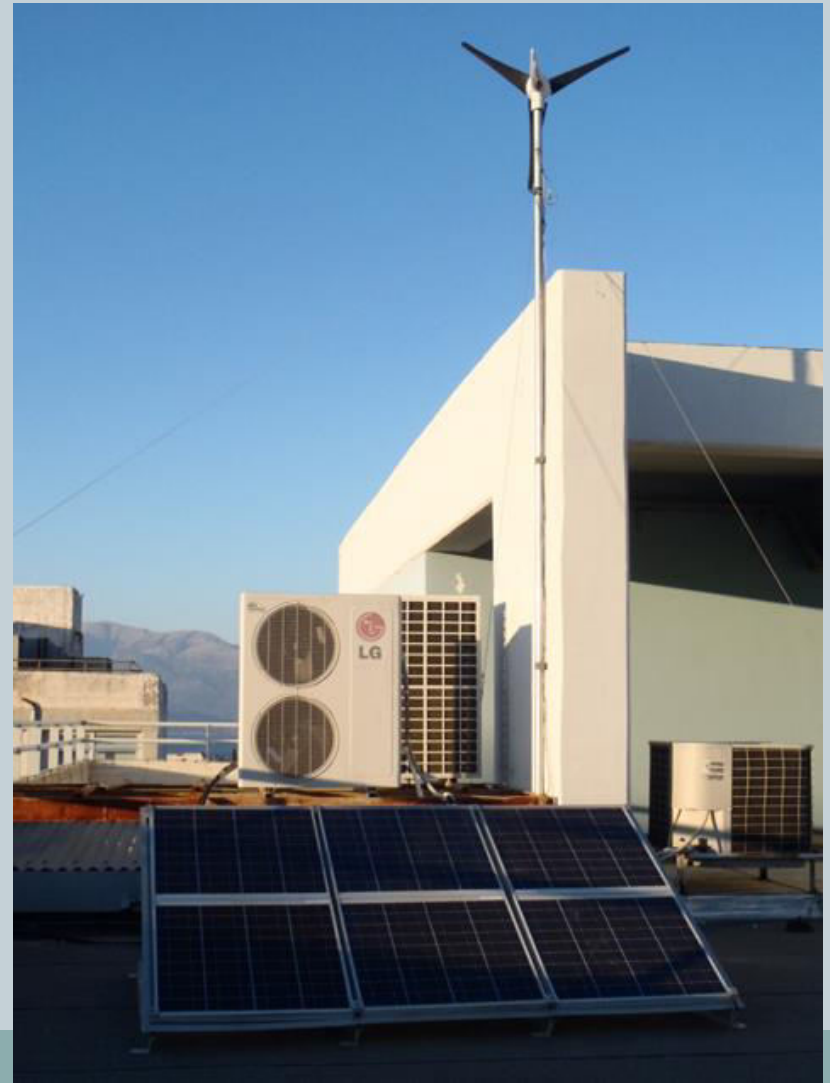
Fig. 3. Continuous operation of the three-filter system. Experimentally determined (a) NO_3^- -N and NO_2^- -N and (b) H_2 and CO_2 concentrations along the filter height and the corresponding model predictions, for gas flow rates of 10.0 and 1.5 ml/min.

Lab scale set up



Batch – Suspended Growth

Use of renewable energy sources for power generation



Water and Wastewater Treatment Processes



➤ Water and Wastewater Treatment Processes

Biological pollutants removal

Electrochemical pollutants removal

Lab- scale

Pilot- scale

Full- scale

Lab- scale

Pilot- scale

➤ Post-treatment of effluents (constructed wetlands, lagoons)

➤ Nutrients recovery from wastewaters using zeolite and microalgae

Olive Mill Wastewater (OMW)



Phenol degrading microorganisms (indigenous)

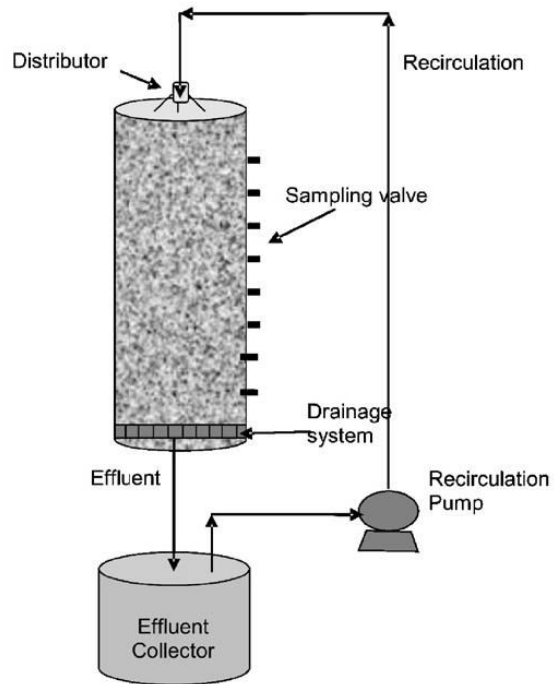
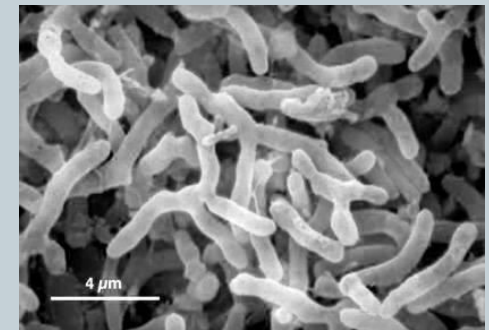


Fig. 3. Schematic drawing of the bench-scale packed bed reactor.

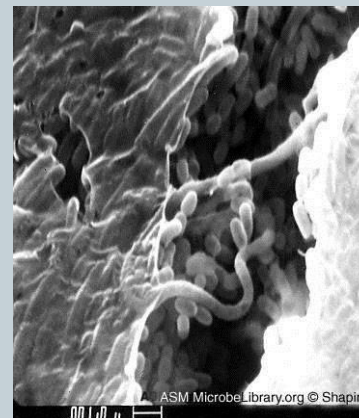
G. Tziotziou et al, 2007



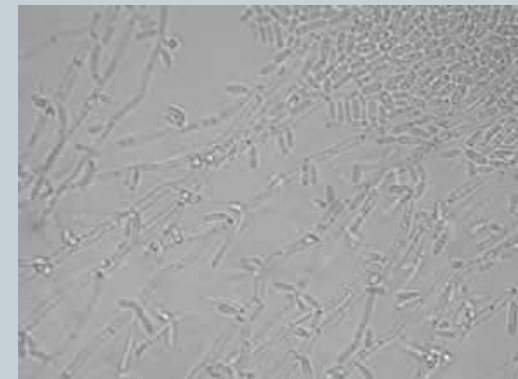
Alcaligenes sp.



Rhodococcus sp.



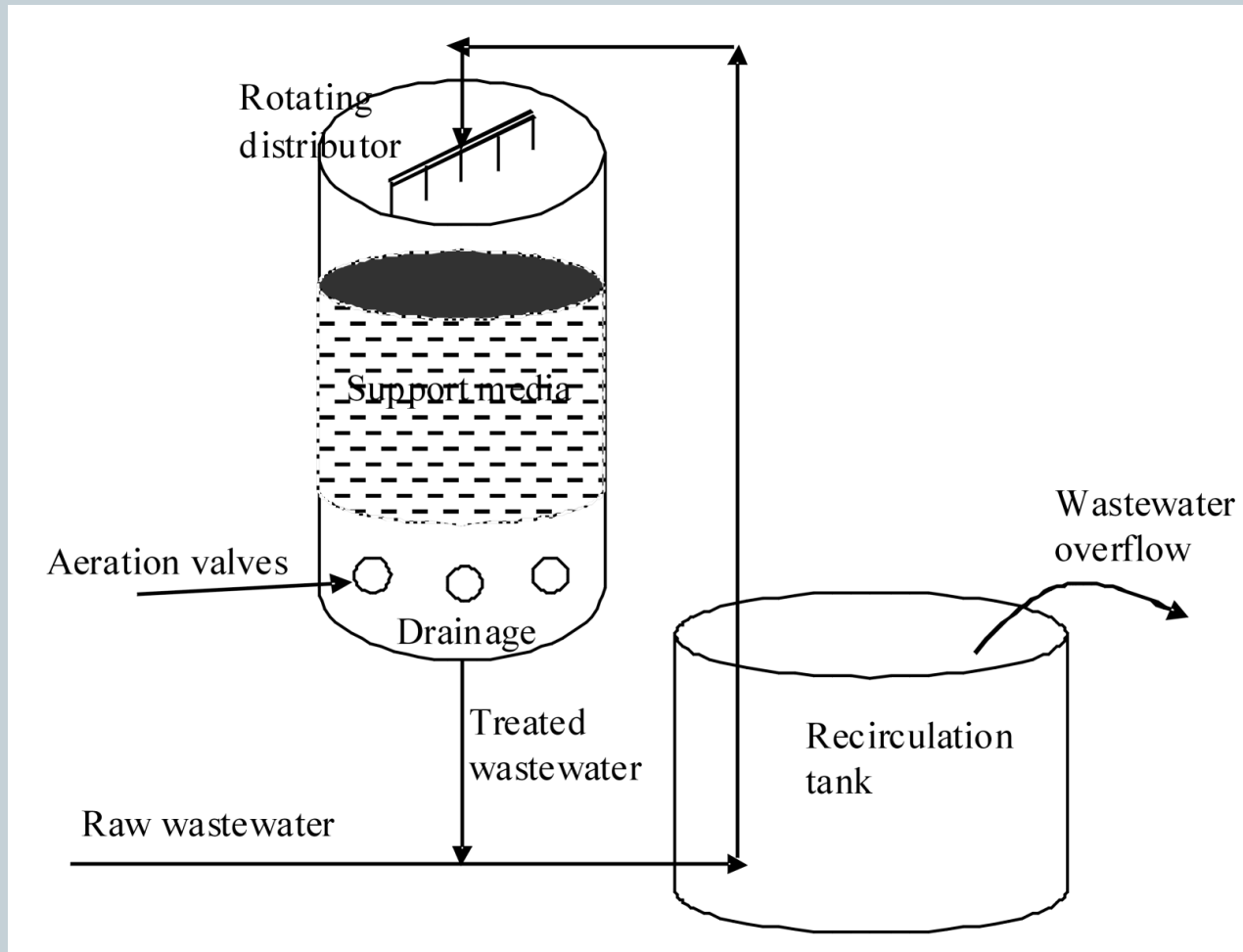
Pseudomonas putida



Candida tropicalis

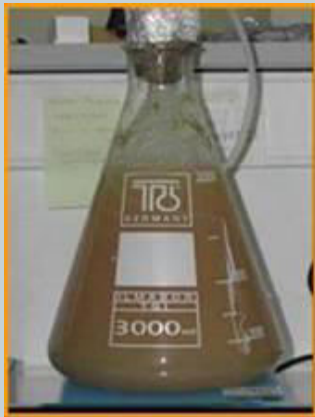


Flow sheet





From Laboratory to Industry





Applied to the industry...





Table Olive Wastewater (DW)

Dairy Wastewater (DW)

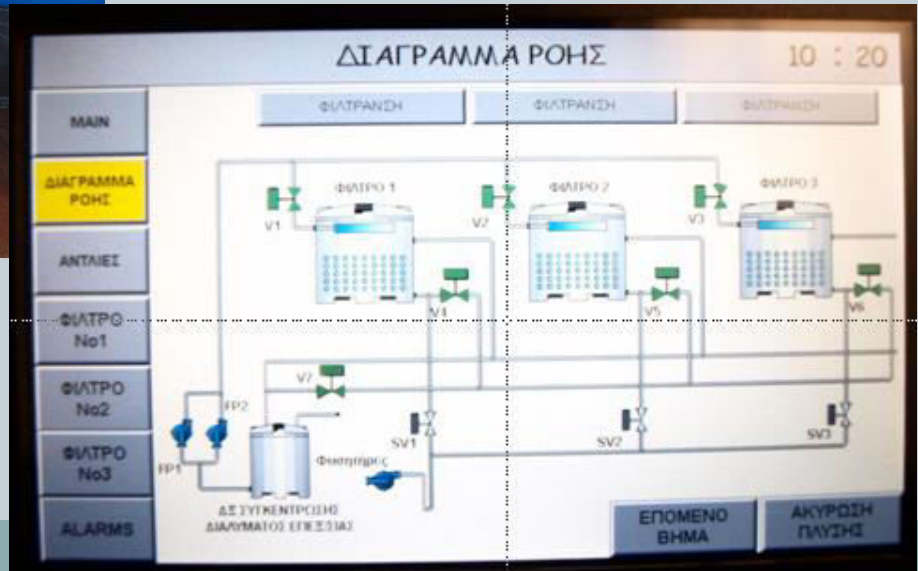


Indigenous microorganisms were used





Applied to the industry...



Water and Wastewater Treatment Processes



Water and Wastewater Treatment Processes

Biological pollutants removal

Electrochemical pollutants removal

Lab- scale

Pilot- scale

Full- scale

Lab- scale

Pilot- scale

➤ Post-treatment of effluents (constructed wetlands, lagoons)

➤ Nutrients recovery from wastewaters using zeolite and microalgae

Removal of NO_3^-



Basic laboratory research

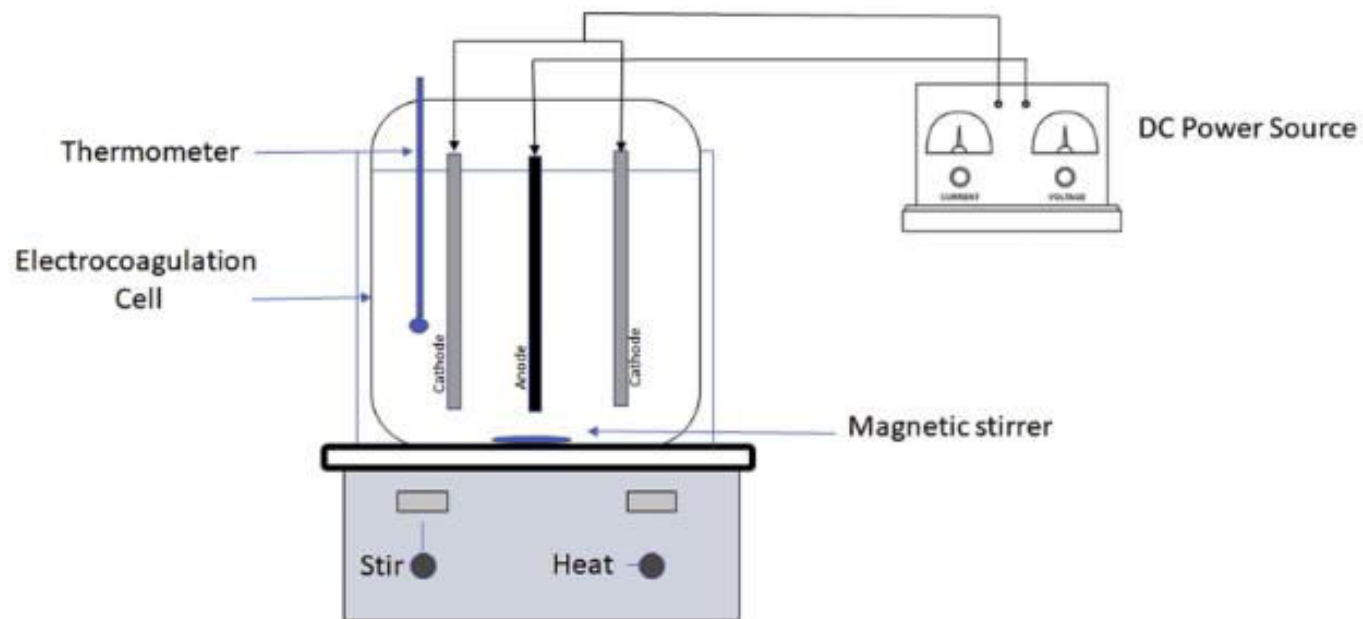
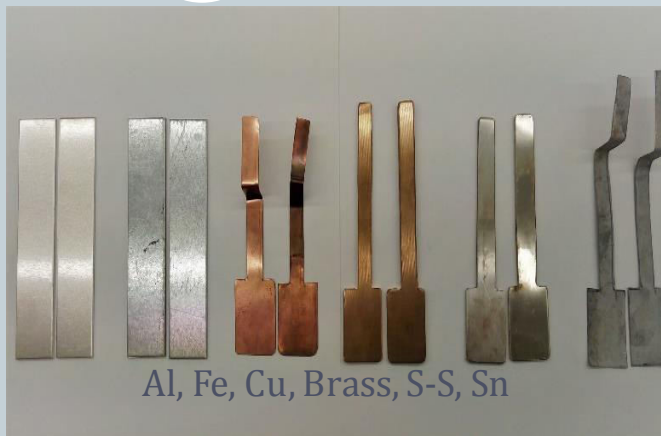


Fig. 1. Schematic set-up of the electrocoagulation reactor.

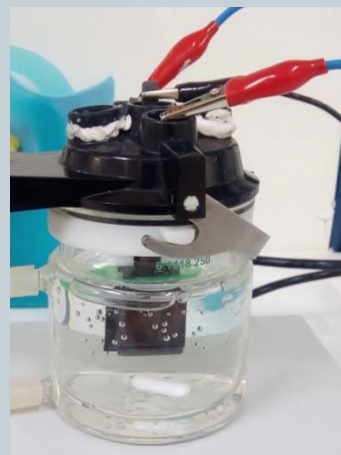
Lab scale set up



Ti anodes with catalyzing coatings



Electrocoagulation



Electrochemical reduction



Water and Wastewater Treatment Processes



➤ Water and Wastewater Treatment Processes

Biological pollutants removal

Electrochemical pollutants removal

Lab- scale

Pilot- scale

Full- scale

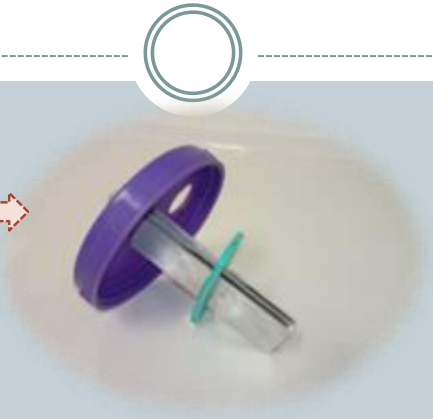
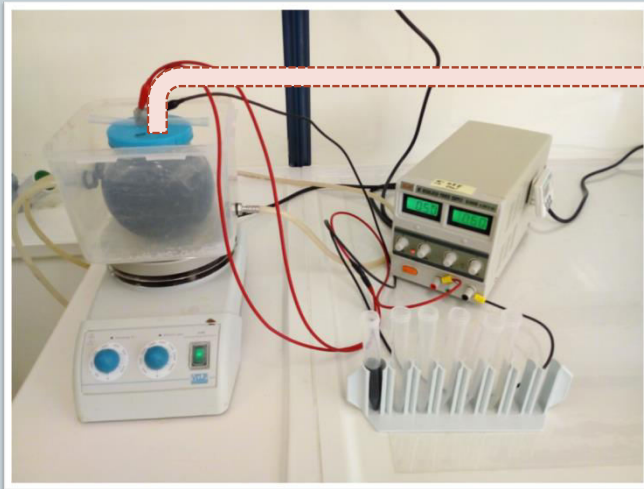
Lab- scale

Pilot- scale

➤ Post-treatment of effluents (constructed wetlands, lagoons)

➤ Nutrients recovery from wastewaters using zeolite and microalgae

Laboratory set up to Pilot scale

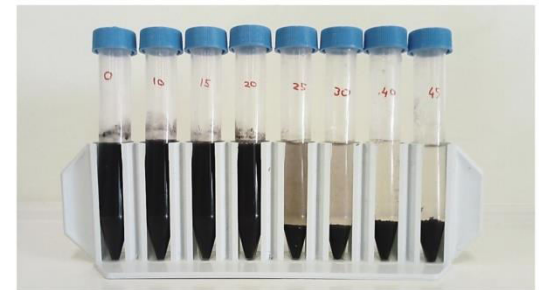
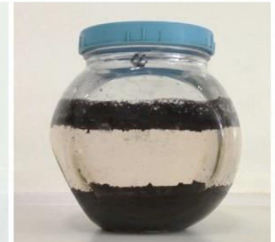


Basic laboratory research

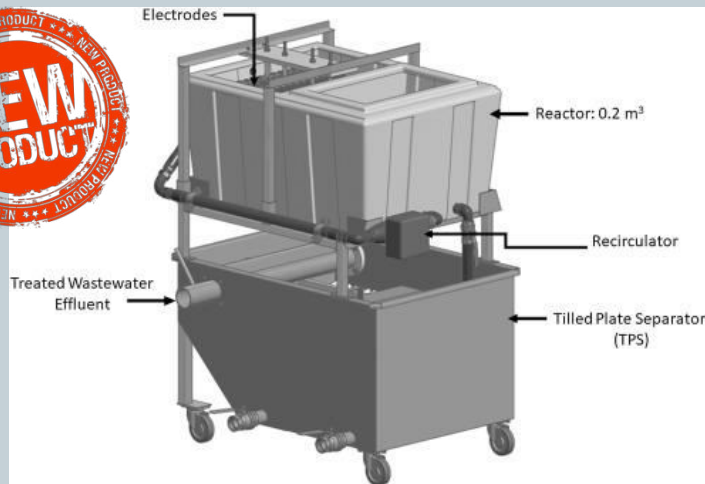
i. Sample before treatment



ii. Sample after treatment



iii. Samples during treatment



K. Papadopoulos et al., 2019

A. Benekos et al., 2019

Wastewaters before and after.....



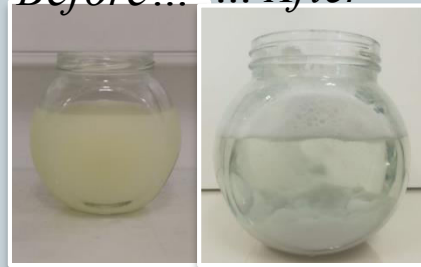
TOPW

Before... .. After



DW

Before... .. After

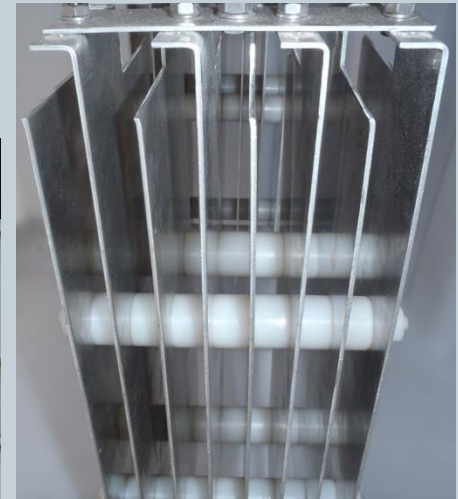
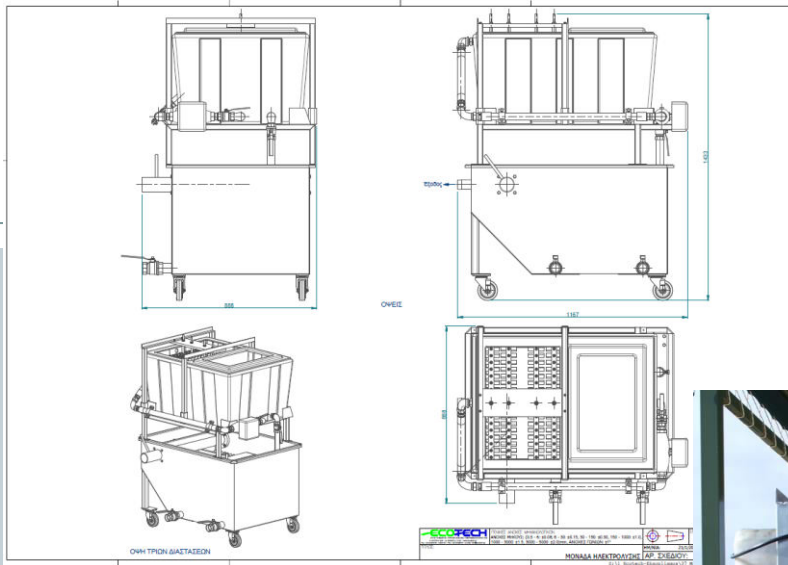


PIW

Before... .. After



Pilot scale...

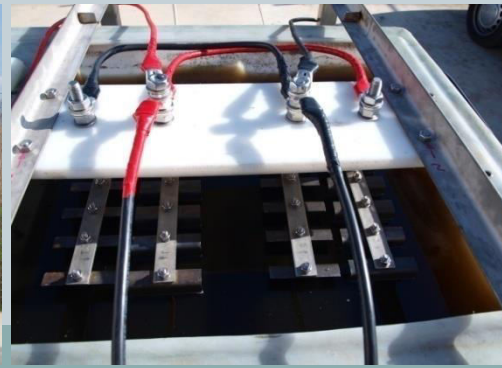
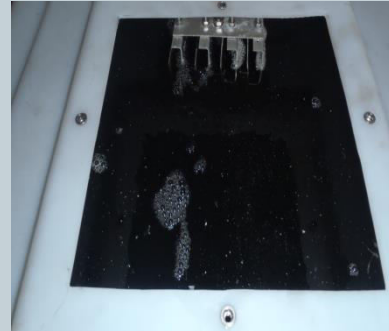


A. Benekos et al., 2019





Applied to the industry



Water and Wastewater Treatment Processes



➤ Water and Wastewater Treatment Processes



Biological pollutants removal



Electrochemical pollutants removal

Lab- scale

Pilot- scale

Full- scale

Lab- scale

Pilot- scale



➤ Post-treatment of effluents (constructed wetlands, lagoons)

➤ Nutrients recovery from wastewaters using zeolite and microalgae

Lagoons



Composting



Indigenous
microorganisms



Water and Wastewater Treatment Processes



➤ Water and Wastewater Treatment Processes



Biological pollutants removal



Electrochemical pollutants removal

Lab- scale

Pilot- scale

Full- scale

Lab- scale

Pilot- scale



➤ Post-treatment of effluents (constructed wetlands, lagoons)

➤ Nutrients recovery from wastewaters using **zeolite** and microalgae

Lab scale



Lab scale filters



A. Kotoulas et al., 2019a



A. Kotoulas et al., 2019b

Water and Wastewater Treatment Processes



➤ Water and Wastewater Treatment Processes



Biological pollutants removal



Electrochemical pollutants removal

Lab- scale

Pilot- scale

Full- scale

Lab- scale

Pilot- scale



➤ Post-treatment of effluents (constructed wetlands, lagoons)

➤ Nutrients recovery from wastewaters using zeolite and microalgae

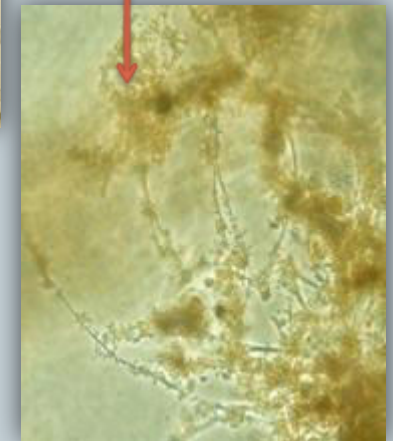
Lab scale experiments



O.N. Tsolcha et al., 2015
Ch. N. Economou et al., 2015



1L stirred PBRs



Leptolyngbya
sp. filaments

Pilot scale



30 cm

50 cm

30 cm

15 cm

30 cm

15 cm

60 cm

50 cm

cm

cm