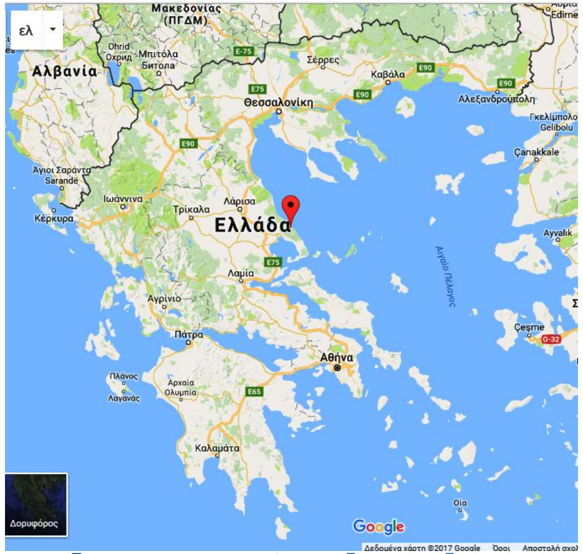
LIFE PureAgroH2O Pollutant Photo-NF remediation of Agro-Water

José Antonio Sánchez Pérez - Universidad de Almería

Pollutant Photo-NF remediation of Agro-Water « LIFE PureAgroH2O »



PROJECT LOCATION: Greece, Zagora
Spain, Almeria

BUDGET INFO:

Total amount: 2,163,728€

EC Co-funding: 1,290,177€

DURATION: Start: 02/07/2018 - Expected End Date: 31/12/2021

PROJECT'S IMPLEMENTORS:

Coordinating Beneficiary: Benaki Phytopathological Institute

Associated Beneficiaries:

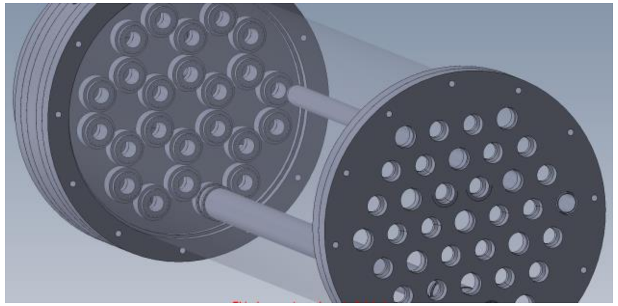
National Center for Sciencific Research " DEMOKRITOS"

Agricultural Cooperative of Zagora Pilios-ZAGORIN

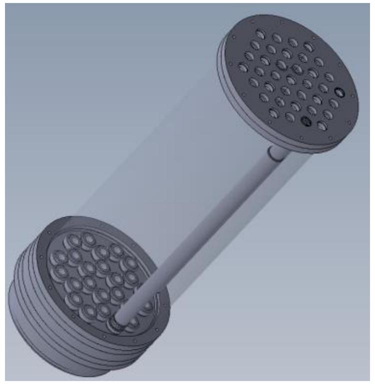
University of Almeria (CIESOL) & Citricos del Andarax SA

OBJECTIVES

The primary target of LIFE PureAgroH2O is the development of a close-to-market Photocatalytic NanoFiltration Reactor (PNFR) for the treatment of agrofood wastewater.



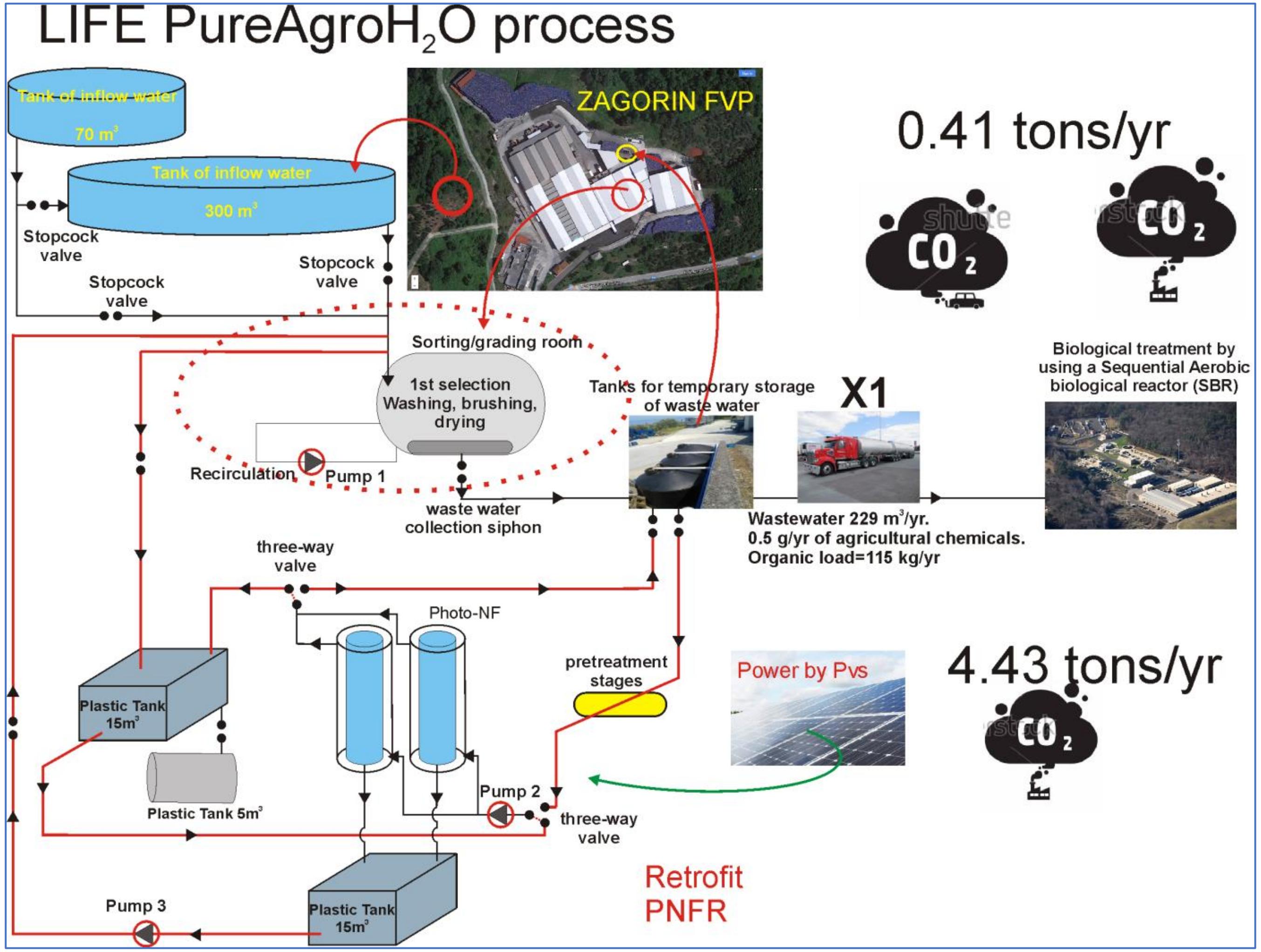
Novelty: Synergetic integration of photocatalysis and NF



Competitive Technologies	Advantages of PNFR
Granular Activated Carbon	No regeneration
Nanofiltration (NF)	No fouling-No toxic condensates
NF-RO	Energy efficiency
Ozonation	No influence by Natural Organic Matter (NOM)
Slurry photocatalysis	Simpler and more versatile

UNIVERSIDAD DE ALMERIA
Cítricos del Andarax S.A.
NATIONAL CENTRE FOR SCIENTIFIC RESEARCH "DEMOKRITOS"
INSTITUTE OF NANOSCIENCE AND NANOTECHNOLOGY

PROBLEM STATEMENT-ZAGORIN Greece



1) 15-20 m^3 of fresh water are used on a daily basis in the washing / brushing / drying process.

2) Annual water usage 4425 m^3

3) The water effluent, has in average a total number of 51 active substances, with an average concentration of pesticides of 9.03 mg/m^3.

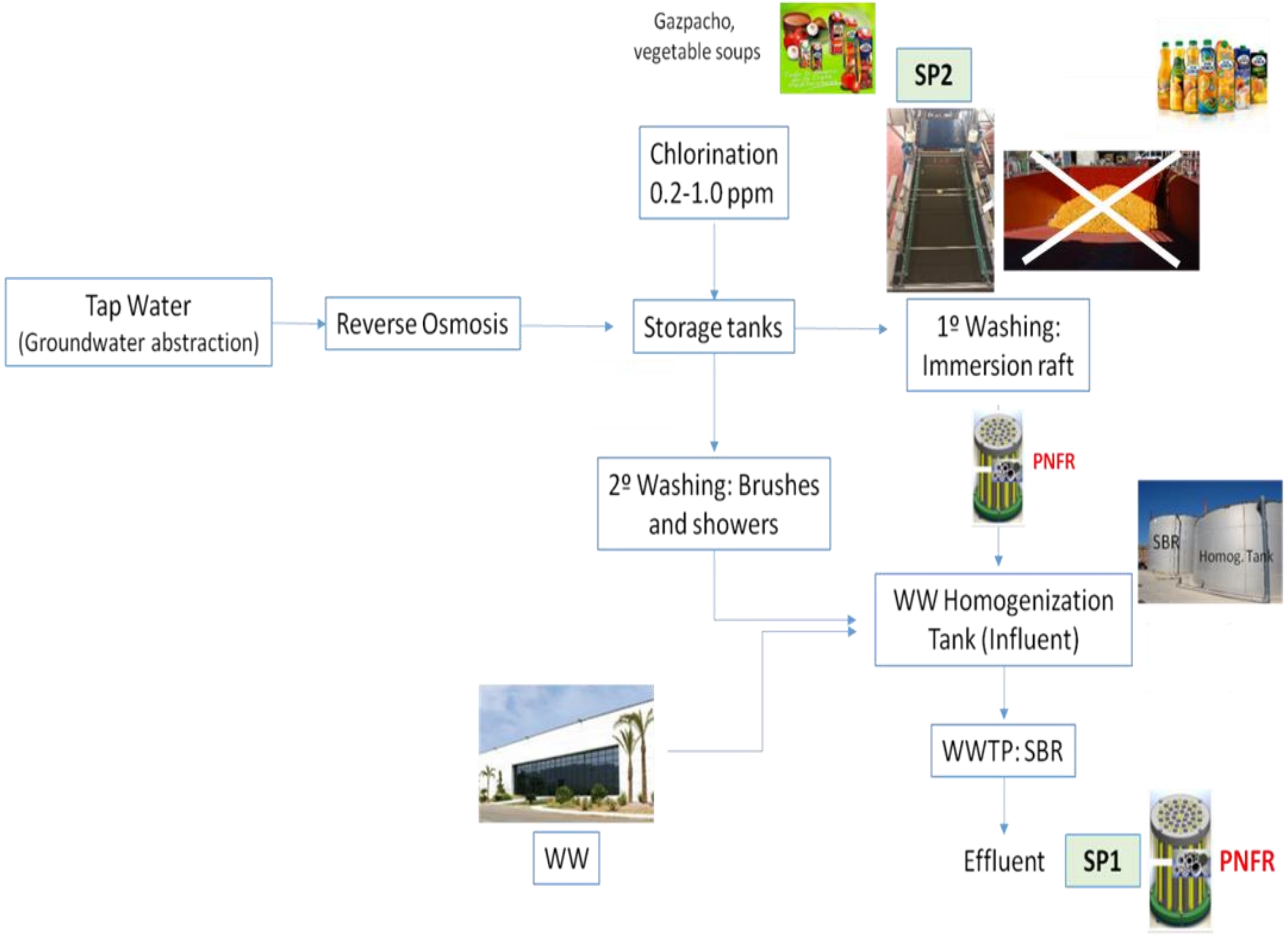
4) The effluent is transferred to a Wastewater Treatment Plant (WTP)-(Biological treatment). Total carbon emissions annually for the transfer 1.7 tons.

5) The CO_2 emissions resulting from the treatment of the above wastewater in WTP are estimated to be approximately 6.5 tons.

6) Possibly 40 g of pesticides reach the environment on an annual basis, and about 8.2 tons of CO_2 are emitted due to the current wastewater management.

UNIVERSIDAD DE ALMERIA

PROBLEM STATEMENT-CÍTRICOS DEL ANDARAX Spain



With this project we can save 20.000 L daily

Washing line of vegetables for "gazpacho" production was selected as the best choice:

- Enough physical space for the placement of the reactor.
- The washing water was collected in a tank and could be easily connected to the reactor
- Similarity to Zagorin washing water

- 4 samplings from October to December 2018

COD: 67 – 413 mg/L !!

Optimum PNFR performance COD < 50 mg/L

Washing water pretreatment is required

EXPECTED IMPACTS by applying the PNFR technology

- **Recycle/reuse of wastewater generated in fruit-industry by 95% (4,200 m^3/year will be reused).**
- **Prevention of losses of inorganic and organic contaminants (pesticides/priority substances and heavy metals) to the environment by 99-100% (~40 g/year)**
- **Reduction of Carbon Footprint by 41% (save 3.36 tons/year)**
- **Socioeconomic impact-Job creation +10% (4 FTE)**
- **Legislation / Environmental Technology**

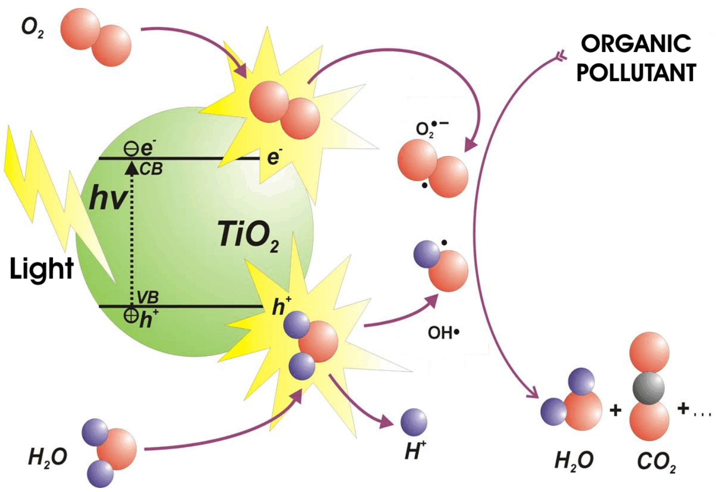


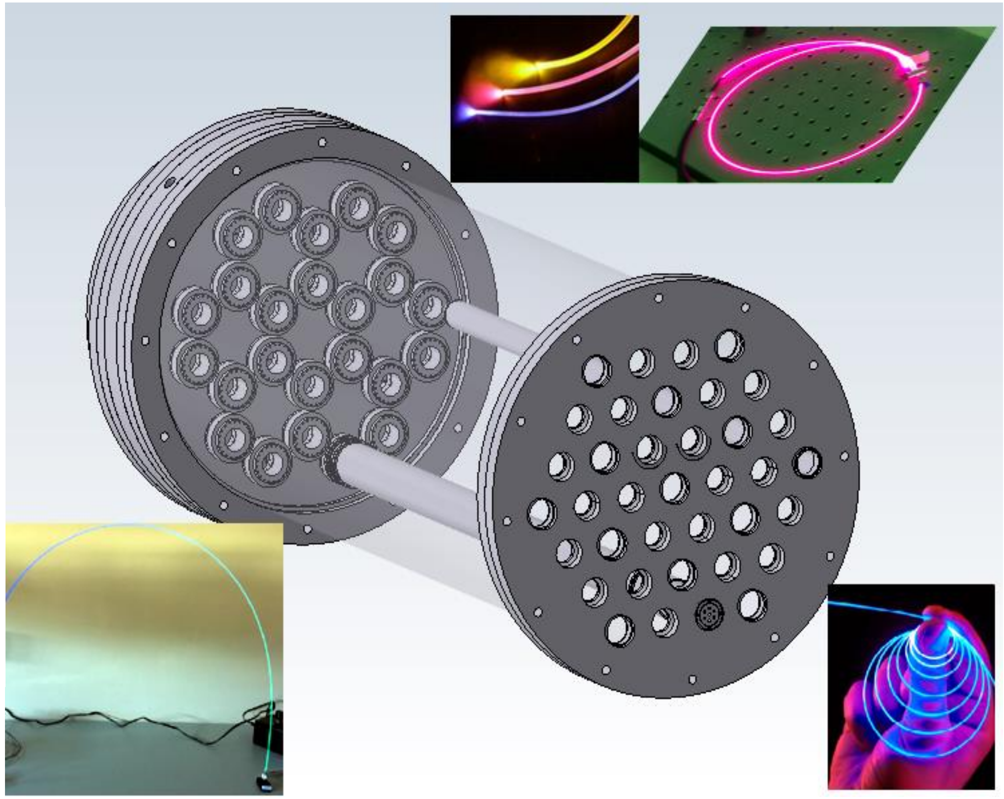


Description of the technology

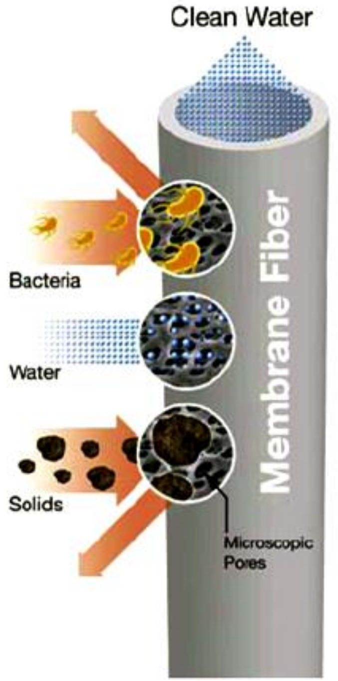
The PNFR technology/reactor, integrates synergistically the most effective, currently existing, micropollutant abatement technologies such as photocatalysis (P) and nanofiltration (NF), in one smartly designed membrane reactor (R) module-PNFR.

Photocatalysis

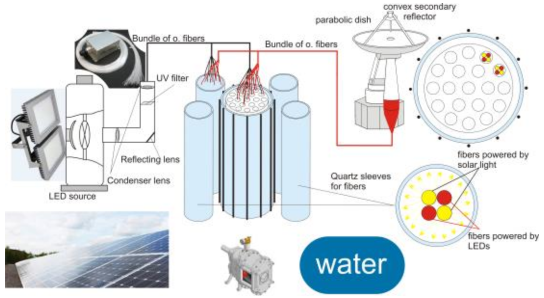


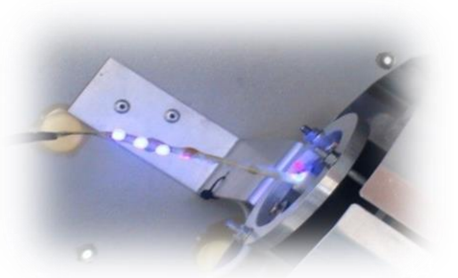


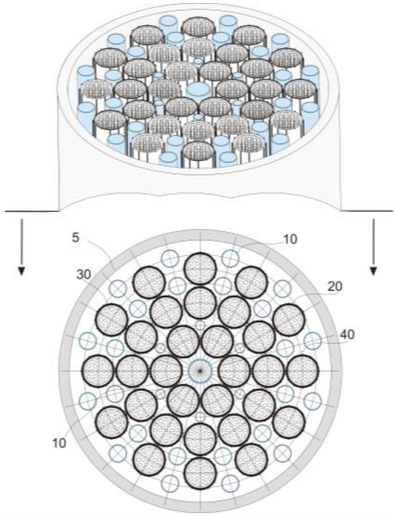
Pressure driven membrane filtration MF, UF, NF

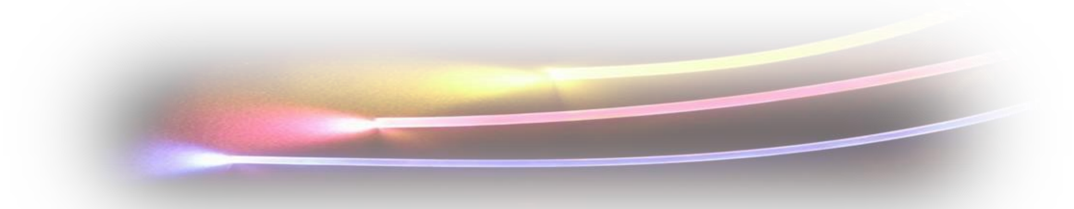


Patented by NCSR “Demokritos”









(19) Europäisches Patentamt / European Patent Office / Office européen des brevets

(11) **EP 2 409 954 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication: **25.01.2012 Bulletin 2012/04**

(21) Application number: **10275076.7**

(22) Date of filing: **20.07.2010**

(51) Int Cl.:
C02F 1/30 (2006.01) ***C02F 1/44*** (2006.01)
B01J 19/12 (2006.01) ***B01J 35/00*** (2006.01)
B01J 21/18 (2006.01) ***B01D 69/04*** (2006.01)
B01D 53/00 (2006.01) *C02F 1/72* (2006.01)
C02F 1/32 (2006.01) *C02F 9/00* (2006.01)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
BA ME RS

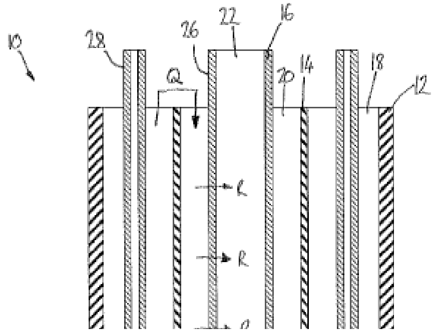
(71) Applicants:
- **National Center for Scientific Research Demokritos 15310 Athens (GR)**
- **Innovative Research & Technology Limited London WC1B 5LF (GB)**

(72) Inventors:
- **Falaras, Polycarpos 15351, Pallini Attikis (GR)**
- **Romanos, Georgios 15562, Cholargos Attikis (GR)**
- **Aloupogiannis, Panagiotis 14341, Nea Philadephia Attikis (GR)**

(74) Representative: **Holmes, Derek Malcolm Keltie LLP Fleet Place House 2 Fleet Place London EC4M 7ET (GB)**

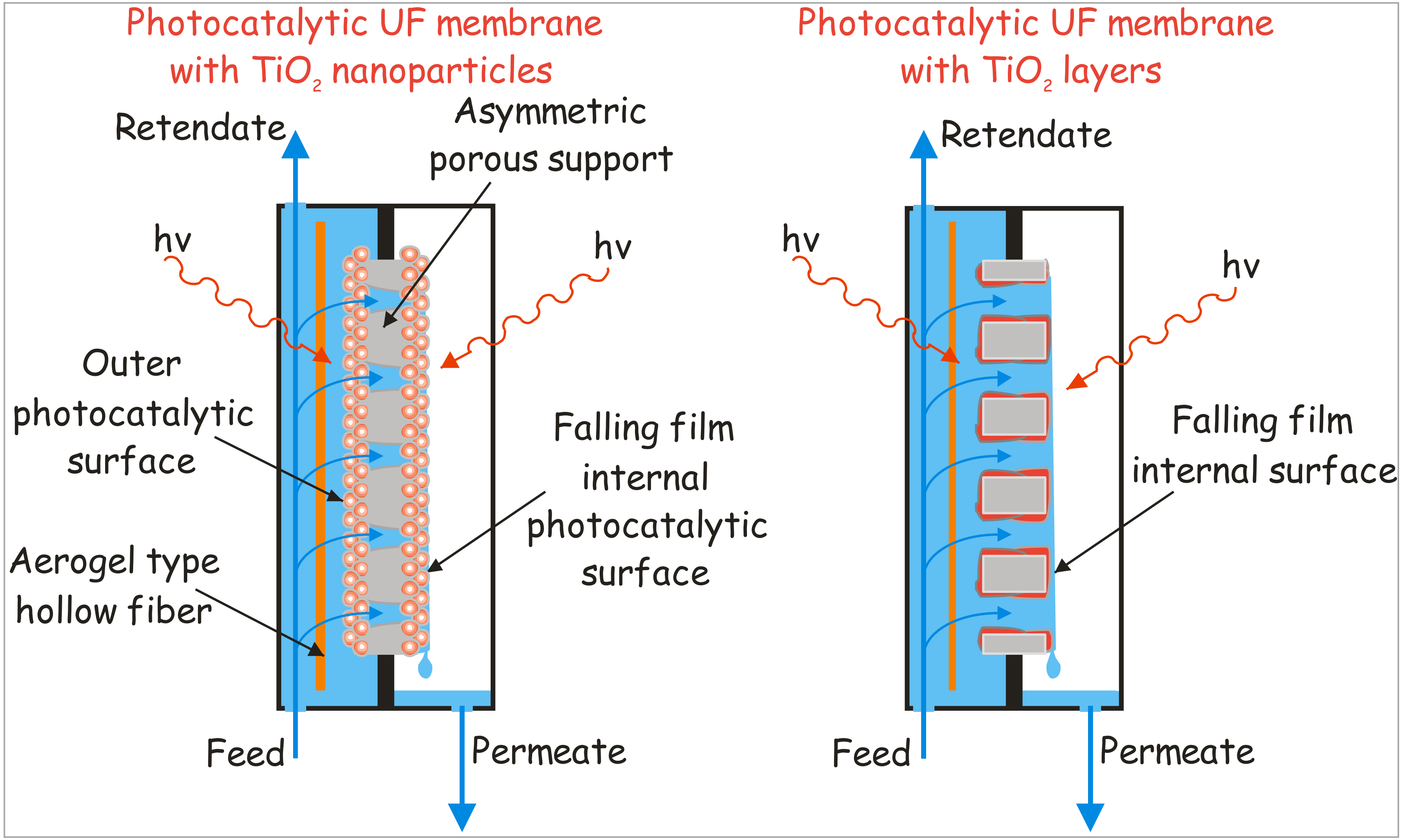
(54) **Photocatalytic purification device**

(57) A photocatalytic reactor (10) for the treatment of contaminated fluids, such as water, is described. The reactor comprises a first flow channel (18) for receiving fluid from an inlet means, a second flow channel (22) for delivering fluid to an outlet means, a selectively-permeable filtration membrane (16) intermediate the first and second flow channels (18, 22), having a first surface (26) that receives fluid from the first flow channel (18) and an opposite second surface (24) defining, at least in part, the second fluid flow channel (22), and at least one photocatalyst support (28) disposed in the first flow channel (18). The first and second surfaces (24, 26) of the filtration membrane (16) and the photocatalyst support (28) each comprise an immobilised photocatalytic material capable



UNIVERSIDAD DE ALMERIA
Cítricos del Andarax S.A.
NATIONAL CENTRE FOR SCIENTIFIC RESEARCH "DEMOKRITOS"
INSTITUTE OF NANOSCIENCE AND NANOTECHNOLOGY

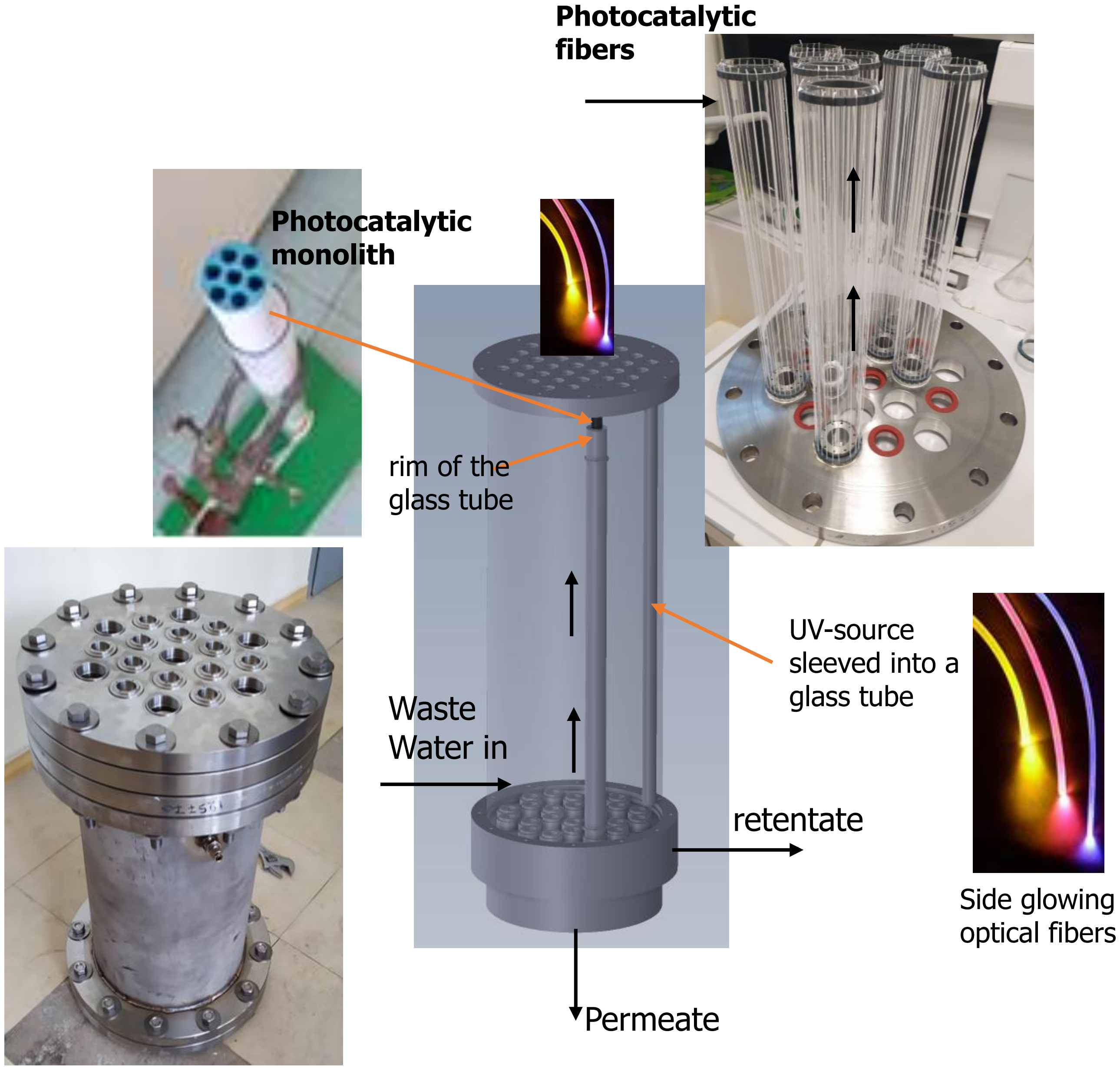
CONCEPT of the PNFR PROCESS



BENEFITS of the PNFR PROCESS

- Does not generate concentrated effluents. Especially important in the case of very toxic pollutants.
- The membrane is resistant to fouling.
- The membrane exhibits very high permeability due to photo-induced hydrophillicity.
- The retentate can be recycled and retreated towards complete degradation with less energy consumption.

Description of the reactor



- Wastewater inlet on the reactor cell (bottom side).
- Flows upwards in the space between the reactor cell and the glass tube (contact with photocatalytic fibers).
- Overflows at the rim of the glass tube and flows downwards in the space between the glass tube and the monolith cell.
- Back Pressure Regulator increases the pressure to 10 bar. Fraction of the water crosses the membrane and flows down on the lumen photocatalytic surface (permeate)

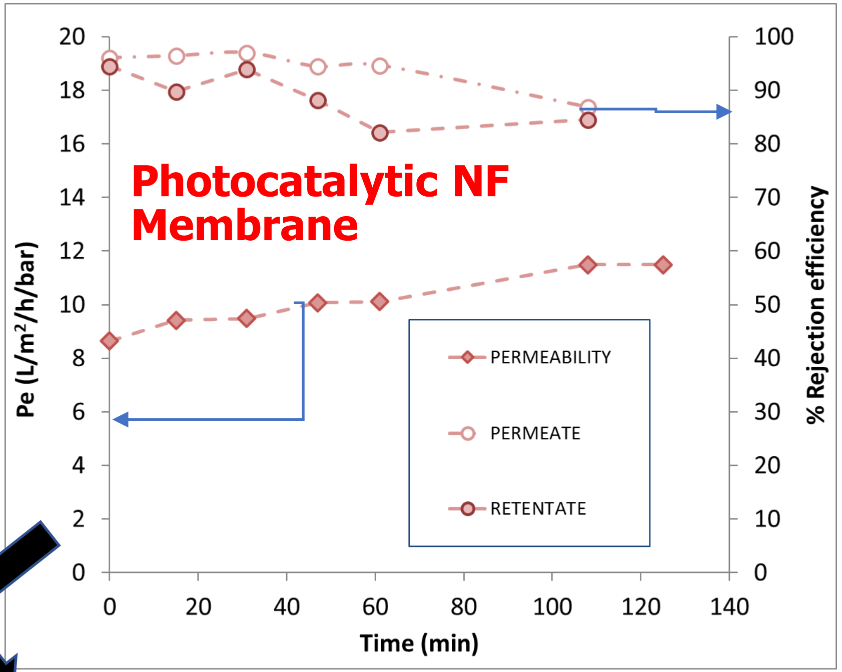
UNIVERSIDAD DE ALMERIA
Cítricos del Andarax S.A.
NATIONAL CENTRE FOR SCIENTIFIC RESEARCH "DEMOKRITOS"
INSTITUTE OF NANOSCIENCE AND NANOTECHNOLOGY

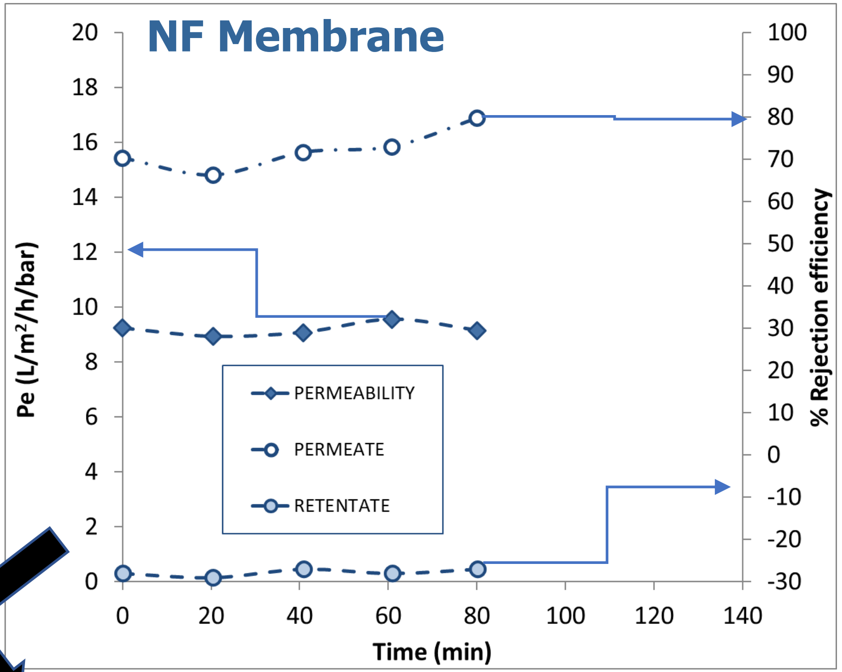
Performance- Rejection efficiency-Feed 1ppm Chlorpyriphos

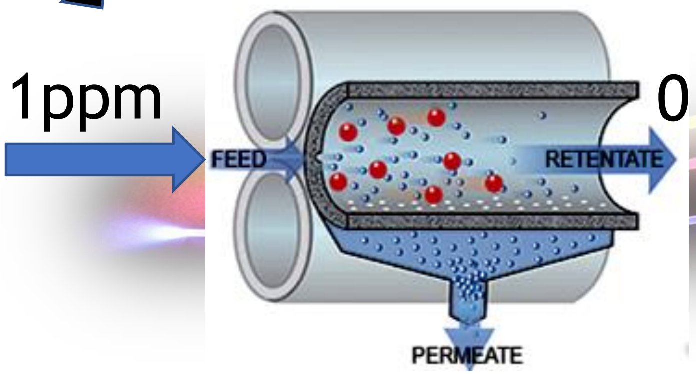
$$\% \, Rejection = \frac{C_0 - C_{eff}}{C_0} \times 100$$

$C_0 = concentration \; of \; Chlorpyriphos \; in \; the \; feed$

$C_{eff} = concentration \; of \; Chlorpyriphos \; in \; the \; effluent \; (Retentate \; or \; Permeate)$



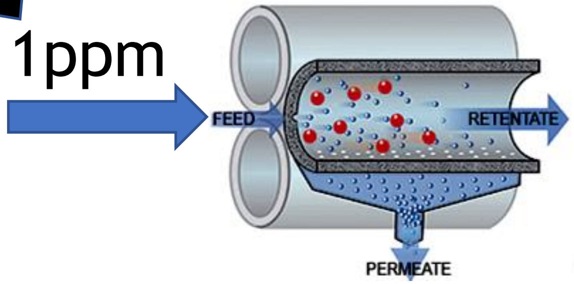




1ppm

0.11ppm

0.057ppm



1ppm

1.33ppm

0.32 ppm

UNIVERSIDAD DE ALMERIA

Cítricos del Andarax S.A.

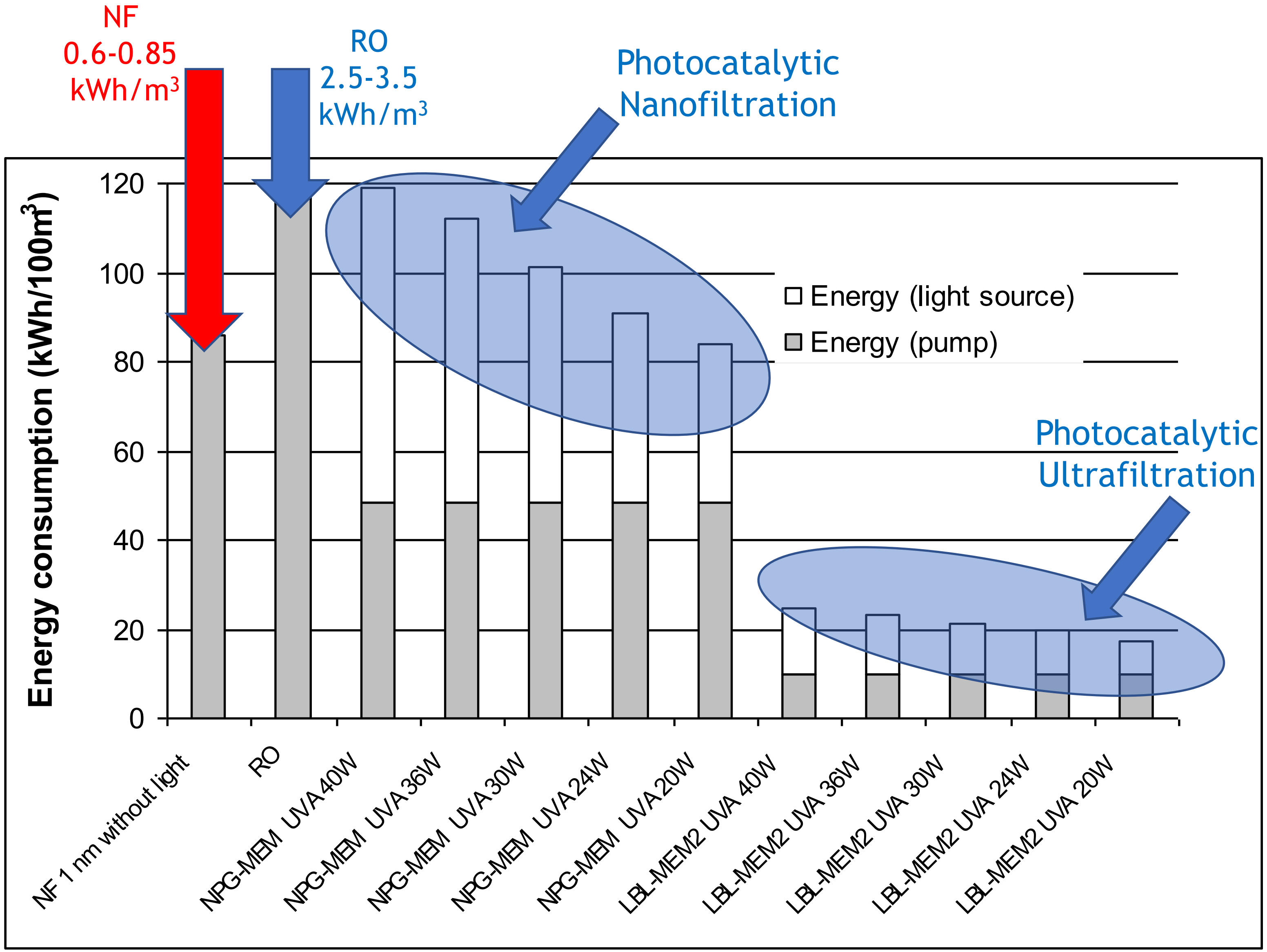
NATIONAL CENTRE FOR SCIENTIFIC RESEARCH "DEMOKRITOS"

INSTITUTE OF NANOSCIENCE AND NANOTECHNOLOGY

Performance- Energy Efficiency

Less Energy Consumption for the pump compared to conventional NF and RO.

Visible light active photocatalytic membranes. – Further reduction of the energy demand for artificial light sources.



Synergy between NF and Photocatalysis- Problems that can be solved

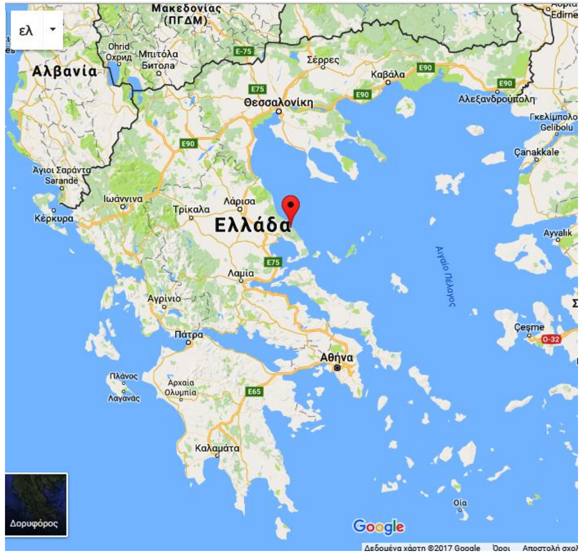
- **Competitive action of the organic loading. Consumes sorption sites and oxidising radicals.**
- Pre-treatment stages (CFS and adsorption on PAC) reduces COD to 100 ppm.
- NF further rejects large molecules of NOM. Solely the smaller micropollutants pass through the membranes and are degraded in the lumen side of the monolith with the action of photocatalysis.

- **Dependence on the physicochemical, electrical properties of the micropollutants in combination with the multitude of different molecules that can exist in the waste**
- At pH (6-8) TiO_2 is negatively charged.
- NOM is negatively charged.
- Only very small and positively charged micropollutants pass through the pores and reach on the lumen photocatalytic surface.

- **Ozonation produces side products due to partial oxidation and reaction with other compounds, halogenated.**
- Large chlorinated compounds can be removed by NF.
- The high surface area of the photocatalysts ensures more efficient and successive oxidation steps towards mineralization

- **Demand for very frequent regeneration/replacement of the membranes**.
- The molecules attached on the membrane surface are photodegraded

Pollutant Photo-NF remediation of Agro-Water
« LIFE PURE AGROH2O »



Thank you
for
your attention

UNIVERSIDAD DE ALMERIA

Cítricos del Andarax S.A.

NATIONAL CENTRE FOR SCIENTIFIC RESEARCH "DEMOKRITOS"

INSTITUTE OF NANOSCIENCE AND NANOTECHNOLOGY