Research and Innovation Centre
PRO-AKADEMIA

BioprocessLab: Industrial Wastewater Treatment

Integrated systems incorporating Microbial Electrochemical Technologies

Sector: Textile, Dairy
Countries involved : PL, DE, NL, CY, HU
Funding: Horizon 2020, Era-Net, IEOP

- Industrial wastewater treatment for water recovery
- Simultaneous energy production
- Nutrients (N, P, K) recovery
- Added-value products biosynthesis

Introduction

Problem of water pollution and how to deal with it is almost as long as the civilization itself. On the breakthrough of second millennia, together with rapidly growing industry and big cities, which are the main source of the pollutants, it have become really serious. The absence of access to clean, fresh drinking water is no longer problem of the third world countries – it threatens in the same, if not in bigger manner, to whole Western civilization.

That's why the wastewater treatment, especially on industrial scale, is so important to keep our society with good health, and to left the planet Earth to our next generations in not worse condition that we have inherited it.

But the same wastewater treatment can generate unnecessary byproducts (like CO_2) and be really energy consuming process.

Currently applied industrial wastewater technologies could be described as:

- energy intensive (consumption of **22 Terawatt hour** of electricity / year)
- carbon positive (emission of **0.75 GigaTonnes of CO_2-equivalent**)

Therefore, there are numerous attempts to make this process more environmentally friendly. From many scientific points of view, clear conclusion are arousing, that wastewater technologies should be:

- energy less intensive (through e.g. energy production and elimination of aeration)
- carbon negative (through e.g. including the biosynthesis with the use of waste CO_2)
- economically justified (high efficiency and lower operating costs)
- environmentally friendly (avoidance of toxic chemicals, reduced sludge production, water reuse)

That's why our BioprocessLab at **RIC Pro-Akademia** decided to look closely on this matter and tries to solve some problems, regarding industrial wastewater treatment.

About the laboratory and researches

BioprocessLab investigates different physical - chemical methods as a first step of wastewater treatment. We try to find new, cheap and environmental friendly compounds to improve the performance and decompose the most persistent pollutants. Additionally, we optimize the process parameters to decrease energy demand, chemicals use and volume of waste generated. Depending on the type of wastewater treated such processes can be applied solely or in combination with further biological treatment.

Following the newest trend in wastewater treatment we replaced conventional biological treatment with **Microbial Electrochemical Technologies (METs).** To increase their performance in our studies we test and compare different materials for electrodes (anodes/cathodes), different types of membranes (cation exchange membranes), different geometry of devices and components as well as different type of wastewater. We are one of the first group that applied **Additive Manufacturing** technique for fabrication MFC device.

Head of BioprocessLab at work, with visible results.

Applying of different METs gives us a chance to make some improvements in offered systems. Generally, our research are focused on nutrients recovery from MFC's effluent to form commercial products such as struvite.
Other very promising option is to use three-compartment MFC for wastewater desalination with following salt recovery. Such solution we would like to investigate for application in textile industry.

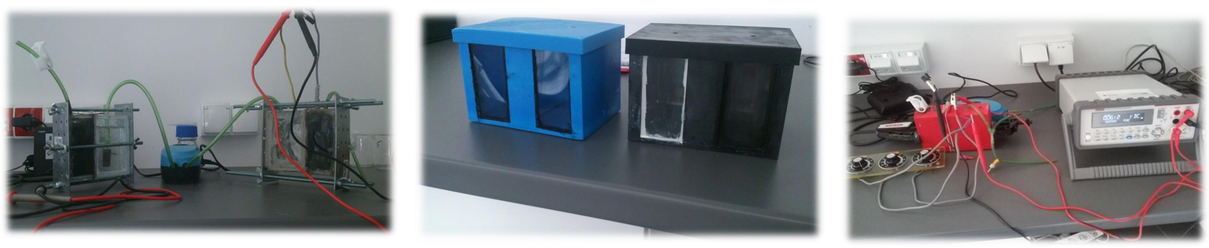
Schematics of wastewater treatment process

Physical & Chemical Treatment
- Coagulation / Flocculation – new perspective chemical tested
- Advanced Oxidation Techniques (Fenton-like processes)
- Performic acid oxidation
- Microwave irradiation

METs (MFC, MES, MEC)
- Clean water
- Electricity
- Added value products (H_2O_2, CH_3COOH)
- Biofuels (H_2, CH_4, C_2H_5OH etc.)
- Lower sludge production

Additional improvements
- Nutrients recovery & fertilizers production (struvite)
- Desalination

Outputs
- **Purified water**
- **Clean energy**
- **Added-value products**



Microbial fuel cells constructed at BioprocessLab.

Expected results from application of METs

↓ Decreased energy consumption by 50%
↓ Reduced sludge production by 50% (in comparison with conventional biological treatment)
↓ Decreased investment and operational costs
↓ Minimizing the volume of chemicals used

Partners

Contact

Karina Michalska, Ph.D.
karina.michalska@proakademia.eu
www.proakademia.eu

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