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## LEACHATE TREATMENT STUDY USING MIXED GRANULAR MICROALGAE – BACTERIA BIOMASS

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### **Introduction**

Research studies on microalgae have increased in recent decades with the involvement of photosynthetic microorganisms in a wide range of applications. In terms of environmental services, microalgae can play an important role in the wastewater sector and greenhouse gas mitigation by carbon dioxide capture. Moreover, microalgae are characterized by high metabolic adaptability having the capacity to grow in different environments, such as wastewater, assimilating macronutrients and other essential elements such as metals.

Considering their metabolic properties, recent investigations have shown that microalgae can be also considered for leachate treatment. Compared to wastewater, the leachate is represented by an effluent rich in organic and inorganic substances resulting from a natural process of municipal waste decomposition, as well as from the percolation of rainwater, characterized by specific physico-chemical particularities limiting the application of conventional technologies applied in the case of wastewater treatment (ex. activated sludge process). Several physico-chemical and biological methods are known so far to be applied for leachate treatment, high nitrogen and phosphorus concentrations of the influents promoting also the initiatives to test the feasibility of using microalgae in the treatment stage. The research aimed to assess the leachate treatment performance obtained using granular biological structures composed of microalgae developed in symbiosis with bacteria.

### **Materials and methods**

The experimental part was divided into two stages: (i) microalgae-bacteria granules culturing and adaptation to synthetic standardized municipal wastewater and (ii) leachate treatment. The biomass was represented by three photoautotrophic species of microalgae: unicellular eukaryotic microalgae *Chlorella* sp. and *Lobochlamys segnis*, and filamentous microalgae *Phormidium* sp. (Phylum Cyanobacteria). *Chlorella* sp. and *Phormidium* sp. belong to the culture collection of the National Research and Development Institute for Industrial Ecology-ECOIND, *Lobochlamys segnis* belong to the culture collection of the Norwegian Institute of Bioeconomy Research-NIBIO.

(i) Microalgae-bacteria granules culturing. During the first 14 days, the microalgae were cultivated in synthetic standardized municipal wastewater, in the absence of the addition of organic substrate. Conventional activated sludge, sampled from the wastewater treatment plant of Buftea municipality, was inoculated on day 15 to

promote the development of granular symbiotic microalgae-bacteria biomass and the occurrence of metabolic reactions found in the activated sludge process (ex. nitrification, denitrification, organic matter degradation) in addition to those provided by microalgae (ex. photosynthesis, nutrients assimilation). The operational conditions applied for the granulation process were followed according to the patent RO130247.

(ii) Leachate treatment. Considering the high COD concentration of leachate (~ 4000 mg O<sub>2</sub>/L), a 2% dilution was performed in synthetic standardized municipal wastewater resulting in a final organic load in the influent of 430 - 570 mg O<sub>2</sub>/L COD with NH<sub>4</sub><sup>+</sup> ranging between 50 and 60 mg/L and PO<sub>4</sub><sup>3-</sup> up to 16 mg/L. Both stages were operated in sequential batch mode with a hydraulic retention time of 23 h 35 min. The leachate treatment was conducted during 30 batches with periodical analyses of the biomass morphology and leachate treatment performance following the assessment of color index and microalgae biomass harvesting efficiency.

### **Results and conclusions**

The COD removal efficiency ranged between 73 and 88% with the recording of a direct correlation between the decrease of organic loading in effluents from 150 to 70 mg O<sub>2</sub>/L COD with an increasing number of treatment sequences. The resulting ammonium in influents was almost double compared to the maximum allowed limits for municipal wastewater. Despite this, the nutrient removal increased up to 92.1 ± 0.5% after 24 batches (from 71.7 ± 1.9 – batch 1), with the same trend as that recorded in the case of the COD parameter. As a result, the nitrification process was incomplete, however, the concentrations of NO<sub>2</sub><sup>-</sup> and NO<sub>3</sub><sup>-</sup> were kept below 0.1 mg/L and 3 mg/L, respectively. Compared to inorganic nitrogen, the removal efficiency of total nitrogen content did not exceed 40%, emphasizing the low removal performance achieved in the case of organic nitrogen probably caused by the linkage of nitrogen to low biodegradable organic compounds (such as humic acids), the leachate biodegradability coefficient being below 0.2. The color index (CN) was monitored to investigate the influence of the applied biological method on the removal of influent color (CN = 0.066 ± 0.003), with CN value in effluents ranging between 0.03 and 0.045 with a resulting CN removal efficiency varying from 16 up to 56%. This result could underline pointed above hypotheses of the low removal capacity of recalcitrant organic compounds which are also responsible for the brown to dark colour of leachate. Overall, the application of granular microalgae-bacteria biomass for treatment of 50 times diluted leachate ensured the proper quality of effluents, according to national norms, in the case of the following parameters: COD, BOD<sub>5</sub>, nitrates, nitrites, phosphate, and total phosphorus, by allowing the occurrence of the aerobic processes only by photosynthesis. Moreover, in comparison with activated sludge processes, in the aerobic stage, the method limited the increase of nitrates concentration in the effluent. The initial size of the microalgae-bacteria granules' diameter was around 0.4 cm increasing progressively, some of them even exceeding 1 cm. The development in the granular-like structure of the biomass allowed efficient harvesting of microalgae (> 99%) by gravity settling.

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