TOWARDS SUSTAINABLE WATER MANAGEMENT THROUGH SYSTEMIC MODELLING

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ABSTRACT

Zero-pollution environment is an important EU goal to be achieved by 2050 through industrial wastewater treatment [1]. Water depletion and generated industrial wastewater point out the opportunity for further treatment and proper management of wastes to recover resources [2], including water, mitigating the pressure on the environment, resulting in added-value products and less waste. Circular economy practices are being adopted in the industrial sector that is attempting to close the water loops through reuse, recycling and recovery, reincorporating the reclaimed resources, secondary materials and by-products into the value chain. In addition, the exchange of resources, waste and by-products among the industrial actors can offer a huge impact on the transition to a circular model through synergies and collaborative networks [3]. To this end, the by-products from one actor can be exploited as raw materials for another actor, closing the loop and promoting sustainability.

This research lies in the investigation and modelling of water and wastewater treatment and management as well as synergies at different levels in the process industry. This study derives from the process industries (DOW, BASF, Solvay, Agricola, TUPRAS) participating in the EU-funded AquaSPICE project, which aims to materialize water use, build resource-efficient industries and implement innovative technological and circular solutions.

The pillars for sustainable water management encompass the reduction of water resources consumption, enhanced industrial processes' performance and exploitation of all generated by-products. Overall, there are four levels to be modelled: (i) in-process modelling, (ii) in-factory modelling, (iii) industrial symbiosis and (iv) systemic modelling. The first level includes the development of mathematical models to predict water quality, process performance, energy requirement and chemical consumption. The second level of modelling encompasses a treatment train or a factory (more than one production process) and targets to minimize water losses and optimize water demand and supply through water balance and management models. Industrial symbiosis modelling refers to the exchange of water and by-products among industries, while systemic modelling incorporates also non-industrial actors, such as the municipality or the local authorities, considering quality, costs, water tariffs and their interdependencies. In conclusion, fit-for-purpose closed-loop approaches are required in the industry.

KEYWORDS: process industry, wastewater treatment, systemic models, sustainability

REFERENCES

[1] European Council (2024). Wastewater treatment. Available: https://www.consilium.europa.eu/en/policies/wastewater-treatment/#:~:text=The%20new%20rules%20will%20require%20member%20states%20to%20remove%20nitrogen,have%20to%20remove%20micro%2Dpollutants.

[2] Michaela Procházková, Michal Touš, David Horňák, Václav Miklas, Marek Vondra, Vítězslav Máša (2023). *Industrial wastewater in the context of European Union water reuse legislation and goals*, Journal of Cleaner Production, 426, 139037, https://doi.org/10.1016/j.jclepro.2023.139037.

[3] Athanasios Angelis-Dimakis, George Arampatzis, Andreas Alexopoulos, Antonia Vyrkou, Andreas Pantazopoulos, Vasilis Angelis (2023). *Industrial Symbiosis in the Balkan-Mediterranean Region: The Case of Solid Waste*, environments, 10, https://doi.org/10.3390/environments10010001.

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