Anaerobic treatment in the context of circular economy

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ABSTRACT

Anaerobic treatment technologies have received a great attention in the context of cost and energy saving approaches as alternative treatment of wastewater (mainly agro-industrial and organic-rich wastewater). Nowadays, anaerobic technology is applied as a mature technology for treating high strength industrial wastewater. Specifically, high-rate anaerobic treatment is considered more energy-efficient; it produces less sludge and can handle higher organic loads in comparison to aerobic processes. However, commercialized high-rate anaerobic technologies are still limited for wide application due to obstacles related to operational stability, e.g.: activated biomass washout, lengthy periods of acclimation, low quality of the produced biogas, in addition to sensitivity to toxic compounds that may affect the stability and performance of the anaerobic process. Also, even beyond these obstacles (assuming they were overcome), this traditional concept of anaerobic processes with biogas as the final and main product is not ambitious. The biogas has limited applications and utilization, since it typically consists of 60-70% methane and 30-40% CO_2, and often contains additional undesirable gases (i.e., traces of water vapor, H_2S, and other contaminants). Therefore, despite the fact that biogas can be used for heating or to generate power, the large volume of CO_2 reduces the heating value of the biogas, increases compression and transportation costs and limits its economic feasibility. Thus, it cannot be used as vehicle fuel and cannot be integrated into the natural gas energy system before removing substantial amounts of the CO_2 component.

These issues challenge and motivate researchers for new approaches including biogas upgrading and redirecting the anaerobic process towards the production of valuable resources such as organic acids that can be subsequently converted into fuels, alcohols, and bioplastics.

This presentation will focus on two aspects: (1) New technology for increasing the stability of the traditional anaerobic processes and the tolerance under inhibitory conditions. (2) New approaches for production of more valuable resources. In the regard of the first aspect, I will summarize an innovative immobilization approach that was developed recently in my laboratory. This technology was shown to successfully overcome the main problems of operational stability of high rate anaerobic systems under extreme conditions of high loading rate (hydraulic and organic) and sudden toxic shocks. This immobilization approach also enables the application of the anaerobic treatment for municipal wastewater. Integrating this developed technology at municipal WWTPs that are experiencing extreme load fluctuations can improve efficiency by: saving energy spent on conventional aerobic processes, removing a greater percentage of organic and particulate matter before the aeration basin, and an overall reduction in amount of sludge, and hence reduce the carbon (C) footprint of the WWTP. Within the Horizon2020 SMART-Plant Innovation Action (www.smart-plant.eu), a 30 m^3 high rate anaerobic system based on the developed immobilization technology is being demonstrated in a real environment by AgRobics (www.agrobics.com) jointly with the Mekorot Company at the Karmiel WWTP. The performance of this specific system and its potential to be integrated with the other promising

technologies of the SMART-Plant project will be presented. The second aspect will focus on different examples of in-situ, ex-situ biological biogas upgrading and an innovative electrode assisted anaerobic digestion process based on our own recent achievements as well as on reported results in the literature. In addition, I will present an overview of new current and future approaches of redirecting anaerobic processes for the production of organic acids and subsequently more valuable products.