International Doctorate in Civil and Environmental Engineering

Recovery and valorization of Extracellular Polymeric Substances (EPS) from granular sludge as new sustainable bio-based material

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Abstract

As a novel biotechnology, sludge granulation emerged in the last decade for a wide range of biological wastewater treatment processes. As in conventional biofilms, in granular biomass microorganisms produce a significative amount of highly hydrated extracellular polymeric substances (EPS) to form an hydrogel matrix in which they are self-immobilized. EPS are a complex mixture, consisting of polysaccharides, proteins, nucleic acids, (phospho)lipids, humic substances and some intercellular polymers, representing a key element for shape, structure, strength, filterability and settling behavior of these microbial aggregates. Given that the excess sludge is considered as waste product, whose costs of handling/disposal represents up to 50% of the wastewater treatment operative costs, the EPS recovery and conversion into bio-based commodities could be an appealing route to enhanced sustainability and economics of wastewater treatment, towards a circular economy pathway. Since their versatile properties (e.g. sorption properties, gel-forming ability), EPS can be destinated to several application sectors and markets. In this perspective, this PhD project investigates the feasibility to recover and valorize Extracellular Polymeric Substances (EPS) from granular waste sludge (e.g. anammox and aerobic granules) as new sustainable bio-based material. The main goal is the development of stable, cost-effective and high-performance EPS-based bioproducts to be applied in wastewater treatment systems or other industrial sectors. Structural EPS from aerobic granular sludge (AGS) are studied for their gel-forming capability and post-gelling mechanical properties, as pre-requisite for the evaluation of potential applications in industrial sectors where biopolymers-based hydrogels are getting increasing

attractiveness due to their great properties (e.g. high water content, flexibility and biocompatibility). Anammox granules-derived EPS are investigated for their metal sorption capability, leading to the development of sustainable technologies for the treatment of heavy metal-contaminated effluents, answering to the restrictive environmental legislation.