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Syntrophic microorganisms interations in anaerobic digestion (ad): A critical review in the light of increase the energy production

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Despite the worldwide growth of Anaerobic Digestion (AD) plants able to produce biogas, further investigations research on the functioning of the consolidated AD technique, which relies on the correct cooperation of syntrophic organisms within mixed. Micro consorptium in AD depend on process conditions and on the intrinsic characteristics of microorganisms, which are able to organize themselves in low-energy consumption configurations, close to thermodynamic limits, possibly better than any other known form of life. However, chemotropic organisms obtain energy by extracting an electron flow from different organic compounds, which are successively passed through different Red-Ox cycles, supported by enzymes and carries at different red-ox potentials (E°). Among the enhancement techniques for bioreactors, supplementation of zero-valent metals and conductive particles to fermentative broths is gaining ground. Oxidation-reduction cycles are present not only at intracellular level (metabolic pathways), but also as interspecies (exocellular) electron exchange, mediated through chemical compounds (Shuttled Interspecies Electron Transfer, SIET) or based on electrical interactions between bacteria (Direct Interspecies Electron Transfer, DIET). Metal particles, thus, generate an additional phenomenon that interacts with the biological system suggesting that a higher methane yield and Energy recovery are achievable, due to modification in syntrophic relationships and to the availability of different metals that seems to generate a positive bio-stimulatory effect. This review addresses the state-of-the-art of syntrophy among microorganisms, revises the fundamental role of Hydrogen as the key intermediate metabolite of AD, presents the exocellular electron exchange mechanisms (SIET and DIET), introduces the principles of Anaerobic Corrosion (AC) experienced under the operative conditions of AD, summarizes the different laboratory-scale studies that have been performed with metals particles, calculating the Supplementation Index (Is) that relates the amount of metal added with the present biomass and hypothesizes the enhancement mechanisms that the supplementation of metals could generate.

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