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Anaerobic Co-digestion in Two-Phase TPAD System of Sewage Sludge and Fish Waste

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Abstract : Biotransformation of organic waste into biogas is considered an interesting alternative for the production of clean energy from renewable sources by reducing the volume and organic content of waste Anaerobic digestion is considered one of the most efficient technologies to transform waste into fertilizer and biogas in order to obtain electrical energy or biofuel within the concept of the circular economy. Currently, three types of anaerobic processes have been developed on a commercial scale: (1) single-stage process where sludge bioconversion is completed in a single chamber, (2) two-stage process where the acidogenic and methanogenic stages are separated into two chambers and, finally, (3) temperature-phase sequencing (TPAD) process that combines a thermophilic pretreatment unit prior to mesophilic anaerobic digestion. Two-stage processes can provide hydrogen and methane with easier control of the first and second stage conditions producing higher total energy recovery and substrate degradation than single-stage processes. On the other hand, co-digestion is the simultaneous anaerobic digestion of a mixture of two or more substrates. The technology is similar to anaerobic digestion but is a more attractive option as it produces increased methane yields due to the positive synergism of the mixtures in the digestion medium thus increasing the economic viability of biogas plants. The present study focuses on the energy recovery by anaerobic co-digestion of sewage sludge and waste from the aquaculture-fishing sector. The valorization is approached through the application of a temperature sequential phase process or TPAD technology (Temperature - Phased Anaerobic Digestion). Moreover, two-phase of microorganisms is considered. Thus, the selected process allows the development of a thermophilic acidogenic phase followed by a mesophilic methanogenic phase to obtain hydrogen (H_2) in the first stage and methane (CH_4) in the second stage. The combination of these technologies makes it possible to unify all the advantages of these anaerobic digestion processes individually. To achieve these objectives, a sequential study has been carried out in which the biochemical potential of hydrogen (BHP) is tested followed by a BMP test, which will allow checking the feasibility of the two-stage process. The best results obtained were high total and soluble COD yields (59.8% and 82.67%, respectively) as well as H_2 production rates of 12LH_2/kg SVadded and methane of 28.76 L CH_4/kg SVadded for TPAD.

Keywords : anaerobic co-digestion, TPAD, two-phase, BHP, BMP, sewage sludge, fish waste
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