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Industrial Wastewater from Paper Mills Used for Biofuel Production and Soil Improvement

Authors : Karin M. Granstrom

Abstract : Paper mills produce wastewater with a high content of organic substances. Treatment usually consists of sedimentation, biological treatment of activated sludge basins, and chemical precipitation. The resulting sludges are currently a waste problem, deposited in landfills or used as low-grade fuels for incineration. There is a growing awareness of the need for energy efficiency and environmentally sound management of sludge. A resource-efficient method would be to digest the wastewater sludges anaerobically to produce biogas, refine the biogas to biomethane for use in the transportation sector, and utilize the resulting digestate for soil improvement. The biomethane yield of pulp and paper wastewater sludge is comparable to that of straw or manure. As a bonus, the digestate has an improved dewaterability compared to the feedstock biosludge. Limitations of this process are predominantly a weak economic viability - necessitating both sufficiently large-scale paper production for the necessary large amounts of produced wastewater sludge, and the resolving of remaining questions on the certifiability of the digestate and thus its sales price. A way to improve the practical and economical feasibility of using paper mill wastewater for biomethane production and soil improvement is to co-digest it with other feedstocks. In this study, pulp and paper sludge were co-digested with (1) silage and manure, (2) municipal sewage sludge, (3) food waste, or (4) microalgae. Biomethane yield analysis was performed in 500 ml batch reactors, using an Automatic Methane Potential Test System at thermophilic temperature, with a 20 days test duration. The results show that (1) the harvesting season of grass silage and manure collection was an important factor for methane production, with spring feedstocks producing much more than autumn feedstock, and pulp mill sludge benefitting the most from co-digestion; (2) pulp and paper mill sludge is a suitable co-substrate to add when a high nitrogen content cause impaired biogas production due to ammonia inhibition; (3) the combination of food waste and paper sludge gave higher methane yield than either of the substrates digested separately; (4) pure microalgae gave the highest methane yield. In conclusion, although pulp and paper mills are an almost untapped resource for biomethane production, their wastewater is a suitable feedstock for such a process. Furthermore, through co-digestion, the pulp and paper mill wastewater and mill sludges can aid biogas production from more nutrient-rich waste streams from other industries. Such co-digestion also enhances the soil improvement properties of the residue digestate.

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