FEEDSTOCK PROPERTIES' INFLUENCE ON THE PRODUCTION OF BIODIESEL FROM WASTE URBAN SLUDGE

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Safe disposal of sewage sludge is one of the most important issues in the wastewater treatment cycle: at the European Union level, the 2005 sludge production was estimated in 9.5 million tons dry weight, up more than 54% in ten years, and is expected to reach 12.9 Mt by year 2020, a further increase of more than 30%. Sludge disposal costs may constitute up, and sometimes above 50% of the total cost of operation of a WWTP. Most common disposal options at the moment are: landfilling, disposal in agriculture (about 40% EU-wide), incineration or co-incineration, use in industrial production of bricks, asphalts, concrete. Sewage sludge, however, still contains beneficial resources such as nutrients, that can be recovered through specific processes (e.g. precipitation as struvite) and energy, recoverable through a variety of approaches.

On the other hand, to reduce fossil fuels consumption and carbon emissions, energy industry and government policies worldwide are promoting the use of biodiesel and other non-petroleum biofuels. The current EU commitment under Directive 2003/30/EC on the promotion of biofuels for transport, sets a target of 5.75% of all transport fuels by 2010, increased to 10% by 2020 by the recent European Commission energy roadmap. A "biofuel" is defined as a fuel that is produced through contemporary biological processes, rather than by geological ones, such as those involved in the formation of fossil fuels. An ongoing debate on biofuels sustainability has emerged since the biofuels industry gathered momentum. While 1st generation biofuels were (and are) mainly produced with feedstock with food value for humans or animals, 2nd generation biofuels are increasingly being produced from lignocellulosic and waste materials and could enable far greater reductions in greenhouse gases (GHG) emission.

Traditionally, sewage sludge is processed in anaerobic tanks to produce biogas, a mixture of CH_4 and CO_2 that can be used as such or further refined to obtain bio-methane, a renewable fuel with characteristics practically identical to those of fossil methane. However, recent work has demonstrated that the production of biodiesel using the lipids extracted from sewage sludge could be economically feasible because of the remarkably high yield of oil and low cost of this feedstock, as compared to conventional biodiesel feedstocks. The authors demonstrated this using a thermochemical process under ambient pressure in a continuous flow system to process digested urban sludge.

The same methodology previously used has been applied in the present study, in which undigested sludge from the same WWTP has being subject to microwave-induced pyrolysis. The purpose of the study, having already demonstrated the possibility of recovering biodiesel from waste sludge materials, is to attempt a more encompassing energy balance of the process, in order to comprehensively define in energetic and economic terms its overall sustainability. The previous study, in fact, did not exploit the full oil production potential of the sludge, as part of its energetic content had already been anaerobically converted to biogas, and neglected the contribution of syngas generated during pyrolysis to the overall energy balance.

In the present study, biodiesel and syngas (indicating as syngas the combustible gas generated during the process, to distinguish it from biogas, generated by anaerobic bacterial fermentation in the digestion process) fractions have been collected and analyzed under various process conditions, to determine maximum energetic recovery from sludge under the microwave-induced sludge pyrolysis process. Results are discussed and compared with the energy recovery obtained by the sludge digestion process currently used at the treatment plant. Of interest are both the attainable net energy recoveries from either process, pertaining to the sustainability of the technology, and the current (with anaerobic digestion and subsequent processing) vs. foreseen (with use of MW-pyrolysis) disposal options and costs of the sludge residues.

Conclusions about the general applicability and impact on WWTP operation of the investigated process are exposed.

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