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ANAEROBIC DIGESTION AS A KEY PROCESS FOR SUSTAINABLE ORGANIC WASTE MANAGEMENT AND ENERGY PRODUCTION

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1. What is anaerobic digestion?

Anaerobic digestion (AD) is a microbiological process that occurs naturally in the environment, for example in lagoons or in the stomach of ruminants. Under anaerobic conditions, organic materials are biodegraded through a complex microbiological process leading to the production of a more stabilized organic material and biogas with high methane content.

The technological application of this process in bioreactors gives an appropriate solution for the treatment of organic wastes and by-products. The effluent of bioreactors can be used as an organic fertiliser as long as it meets current legislation for land application. Methane content in biogas depends on the composition of the raw materials treated and operational conditions (reactor design, process temperature, residence time, etc.), being typical values 60-70%. As methane energetic value is 10 kWh/m^3, it can be used for heating and/or electricity production, giving an energetic valorisation of the organic materials treated. Hence, technological strategies based on AD may allow for both sustainable waste management and renewable energy production.

2. Is it environmentally friendly?

If we take into account the main features of the process, one could think of anaerobic digestion, also known as biomethanation, as an environmentally friendly technology. Its major advantage compared to alternative biological treatment technologies (like composting) is the production of renewable energy, with an overall positive energy balance, i.e. substitution of fossil fuels or wood, which could help decrease deforestation rates in certain areas. Moreover, as the process takes place in a controlled and enclosed reactor, the digester, it helps reducing offensive odors and CH_4 uncontrolled emissions mitigation. Additionally, there is a reduction of CO_2 emissions (from the substituted fossil fuels), with an overall reduction of greenhouse gases emissions. The partial stabilization or mineralization of the organic materials makes it appropriate for land application, i.e. agriculture, gardening or land reclamation, closing the organic matter cycle. In this sense, the performance of AD followed by a composting stage should provide a better quality end-product.

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3. Which wastes or by-products can be digested?

Theoretically, any easily biodegradable organic waste or by-product could be treated in anaerobic digesters. Currently, the major sources include animal manure or slurries, sewage sludge, organic fraction of municipal solid wastes (OFMSW), and wastes from agro-industries, depending on the geographical location and the corresponding regulations (if any). Their mixture is particularly interesting, because it provides more equilibrate substrates for microorganisms, improving process performance, through the so called co-digestion. Unfortunately, the application of this practice tends to be more complicated, as it usually involves different stakeholders, and in many countries there is a need for supporting legislation.

4. What about the technological application?

The application of AD is usually described as complex and expensive when compared to composting. Hence, it has been commonly reduced to the treatment of semi-liquid wastes, which cannot be composted without prior dewatering (i.e. treatment of pig slurries and sewage sludge, but not manure or OFMSW), or when energy production is accounted for. However, one strength of AD is that it is indeed a natural process that can be performed in both high-tech heated and expensive bioreactors, or in very simple and inexpensive systems operated at environmental temperatures. This allows for its application in a wide range of realities, from industrialized and densely populated areas, where big digesters operated at 35 or 55ºC should cope with relentless accumulations solid wastes, to isolated communities, where the treatment of animal manure can provide a source of energy for cooking in substitution of wood, as well as an organic fertilizer.

5. Current situation and perspectives

A growing interest in AD started early in the seventies, as a result of the 1973 energy crisis. However, after a sudden rise, there was a progressive decrease in the implementation of these systems mainly due the economical constraints. Nowadays, with the increasing awareness of the necessity for environment protection, stringent environmental legislation is to apply in all countries, and all sectors (local authorities, private industries, farmers, etc.) will have to cope with their wastes and emissions in the near future. Some authorities even offer some subsidies with the aim of promoting the implementation of treatment technologies, in countries like Denmark, Germany or Austria. Together with this, there is an urgent need for increasing renewable energy production.

Bearing in mind the above described scenario, it seems the time to give another chance to anaerobic digestion systems has arrived. For this to happen, however, some considerations are required. First of all, the cost of waste treatment should be internalized in the production function, thus in the final prize of all products. Secondly, energy production from biogas should be subsidized, and grid connection (electrical and gas) facilitated, in order to allow its introduction in the energy market. In developing countries, the promotion of this technology may help reducing the lack of energy supply in many areas.