Exploitation of solar energy for ammonia sulfate recovery from digestate

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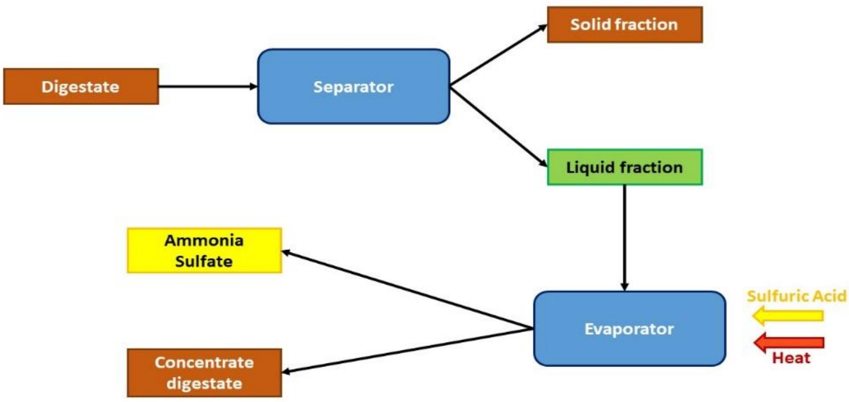
Anaerobic Digestion (AD) is known to be one of the most robust biotechnology for biofuels production. It has been estimated that over 17,000 biogas plants are present in Europe: more than 10,000 and 1,500 plants are located in Germany and Italy, respectively, the two Countries where this technology has been more adopted (EBA, 2016).

AD converts different typologies of organic substrates in oxygen absence condition into biogas, a gaseous blend mainly composed by methane and carbon dioxide. The AD solid-liquid output is constituted by digestate, whose composition depends on the substrates fed within the bioreactor, the operative conditions during the AD and the conversion yield into biogas. Generally, digestate is composed by recalcitrant organic matter not converted into biogas, and some important soil nutrients compounds, such as the N and the P ones. Ammonia evaporation and nitrate leaching do not make the direct application as fertilizer, to be the best option for digestate use (Riggio *et al*, 2017) and a post-treatment of the digestate is recommended.

Phosphorous compounds are mainly attributed to the solid fraction, while the Nitrogen ones are mainly present in the liquid fraction depending on the method of separation.

Today there are different ammonia recovery processes from the liquid fraction of digestate (Bolzonella *et al*, 2018). The most used is represented by the air or steam stripping of liquid digestate, followed by sulfuric acid absorption, in order to recover ammonia sulphate $(NH_4)_2SO_4$ (Figure 1), a common commercial salt, known to be a good soil fertilizer (Sotoft *et al*, 2015). Ammonia recover cost from digestate depends on its moisture content and the technology adopted, but estimations report that they run from 1 to 13 $ for kg of ammonia recovered (Zarebska *et al*, 2015).

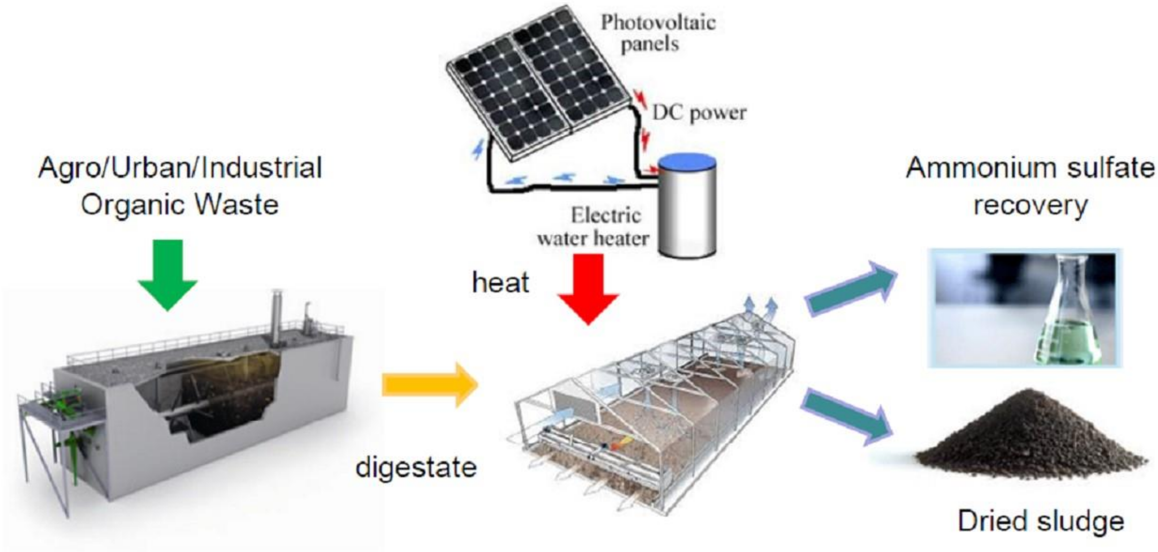
Figure 1. Ammonia sulfate recovery by air stripping from digestate



The aim of this research work is the integration of the ammonia sulfate recovery from anaerobic digestate with other renewable energies in order to reduce the OPEX and CAPEX. In particular, solar energy has been used to favour the digestate drying and the ammonia evaporation. Different digestate typologies, which differ for the substrates fed to the bioreactor (the organic fraction of municipal solid waste, OFMSW, agricultural residues, industrial wastewaters) and for the Total Solid (TS) content (wet, semi-dry, dry fermentation) have been located in a transparent greenhouse, exposed to sunlight. The digestate drying has been assured by air fan, electrically fed by some solar panels located at the top of the greenhouse. Ammonia vapours from digestate have been sent to an adsorption column, where the contact with sulfuric acid solution (38% *w/w*) allowed the ammonia sulfate precipitation. Figure 2 summarizes the above-described process.

The test performances have been evaluated taking into account the flow and the composition of vapour phase flow from the different digestate, the amount of ammonia sulfate recovered and the amount of reagents used during the experimental tests.

Figure 2. The use of solar energy for the digestate drying in order to recover ammonia sulfate



This research is framed inside Biogasmena project context, which saw the synergy of universities and research centres from different European and Mediterranean Countries. Biogasmena project aimed to support the technology transfer to encourage the North Africa development of: i) full scale plants for biogas production by dry AD and ii) an adequate exploitation of digestate for agronomic purposes. For these reasons, the different digestate typologies and the operative conditions for their drying have been chosen to reproduce the most common substrates and to respect the environmental legislation of the North Africa countries where the plants will be built up.

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