Anaerobic co-digestion of water and wastewater sludges

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Water and wastewater treatments produce considerable amount of sludge that must be properly treated in order to minimize environmental problems and to maximize the material and energy recovery.

Water treatment sludge has different characteristics when compare with sewage sludge (Margutti *et al.*, 2018), due to the treatment scheme typically with the following operations: coagulation, flocculation, sedimentation and filtration. Usually in water sludge the chemical components are silica, alumina, ferric oxide, lime and some metals (Ahmad *et al*., 2016).

Sewage sludge has an organic matter content higher than the water treatment. In Table 1 the typical water and sewage sludge compositions are presented (Elbeshbishy *et al*., 2012, Abelleira-Pereira *et al*., 2015, Adekunle, *et al*., 2017).

Table 1. Water treatment and sewage sludges typical composition.

Parameters	Sewage sludge	Water sludge
pH	5 - 7	5 - 10
Moisture (%)	10	25 - 75
TS (g/L)	2,5 - 98	1 - 59
COD (g/L)	20 - 48	0,140 - 5,45
Total nitrogen (g/kg)	-	0,6 – 6,3
Aluminium (g/kg)	-	0,253 - 144
Calcium (g/kg)	-	3 - 295
Iron (g/kg)	.	4 - 90

There are different ways of treating sludge produced in water treatment plants (WTP) and in wastewater treatment plants (WWTP). Usually the water sludge is submitted to chemical conditioning, thickening and dewatering. The final disposal of water sludge is in most cases landfill. Due to the inorganic fraction of water sludge it isn't possible apply anaerobic digestion without another substrate. The new challenge is the mixture of waste sludge with the wastewater sludge for a co-treatment. Typically, wastewater sludge is treated by anaerobic digestion. Anaerobic digestion is a biological process that allows main organic compounds such as carbohydrates, proteins, lipids to be converted to methane, carbon dioxide, water and other vestigial compounds. This process has four sequential steps, hydrolysis, acidogenisis, acetogenisis and methanogenisis. Therefore, anaerobic digestion is widely used process to treat sewage sludge alone or with other substrates. In this way sludge can produces biogas with enough methane content to contribute as a renewable energy fraction and at the same time the digestate can be used as a fertilizer, because it is rich in nutrients.

There are several studies concerning anaerobic digestion of sludge with others organic substrates such as, organic fraction of municipal solid waste, agriculture waste, e.g. rice, maize (Abudi *et al*., 2016).

To evaluate the substrate biodegradability with anaerobic digestion several methods have been applied. The biochemical methane potential (BMP) tests are worldwide applied to gauge the biodegradability of different substrates or mixture of substrates (Kafle *et al*., 2016, Cabrita *et al*., 2016) and is a valuable method to choose potential substrates to anaerobic digestion.

The present work has the objective to evaluate the biogas production by anaerobic co-digestion of water treatment sludge (WTS) with sewage sludge (SS). The sludges are characterized by some parameters like, total solids, volatile total solids, pH, chemical oxygen demand, alkalinity. Therefore, several BMP tests are applied with different fraction of both sludge in order to obtain the adequate WTS/SS ratio that allows a higher methane production, and in consequence the energy production.

The inoculum to be used in the BMP tests is from an anaerobic reactor that treated sewage sludge at a steady-state in order to provide a highly diverse of microorganisms. The BMP tests are done in according the Hansen *et al*., (2004) methodology and Holliger *et al*., (2016) recommendations. The batch reactors are in glass with butyric rubber and have a volume of 500 mL. The tests are done in mesophilic temperature and in triplicate. Besides the reactors with substrates also, blank reactors with the inoculum and control with glucose are done.

The biogas production is measured by volumetric methodology and the composition is analysed by gas chromatography in order to obtain the methane production. The anaerobic digestion results are expressed in methane volume per mass of volatile solids of substrate. This work is still under development.

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