DRY ANAEROBIC DIGESTION AS AN ALTERNATIVE MANAGEMENT & TREATMENT SOLUTION FOR SEWAGE SLUDGE

Life ANADRY

(LIFE ENV/ES/000524)

LAYMAN REPORT / FEBRUARY 2019

25 YEARS Life 1992 - 2017

Project LIFE

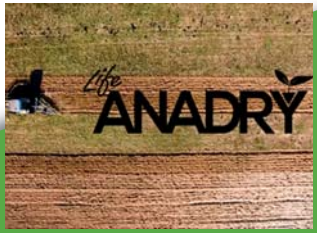
LIFE is the EU's financial instrument which supports environmental projects: climate and nature conservation throughout the EU. Since 1992, LIFE has co-financed nearly 4,200 projects, contributing approximately 3,400 million euros to the environmental and climate protection.
http://ec.europa.eu/environment/life/

Life-ANADRY project

The project is entitled, "Dry anaerobic digestion as an alternative management & treatment solution for sewage sludge". Life-ANADRY is a European project co-financed by the European Commission within the programe LIFE, with a total budget of 1,45 million euros.

The purpose of Life-ANADRY project is to determine the feasibility of an innovative solution which contributes to solve the problems facing the EU in the waste-water treatment and the sewage sludge sector, mainly the small mean size treatment plants without anaerobic digestion.

Life-ANADRY has proved that the project referred above offers a great improvement in efficiency, management and quality on the digestate produced, compared to other methods used with the treatment of sewage sludge in small or medium WWTP.



Life-ANADRY project objectives

- To reduce the environmental impact through lower CO_2 emissions.
- To prove the technical and economic feasibility of the technology as an alternative on the WWTP management.
- To increase the sludge stability due to the reduction of volatile solids concentrations in the effluent.
- To improve the quality of the sludge produced throughout the content of pathogens reduction.
- To reduce the use of inorganic fertilizers due to the sludge use as a fertilizer.

With the development of these goals, we have encouraged a generation of a broad knowledge-base of the beneficial effects on the climate change. It includes the implementation of the dry anaerobic digestion process and the environmental benefits for the local, national and European agriculture, in terms of reduction of WWTP sludge production and improvement of it is management in small /medium size WWTP.

During the project, it has been carried out the promotion and the diffusion of the obtained results, in order to empower the water sector agents (Public Administration, private enterprises, research organizations and farmers) to take appropriate measures and thus, promote the progressive introduction of sustainable and viable processes for the management and treatment solution for sewage sludge.

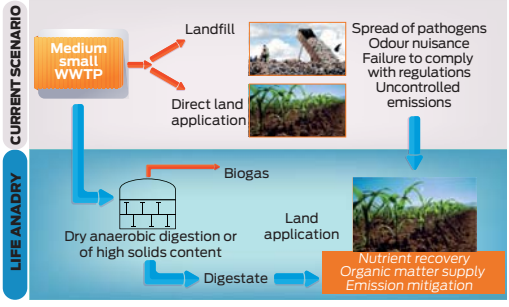
The project solution

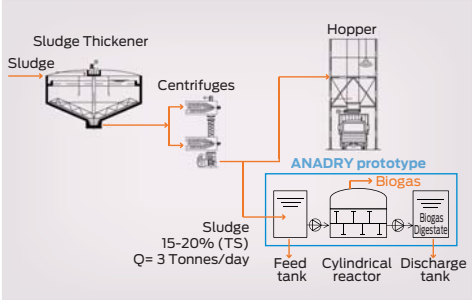
The proposed design on a preindustrial scale is based on a 20 m^3 cylindrical reactor with a capacity of treatment of 3 T/day of dry sludge.

The system works as a dry anaerobic digestion, with a solids concentration about 15-20% (MS) in the influent and it has been operated with two different temperature conditions: mesophilic and thermophilic.

The Life-ANADRY prototype consists of feeding system, anaerobic reactor, digestate tank and heating system (Figure 1). The anaerobic reactor was manufactured in stainless steel with 3.90 m x 2.50 m external dimensions and composed of agitator axis, membrane gasometer and heating system. The heating system consists of a biogas analyser, a dual boiler, a warming jacket and electrical resistances.

Furthermore, the influence on the hydraulic retention time (HRT) on the process yield in terms of sludge stabilization, elimination of pathogens and biogas production has been studied.





Project implementation

The project takes place in the Alguazas WWTP in Murcia (Spain). The Alguazas WWTP is a urban WWTP of medium size that doesn't have anaerobic digestion, and treats 3,500 m^3/d (60,000 inhabitants) of wastewater and produces around 10 T/day of dry sludge.

Life-Anadry phases

01 Design of the dry anaerobic digestion technology and control algorithm

02 Construction, validation and transport of the prototype

03 Start-up of the prototype at Alguazas WWTP

04 Implementation of thermophilic and mesophilic conditions in the prototype

05 Technical and economic feasibility studies

06 Transferability study of full-scale implementation

Results

During the experimental period, the process performance was assessed in two different temperature conditions: mesophilic (35 ºC) and thermophilic (55 ºC). The process was also assessed under different operating conditions related to the Organic Loading Rate (OLR) and hydraulic retention time (HRT).

Prototype design and construction

The prototype designed and constructed consist in a 20 m^3 anaerobic digester. It has been installed a membrane gasometer for the biogas storage at the top. The biogas quality is analyzed using an online analyzer. The biogas generated is used for heat and electric production in order to ensure the energy self-sufficiency. To do so, the prototype has a biogas post-treatment and a dual boyler (gasoil/biogas). The heating system is composed of an intern side where the warm water flows and an electrical resistance in the bottom digester which leads to reach and maintain a uniform temperature.


Feeding systen


Digester


Agitation system


Efluent tank

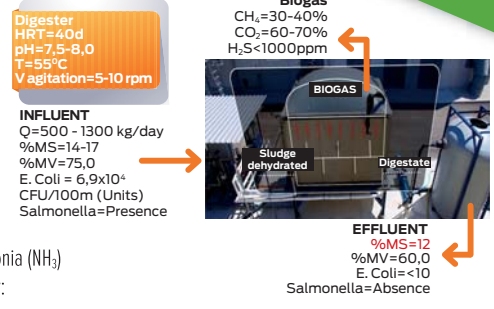

Heating system


Control system

Start-up and implementation in thermophilic conditions

The results obtained during the start-up and implementation period in thermophilic conditions (55ºC), show that the process is limited due to the partial inhibition of the process produced by the high concentration of nitrogen species inside the digester, specially ammonia (NH_3).

In terms of hygienization, it has been achieved a complete *E.coli* and *Salmonella spp.* removal. This microorganism are addressed in the national legislation (Order AAA/1072/2013). In this context, the process in thermophilic conditions presents a technological challenge which has to be addressed in future studies with the aim of improving the performance in this conditions.



The different alternatives which make possible to reduce the ammonia (NH_3) and minimize the partial inhibition in the system are summarized bellow:

Short term action

- To change the HRT to shift the NH_4-NH_3 balance.
- To reduce the temperature to shift the NH_4-NH_3 balance.
- Co-digestion with other residues to change the relation COD/N.

Long term action

- Ammonia stripping and recovery as an ammonium sulfate.
- Precipitation of nitrogen compounds.
- Ion exchange membranes to eliminate NH_4.
- Use of synthetic zeolites or resins for the adsorption of ammonium.

Process monitoring under mesophilic conditions

The start-up of the mesophilic process was carried out with an inoculum from a mesophilic anaerobic digester from an urban WWTP (near to Alguazas). During the mesophilic process, the pH has remained alkaline arround 8.33 ± 0.4, with an AGV concentration (lower than the previous process) arround 4000 ± 1.108 mg HAc · L^{-1}.

Due to the lower temperature used, the total ammonia nitrogen values have remained more stable and lower than 4,000 mg NH4 · L^{-1}. A maximum biogas production of 29.4 m^3 · day^{-1} was obtained, with a stable methane composition of more than 60% at different HRT (30, 20, 15, 12, 10d). The results for the removal pathogens (Order AAA / 1072/2013) are included in Table 1, which demonstrates the hygienization of the sludge.

Parameter	Unit	Thermophilic (55ºC) Influent	Thermophilic (55ºC) Effluent	Mesophilic (35ºC) Influent	Mesophilic (35ºC) Effluent
Q	Kg/d	500-1200kg/d		500-1800 kg/d	
ST	%	15	12,5	13-15	10,5
MV	%	76	60	81	69,2
pH		7,1±0,5	7,5±1,2	7,1±0,5	8,1
Salmonella spp.	presence 25 g	(+)	(-)	(+)	(-)
E. coli	UCF/100 ml	$6,9x10^4$	< 10	$5x10^4$	< 100

Table 1. Summary of the thermophilic and mesophilic phase of the operation on the Life-ANADRY prototype

Disseminations actions

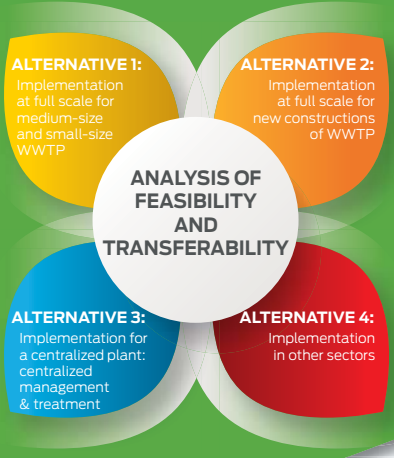
(LIFE14 ENV/ES/000524)

Dry anaerobic digestion as an alternative management & treatment solution for sewage sludge: LIFE-ANADRY

The impacts generated throughout the project thanks to communication actions are estimated to be around 50,000 audiences reached at European level. At international level, the project members have interacted with experts from more than 10 countries, who have learned first-hand about the results of the Life- ANADRY project.
Around 1000 people have been informed about the project progress and results, through various events, conferences and congresses in which the project organized or participated.

Economic and feasibility study

The economic study was developed considering four possible implementation alternatives, depending on the type and size of WWTP where the sludge is produced. Below you can find the 4 alternatives considered and the main conclusions.



The economic study and the technical advances developed in this project, established that the developed technology has an interesting potential to be applied in small / medium sized WWTPs that do not have anaerobic digestion. One of the most interesting options is the implementation in a centralized plant, which allows managing sewage sludge within a distance of 150 km.

Indirect impacts

- Creation of new knowledge in the wastewater treatment sector.
- Research structure strengthening among the partners involved.
- Improvement in the quality and management of the sludge produced.

Crosscutting impacts

- Public awareness about WWTP sludge management.
- New technologies development that can be applied in medium/small sized WWTPs without anaerobic digestion.
- Development of good practices in sludge management aligned with the guidelines of the European Union.

Direct impacts

- Sludge volume reduction up to 40%.
- Energy production due to the biogas produced (30 m^3/d).
- Sludge sanitation due to the reduction of *E. coli* and *Sallmonela spp.*
- Creation of direct and indirect employment during the prototype design, construction and implementation.
- Nutrient recirculation due to the use of digestate as an agricultural amendment.
- Indirect reduction of greenhouse gases (CO_2) due to the lower volume of transported sludge.

Life-ANADRY PROJECT

Reference: LIFE14 ENV/ES/000524
Duration 01-09-2015 al 28-02-2019
Web page: WWW.LIFE-ANADRY.EU

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Beneficiary partners

Entidad de saneamiento de la región de Murcia (ESAMUR)
Centro Tecnológico (CEIT-IK4)
Ingeniería y Desarrollos renovables (INDEREN)
Euro-Mediterranean Information System on know-how in the Water Sector (SEMIDE)

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