Assessment of biogas in a swine farm based the farm's slurry pits (ORIGIN MANURGY).

Abstract

The ORIGIN MANURGY project, comprised of the enterprises Escorxador Frigorífic in Avinyó, the University of Vic and Agropecuària Catalana SCCL, and coordinated by INNOVACC, seeks to assess the carbonaceous organic matter of the slurry as an energy source via mesophilic aerobic digestion. The goal is also to lower methane emissions into the air.

Objectives

The operating group will focus on the following objectives:

- To assess the carbonaceous organic matter of slurry as a source of energy via mesophilic aerobic digestion; this slurry is sorted into two main groups: dry matter in suspension and the Chemical Oxygen Demand (COD) dissolved in the liquid.
- To lower methane emissions (CH_4) into the air.
- To anticipate the evolution in the regulations which are likely to focus on lowering methane emissions into the air in the future, as methane (CH_4) is one of the compounds that contributes the most to greenhouse gas because it is 28 times more harmful than the carbon dioxide (CO_2) emitted after its combustion.

Likewise, the secondary objective is:

- To control ammonia (NH_3) emissions throughout the entire slurry treatment. Furthermore, these emissions do not initially go into the air but are dissolved in the liquid part of the digestate or appear as organic nitrogen in the solid thickened part of the digestate.

Description of the actions planned in the project

The operating group will pursue the following actions:

A. Description of the slurry and assessment of the potential of biomethanisation.

First we will come up with an initial comprehensive characterisation of the slurry, including the different physical and chemical parameters considered in the DACC's monitoring guide of consolidation systems. The parameters to be analysed are: TS, pH, total nitrogen, organic nitrogen, total phosphorous, total potassium, VS, electrical conductivity, ammoniacal nitrogen, copper and zinc.

In addition to the initial characterisations of the physical and chemical parameters of the slurry which we seek to assess, routine characterisations of the different trials will also be carried out during the operation in order to always have the slurry that is fed characterised and to be able to determine the performance of the anaerobic digestion process and interpret the data on the efficiency and efficacy of the anaerobic digestion process, as well as the quality of the end products yielded.

B. Laboratory-scale pilot

If after the preliminary laboratory work it is deemed necessary in order to define the parameters for the design of the industrial prototype, different trials will be held in a pilot anaerobic digestion plant

with a complete mixing reactor with a volume of 100 l. At this plant, we will assess and optimise the operating parameters, such as the hydraulic residence time, the volumetric organic load (kg COD · m-3), the organic load speed (kg VS · m-3 · d-1), the specific biogas production (m3 biogas · kg VS-1 fed) and the methane content of the biogas (%).

We will also assess the need to increase the cell residence time in order to enhance the performance of the reactor and improve its efficiency. The plant to be used in this pilot is illustrated in the figure below and belongs to the BETA Technology Park.

After the process is launched at the BETA Centre's facilities, the plant will be transported to RBS farm and will be operated under real conditions. The plant will have systems to continuously monitor temperature, redox potential and biogas production, in addition to the feeding discharges, and therefore the hydraulic residence time of the reactor and the agitation speed.

The plant will be tracked in physical, chemical and biological terms. More specifically, in addition to the parameters specified in the report, which will also be applied to characterise the digestate, the efficiency of the process will be assessed and optimised via the specific production of biogas, the elimination of COD and VS and TS.

C. Selection of the strategy and working parameters of the industrial prototype

The laboratory work will lay the groundwork for confirming the working parameters of the field installation. The following must be confirmed:

- Regarding the **strategy**, we have to confirm whether the preliminary selection is appropriate, in which the solid sedimentable and liquid parts are separated after they go through the digestor in order to take advantage of the methanisation potential of the dissolved carbonaceous organic matter.
- **CRT of the prototype:** To confirm that the cell residence time in the digestor is appropriate for the methanisation of the organic matter in the solid part (SVS)
- **HRT of the prototype:** To confirm that the hydraulic retention time of the slurry in the system is sufficient for the methanisation of the organic matter in the solid part (COD). As is common knowledge, it is expected to be under the necessary amount for the anaerobic digestion of the solids (SVS) in suspension in the slurry, given its state of hydrolysis.
- **SVSe**: To confirm the % of elimination of the volatile organic matter and the relationship between the CRT and the SVSe.
- **SS** in the different parts of the system: SSi, SSr and TSS
- **Oligoelements**: The laboratory work should also enable us to confirm that the slurry has all the oligoelements needed for proper anaerobic digestion. If the system is lacking any, we must plan to add it to the system.
- **Biogas**: It will help confirm or correct the preliminary design:
    - Specific biogas production
    - Composition of the biogas

D. Design and launch of the industrial pilot.

With the data and results, the decentralised farm pilot industrial anaerobic digestor will be designed including the operating and monitoring elements. It is important to note that the system proposed seeks to be easy for non-expert staff to operate and monitor. This prototype will have an approximate volume of 130 m3 and will allow 50% of the slurry produced on the farm to be treated.

The companies supplying the equipment and services will be contracted following the procedures established in the regulations in force and in accordance with the conditions of this call for applications.

The industrial anaerobic digestion pilot will be launched in different phases until reaching the operating regime of the design in a stationary state via exhaustive monitoring. The plant will be monitored via online monitoring systems installed to check the temperature, redox, pH and production of biogas, in addition to the corresponding flow meters, pumps and agitators. Furthermore, the monitoring and tracking of the plant will also be offline, primarily focused on characterising the digestate and the biogas and assessing the efficiency of the systems.

Likewise, the agronomic quality of the digestate obtained will be assessed with scaled trials (Pot Test). These tests will determine the fertilising capacity of the digestate (nutrient release and plant growth). The most appropriate plant will be chosen based on the time of year when the trials are conducted. The trials will be run in duplicate, including a control (with no product applied) and a conventional sludge slurry as a reference.

E. Technical-economic study and environmental impact assessment.

The technical-economic assessment will be conducted using a cost-cycle analysis (CCA) and a cost-benefit analysis. This study will bear in mind the entire value chain, as it will only be feasible if it is economically profitable for all the participating stakeholders. Therefore, the benefits of self-management of the waste generated compared to the current situation will be assessed. From an environmental standpoint, we aim to design the technology bearing in mind the principles of the circular economy.

The environmental benefits of the application of this technology will be assessed via life-cycle analysis (LCA), and both the impact generated by the technology applied (residual emissions from the process) and the impacts stemming from the application of the digestate will be borne in mine. Furthermore, the complete life cycle will be compared with different conventional treatments for managing livestock excrement and different chemical fertilisation strategies.

F. Project coordination

G. Project dissemination

Expected results and practical recommendations

Broadly speaking, this project seeks to anticipate the evolution in the regulations which are likely to focus on lower methane emissions into the air in the future in the future, as methane is one of the compounds that contributes the most to greenhouse gas. Methane is 28 times more harmful than the carbon dioxide emitted after its combustion. Therefore, with the development of the project, greenhouse gas emissions can be lowered, and therefore it will improve employees' working conditions not only near the company but also all around it wherever the pollution from the slurry can reach.

The project also aims to yield innovative results of particular interest by exporting technical knowledge and working on European projects.

Leader of the Operating Group

ORGANISATION: RBS SL

Coordinator of the Operating Group

ORGANISATION: INNOVACC

Other members of the Operating Group (grant recipients)

ORGANISATION: AGROPECUÀRIA CATALANA SCCL

Other members of the Operating Group (not grant recipients)

ORGANISATION: CENTRE TECNOLÒGIC EN BIODIVERSITAT, ECOLOGIA, TECNOLOGIA AMBIENTAL I ALIMENTÀRIA (BETA)

Thematic area(s) of application

☐	Agricultural production system
☒	Agricultural practice
☐	Agricultural equipment and machinery
☐	Livestock farming and animal welfare
☐	Vegetable production and horticulture
☐	Landscape / Territorial management
☐	Pest and disease control
☒	Fertilisation and nutrient management
☐	Soil management
☐	Genetic resources
☐	Forestry
☐	Water management
☒	Climate and Climate Change
☒	Energy management
☐	Waste and by-product management
☐	Biodiversity and environmental management
☐	Food quality/processing and nutrition
☐	Supply chain, marketing and consumption
☐	Competitiveness and agricultural and forestry diversification

☐ General

Geographic area(s) of application

PROVINCE(S)	COUNTY(s)
BARCELONA GIRONA	BERGUEDÀ BAGES GARROTXA

Project dissemination (publications, workshops, multimedia, etc.)

Publication of the news item on the INNOVACC website on 30 August 2021, of the projects of the 2021 Operating Groups requested by the cluster: https://www.innovacc.cat/2021/08/30/__trashed/

Publication of the news item on the INNOVACC website on 19 May 2021, of the projects of the 2021 Operating Groups requested by the cluster: https://www.innovacc.cat/2023/05/19/shan-aprovat-2-dels-projectes- presentats-a-la-linia-grups-operatius-2021/

Project website

https://www.innovacc.cat/2023/05/19/shan-aprovat-2-dels-projectes-presentats-a-la-linia-grups-operatius-2021/

Other information on the project

PROJECT DATES	TOTAL BUDGET
Start date: July 2021	Total budget: 246,510.61 €
Current status: In execution	DACC funding: 113,999.53 €
	EU funding: 85,999.65 €
	Own funding: 46,511.43 €

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Order ARP/113/2021, dated 20 May 2021, approving the conditions regulating the cooperation for innovation grants fostering the creation of European Association for Innovation operating groups on matters of agricultural productivity and sustainability and conducting innovative pilot projects by these groups, and Resolution ACC/1660/2021, dated 27 May 2021, calling for applications for this grant.

Generalitat de Catalunya
Departament d'Acció Climàtica, Alimentació i Agenda Rural

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