

SHORT TERM SCIENTIFIC MISSION (STSM) SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

Action number: CA17133

STSM title: Circular solutions in Reykjavik

STSM start and end date: 15/07/2019 to 12/07/2019

Grantee name: "Optimization of bio-digestion process to get methane and other value-added products at urban-scale from a circular perspective"

PURPOSE OF THE STSM

As part of the Icelandic climate action plan, a switch of the city busses from diesel to biomethane is under discussion. The current government aims to ban registration of new gasoline and diesel vehicles by 2030 to become carbon neutral by 2040.

In this sense the proposed work for this STSM consists of the integral use of bio-residues in the urban biosphere of Reykjavik capital area. The main goal is to analyse the life cycle of bio-methane from the organic waste feedstock to its end-use as biofuel. Different approaching models were simulated in Aspen Plus v.10 by using the data of bioresidues provided from the SORPA landfill.

A literature review with study cases all over the world of anaerobic digestion of municipal solid wastes (MSW), food wastes (FW), animal manure or sewage sludge was done. A literature review was also done to find out different modelling approaches of anaerobic digestion in Aspen Plus (ap) or using other holistic and mathematic models.

DESCRIPTION OF WORK CARRIED OUT DURING THE STSM

I had meetings with the SORPA landfill together with David C. Finger, participated in the activities of the summer school on energy at the University of Reykjavik, submitted an abstract to a nature-based solution International Congress held in Barcelona among other activities.

Through a comprehensive literature review, two models in Aspen Plus were developed: (1) the first one where all reactions (hydrolysis, acetolysis, acetogenesis and methanogenesis) occur in a stoichiometric reactor; (2) the second one with a stoichiometric factor (for hydrolysis reactions) coupled with a continuous stirred tank reactor where kinetics of acidogenesis, acetogenesis and methanogenesis were considered.

Among temperature regimes of anaerobic digestion, two operating conditions were tested on the AP models: mesophilic at 37 °C (same working temperature as SORPA company); and thermophilic at 55 °C as found in previous studies.

Different fractions of bio-residue were analysed and simulated based on the data gathered by SORPA: animal manure, MSW, lignocellulosic biomass and FW.

Two operation modes were also developed: digestion of a single fraction and co-digestion of MSW together with FW.

Considering the previous statements (feedstocks, approaching models, temperatures and operating modes), a total of 16 scenarios were developed.

A multi-criteria analysis was done considering technical, economic and environmental indicators based on the results of the AP results for the 16 scenarios. A final solution that comprises an equilibrium among all the indicators will be selected. Technical indicators were: yield of biogas, purity of methane, digestate generated. Economic indicators were: capital costs, operating costs and utility cost. Finally the total CO₂ equivalent is the environmental indicator considered in this work.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

The main results conducted thanks to the STSM were listed as follow:

- One abstract accepted as oral communication presented at the International Congress TERRAenVISION held in Barcelona from 2nd to 7th September, entitled "Modelling and Multi-Criteria Analysis of anaerobic digestion process to get upgraded methane from bio-residues in the city of Reykjavik".
- A drafted manuscript that will be submitted in November to a high-impact factor journal (Q1). The paper is entitled "Simulation of anaerobic digestion process to get methane and other value-added products at urban-scale from a circular perspective"

FUTURE COLLABORATIONS

As collaboration between two parties was successfully addressed, the University of Reykjavik (specifically David Finger) will collaborate with the University of Cantabria (specifically Tamara Llano) through different ways:

- Through teaching activities showing simulation models to the Master students.
- Through future scientific publications. A draft of the Process Simulation Models has also been prepared. In addition, the research of the multi-criteria analysis using Definite v2.0 software will be also published in a high impact factor scientific journal.
- By preparing a proposal and submitting in a EU Marie Curie Innovative Training Network call of European Joint Doctorates (MSCA-ITN-EJD). Thanks to this proposal, a joint training programme in biorefineries, bio-based products and biofuels will be carried out forming high-level PhD students.