ALGAE CULTIVATION ON RECYCLED CO_2 FROM BIOGAS AND RECYCLED MEDIUM IN A 9000 L PBR

Heirbaut K.[1], S. Van Roy [2], Q. Simons [2], B. Van den Bosch [2], F. Van Hoof [2], H. sterckx [2], L. Bastiaens [2]

1 Heirbaut Algriculture, Veldstraat 218, 9140 Temse, Belgium. heirbautlv@telenet.be
2 VITO, Conversion and Separation Technologies department, Boeretang 200, 2400 Mol, Belgium. leen.bastiaens@vito.be

Introduction

- Heirbaut LV is an agricultural company (dairy cattle) that envisions circular farming. The manure produced by cows is converted in a digester into biogas (CO_2/methane mixture) and digestate rich in nutrients (like nitrogen and phosphorus).

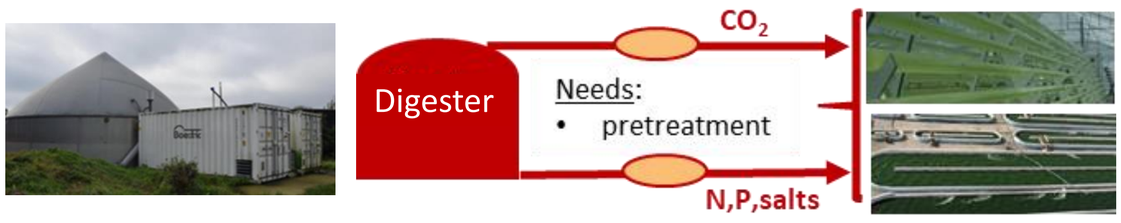

Figure 1: Digester generating biomass that is burned in CHP (Combined Heat and Power) unit creating CO_2 flue gas (left); schematic overview of side-streams from digesters with potential for algae growth (right).

- Photobioreactors were installed near the digester to grow microalgae on recycled CO_2.
- The submerged Membrane Algae Filtration (MAF) technology was used for 1) Pre-harvesting activities, and 2) Medium recycling,

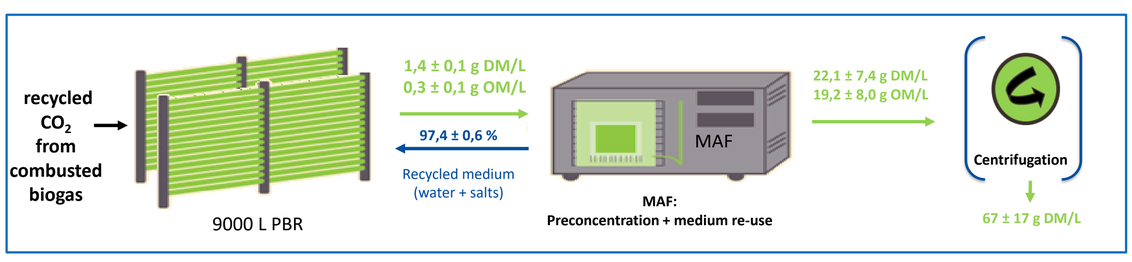

Figure 2: Tubular bioreactor linked to MAF-harvest unit.

Aim of the study = Long-term pilot trial in performance of the MAF-technology connected to pilot photobioreactors for continuous preconcentration of algae biomass and medium recycling.

Results

- Composition of the combusted biogas: 8 % CO_2, 6.8 % O_2, increased temperatures & moisture were observed.
- Some technical challenges were encountered to connect the CO_2 rich gas to the algae system as these are usually designed to be operated with 99.9 % pure gaseous carbon dioxide from a cylinder.
- The nice weather in September/October stimulated the algae growth well, although growth rates and culture densities were lower compared to summer cultivations. The slow growth restricted the daily harvested amount (Table 1).
- The algae biomass was concentrated and partially desalted during the MAF-concentration step. The composition of different algae harvests was determined (Figure 4).

Table 1: MAF-harvesting information related to harvested amounts, daily harvests, cleaning frequency, volume concentration factors (VCF), % medium re-use and fluxes.

	Harvest	Period	Days	L harvested	Cleaning	% medium re-use	av. VCF
9-14/11/2022	harvest 1	day 1-5	5	2147,5		96.6	29.6
14-17/11/2022	harvest 2	day 6-8	3	1792,8	x	96.8	30.9
17-21/11/2022	harvest 3	day 8-12	4	2766,7		97.5	39.7
21-24/11/2022	harvest 4	day 12-15	3	1432,1	x	97.5	40.3
24-28/11/2022	harvest 5	day 15-19	4	1887,5		97.5	41.1
24/11-1/12/2022	harvest 6	day 19-22	3	1368,8	x	97.0	33.1
1-5/12/2022	harvest 7	day 22-26	4	2090,5		98.6	70.8
5-8/12/20228	harvest 8	day 26-29	3	1830,5		98.0	39.9
8-13/12/2022	harvest 9	day 29-34	5	1184,6	x	97.0	32.7
		total	34	16501		97,4	

Set-up

- A *Chlorella* culture was cultivated in a tubular PBR of 9000 L installed in a foil tunnel (Sept-Dec 2022).
- Biogas was pre-treated with Granular Activated Carbon (GAC) prior to the combustion. The flue gas was directly used for algae cultivation
- Computer controlled MAF-3 device with UF submerged membranes was mobilized for continuous harvesting. Biomass was collected twice a week.
- The algae-free MAF permeate (containing water & salts) was recycled via immediate re-injection into the photobioreactor system.
- Compounds that are consumed by the algae (like N, P) were added at regular timepoints.

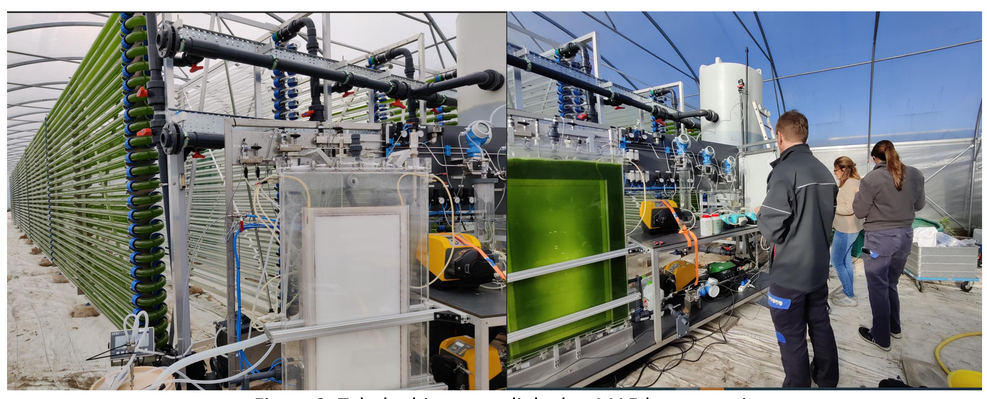

Figure 3: Tubular bioreactor linked to MAF-harvest unit.

Conclusions

- Algae can be cultivated on recycled CO_2 and recycled medium.
- Use of flue gases may require some technical applications as
  - the concentration of CO_2 in flue gas (8%) is significantly lower compared to CO_2 from cylinders (99,9%);
  - cooling is to be foreseen in summer.
- For 4 weeks, 5-8 % of the reactor volume was dewatered daily with an average medium recycling of 97 %.

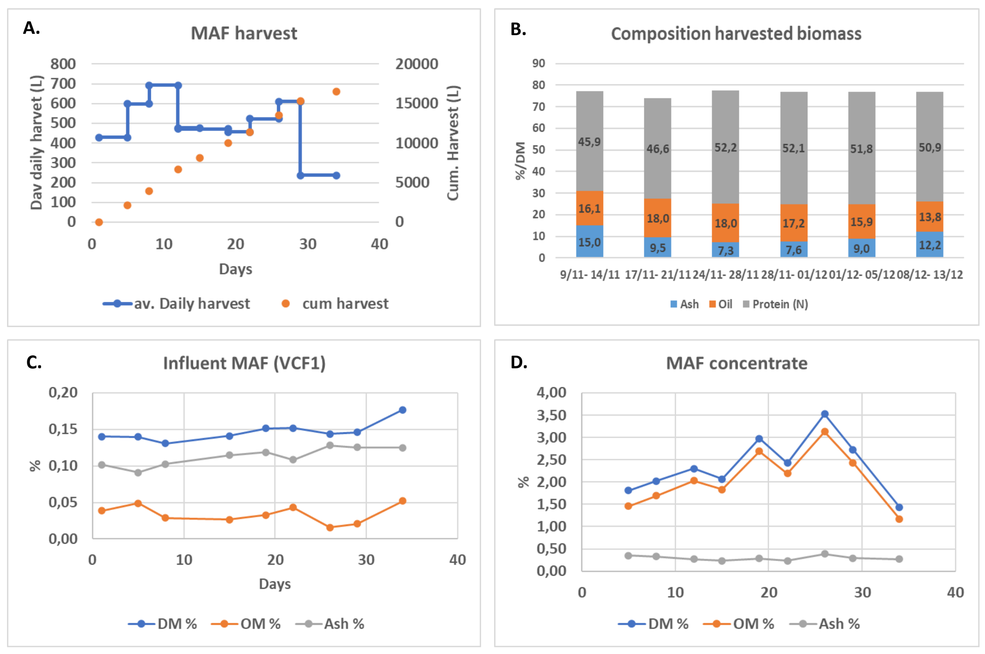

Figure 4: Details of algae harvest and the harvested algae biomass: (A) daily harvested amount, total harvested volumes; (C) Composition of algae biomass; Dry matter (DM); organic matter (OM) and ash content of biomass before (C) and after (D) MAF-harvest.

IDEA - Implementation and development of economic viable algae-based value chains (NWE639)

Duration: 9/2017 – 10/2021, capitalisation till 12/2023

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