Biomethane production improvement through feedstock pretreatment and co-digestion

Rodriguez , Cristina; Alaswad, Abed; El-Hassan, Zaki; Olabi, Abdul-Ghani

Published: 01/01/2017

Document Version
Publisher's PDF, also known as Version of record

Biomethane production improvement through feedstock pretreatment and co-digestion

C. Rodriguez[1], A. Alaswad[2], Z. El-Hassan[1], A.G. Olabi[1]

[1] *Institute of Engineering and Energy Technologies, University of the West of Scotland, Paisley, UK. Email: cristina.rodriguez@uws.ac.uk*

[2] *School of Engineering and the Built Environment, Birmingham City University, Birmingham, UK*

Introduction

Second generation biofuels are limited by the complex structure of biomass. Before undergo anaerobic digestion the feedstock should be suitably conditioned in order to offer the microorganisms in the digester a larger target surface area and thus to improve and accelerate the degradation process. The availability of the substrates for the enzymatic attack will be achieved through the increment of the specific surface area and break-down the structure. In recent years different technologies for biomass pretreatment have been developed in order to increase the availability of substrate for anaerobic digestion.

Objectives

Improve the anaerobic degradation of macroalgae *P. Canaliculata* and waste paper through mechanical pretreatment and feedstock co-digestion. Analysis of operational parameters: pretreatment time (PT), feedstock/inoculum (F/I) ratio and mixing ratio (WP/MA) on the methane yield and net energy.

Materials and Methods

Macroalgae were collected on-shore in Rothesay (Isle of Bute, Scotland) and waste paper from the recycling bins at the School of Engineering (UWS) (Fig.1).

Fig. 1. Raw and pretreated feedstock

The pretreatment process was conducted using a modified Hollander beater (Fig. 2). This beater is normally used in the paper making industry. However, most of biomass mechanical pretreatment processes can use existing facilities previously used for other purposes and other materials that can be considered as a significant advantage of mechanical pretreatment [2].

Fig. 2. Bioreactors setup (left) and Hollander beater used in this study (right)

Results

Pretreated waste paper with a Hollander beater for 60 min improved the methane yield by 20.60%. The highest methane yields were achieved at F/I ratio of 0.3 for all pretreatment times. The net energy of the process was positive for all process conditions with a maximum of 2.19Wh/gVS at 60min beating pretreatment and a F/I ratio of 0.3 (Fig. 3).

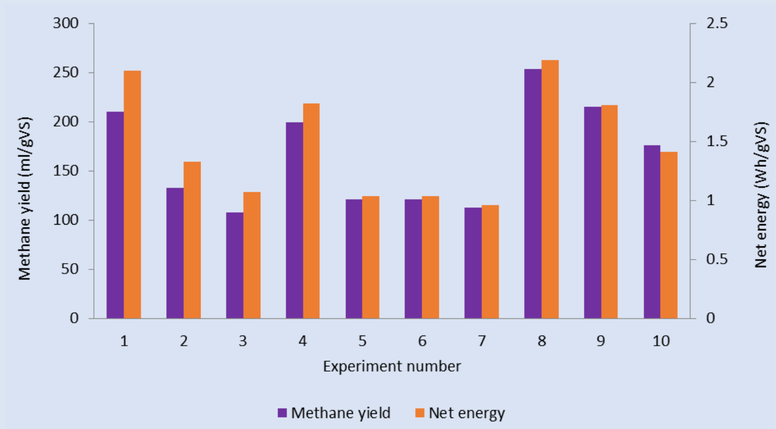

Fig. 3. Waste paper biomethane yield and net energy

Pretreat the macroalgae for 60 min improved the methane yield from 196 ml/gVS correspondent to untreated algae to 340ml/gVS (Fig. 4). The effect of the pretreatment decreases with increasing F/I ratio. The highest net energy was achieved at 60 min pretreatment and F/I = 0.3.

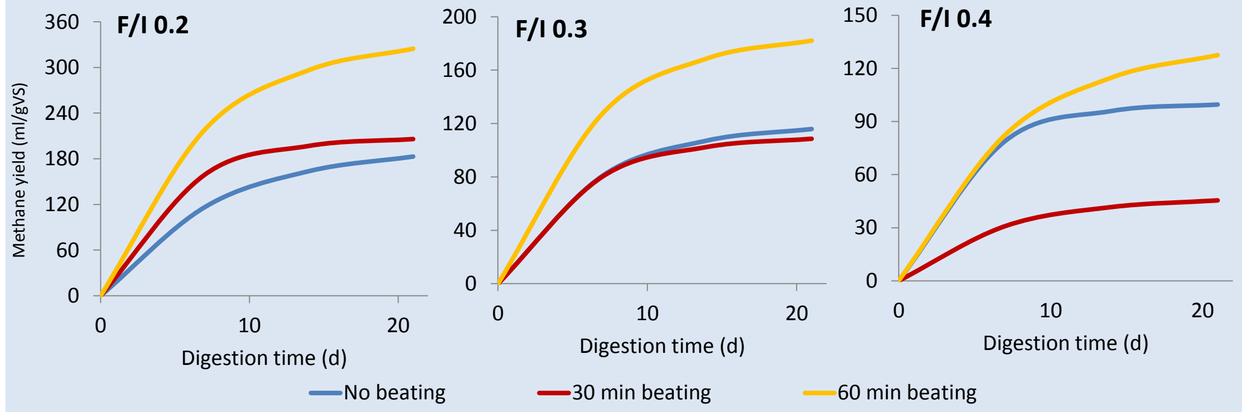

Fig. 4. Macroalgae biomethane yield

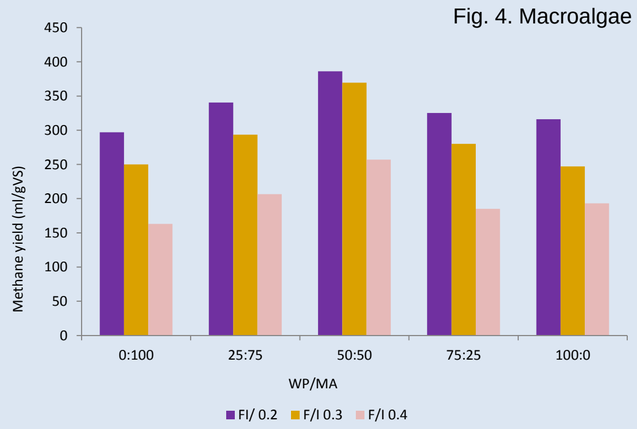

Fig. 5. Waste paper and macroalgae co-digestion

WP/MA ratio 50:50 produced the highest methane yields (Fig. 5), with a maximum value of 386ml/gVS for an F/I 0.2 which represents an increase of 30% and 22% compare with mono-digestion of macroalgae and waste paper respectively.

Conclusions

- The study proved the Hollander beater pretreatment increases the biomethane yield of *P. Canaliculata* macroalgae and waste paper up to 20%.
- Lower F/I ratios increases the biomethane yield leading to a better exploitation of the feedstock and improving waste management.
- The process is economically feasible as positive net energy values were achieved, maximum energy gain of 28% was obtained.
- Co-digestion at a mixing ratio of 50% improved the biomethane yield by 13% compare with mono-digestion of macroalgae and 22% compared with mono-digestion of waste paper

References

[1] C. Rodriguez, A. Alaswad, J. Mooney, T. Prescott, A.G. Olabi, Pre-treatment techniques used for anaerobic digestion of algae, Fuel Process. Technol. 138 (2015) 765–779.

[2] C. Rodriguez, A. Alaswad, K.Y. Benyounis, A.G. Olabi, Pretreatment techniques used in biogas production from grass, Renew. Sustain. Energy Rev. (2016).