Seaweed utilization issues in biogas production

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1. Introduction

Macroalgae can be seen as a renewable feedstock for the production of biofuels in many coastal areas around the World and especially in Baltic Sea region where the eutrophication is particularly troublesome. The investigation of anaerobic digestion technologies for extracting inexhaustible bioenergy from seaweed was conducted in many research institutions mainly in laboratory scale. Although seaweeds seem to have a great potential as a feedstock in anaerobic digestion due to high biomass yields and lack of competition with terrestrial plants on limited agricultural land, their potentially high heavy metals content and other impurities (like sand and plastics) creates significant problems for the digestion process, but also for the further use of the digestate. Due to high levels of contaminants, it is not always possible to directly use the cast seaweed as a substrate for biogas production.

The micro and macro elements uptake by algae strongly depends on factors as water salinity, characteristics of habitats (e.g. presence of an nearby industrial area or existence of an estuary whose waters might carry additional nutrient loads from urban and agriculture areas). The main limiting factor of a digestate utilisation as an organic fertiliser is the heavy metals concentration but the main process issues during anaerobic digestion are caused by the presence of sand in the feedstock. Collected seaweed biomass (especially from sandy beaches) very often contains sand, which can negatively effect the durability of bioreactors and other biogas plant equipment.

Pre-treatment of the collected seaweed is essential for the anaerobic digestion process safety and efficient operation of the biogas plant. Furthermore, different stages of pre-treatment as well as the combination of pre-treatment methods can greatly increase the quality of the methane yield.

Present study focuses on pre-treatment methods case reducing sand contents in seaweed feedstock.

2. Methodology

To reduce the sand content in the seaweed collected from the beach, several experiments were performed. The first one was mixing of untreated seaweed in fresh water. Second one was mixing of untreated seaweed in sulphuric acidic solution with pH level of 2. Next two experiments were conducted using mechanically disintegrated seaweed mixed with fresh water or sulphuric acidic solution (pH 2). Mixing was performed with a mechanical stirrer with a speed of 170 rpm. For each experiment, 100 g of seaweed was weighted and put to a glass beaker with 500 cm^3 of water or acid solution.

Mechanical disintegration of seaweed was performed with a laboratory grinder (power 1200 W, rotary speed 24 000 rpm, screen mash number 60 - 200 mesh) for

120 s. The sand removal degree was calculated as the ratios of the difference between volatile solids of fresh and pre-treated seaweed to the washed ones.

3. Results

As it can be seen in Table 1, the location of biomass collecting is crucial in terms of the sand content in seaweed.

Table 1. Minerals content in marine biomass

Type of algae	Sand content, [%]	Place of sampling
Enteromorpha compressa	11.65	Shallow water
Enteromorpha plumosa	4.96	Shallow water
Potamogeton pectinatus	4.00	Shallow water
Zostera marina	20.88	Beach
Pheaophyta	7.80	Shallow water

When the algae are collected from the beach, the sand content is much higher than when collected from shallow water. It has also been found that sand removal is easier to conduct if the algae are fresh. It is much more difficult to wash off the sand from the biomass if it has been lying on the beach for 1-3 days.

This can be seen in the Figure 1. The minerals content in the seaweed sample was about 39.1% and after pre-treatment it was reduced down to 4.5%

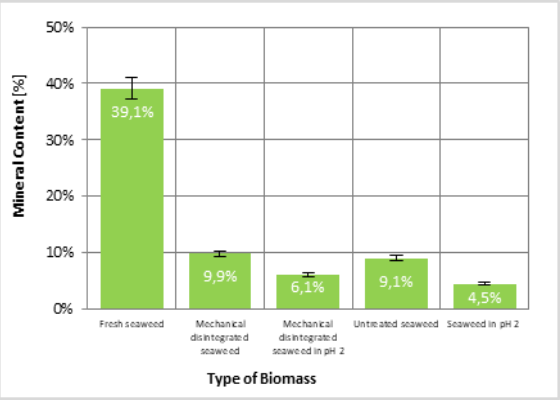

Figure 1. Minerals content in seaweed after different pre-treatment methods

The comparison of four investigated method of send removal is presented in Figure 2. The best result of washing was obtained for undisintegrated seaweed using acidic water for sand removal.

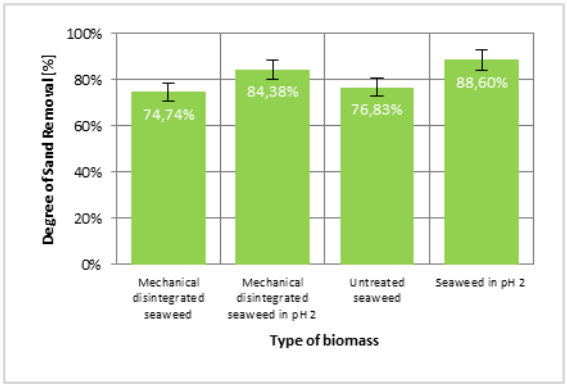

Figure 2. Degree of sand removal after different pre-treatment methods

4. Conclusions

To reduce the negative impact of sand contents in the algae feedstocks on the durability of the biogas plant installation, a two-step process is recommended. In the first stage, impurities such as sand or plastic should be removed from the marine biomass, and then it should be pre-treated to increase the availability of nutrients for anaerobic digestion process.

Research should also be focused on developing affordable pre-treatment methods of the algae to refine the production of biogas. How to combine these processes to get the best biogas yield and a fertilizer of high quality to put back on arable land is also a research area for future projects.

5. Acknowledgements

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