THE USAGE OF POSIDONIA OCEANICA AS A RAW MATERIAL FOR WOOD COMPOSITE AND THERMAL ENERGY PRODUCTION

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Abstract

More or less the energy used today is from non-renewable energy resources like coal, oil, gas, etc. but the reduction of these resources and environmental pollution are forcing research and development of new renewable energy resources. On the other side Lignocellulose-based fibres or particles are the most widely used as biodegradable reinforcing elements for composite materials like particleboards, Medium Density Fiberboards etc. In the last years, the utilisation of lignocellulosic materials in order to produce eco-friendly products is very promising. All the industries are looking for low-cost and environmentally friendly products or byproducts to develop new materials filled with natural fibres and wood. Posidonia seagrass beds formed in sandy bottoms and it is "home" for hundreds of species of marine animals (eg fish, urchins, octopus, sponges, anemones, sea turtles, etc). Both the Posidonia and algae are necessary to sustain life in sea (and not just because the oxygen release is used by all organisms), and their role is similar to that of forest land for land wild animals. The experimental process that will be presented in this paper contains the following stage: Evaluate of the energy derivative from the combustion of seaweed. Chemical analysis of Posidonia oceanica and finally, the possibility of production briquettes or pellets and particleboards based on seaweed.

1. INTRODUCTION

Nowadays, the energy used is from non-renewable energy resources like coal, oil, gas, etc. However, the reduction of these resources and environmental pollution are forcing research and development of new renewable energy resources (Quaak et.al. 1999, Paull and Chen. 2008). On the other side Lignocellulose-based fibres or particles are the most widely used as biodegradable reinforcing elements for composite materials like particleboards, Medium Density Fiberboards etc. In the last years, the utilisation of lignocellulosic materials in order to produce eco-friendly products is very promising. All the industries are looking for low-cost and environmentally friendly products or byproducts to develop new materials filled with natural fibres and wood (Apostolakis et.al.1987, Bledzki and Gassan. 1999, Khiari et.al. 2011, Gemptos 1992, Ntalos 2000, Younquist et. al. 1994)

The biomass energy is one of the renewable resources that hold an important position in the energy system (Skarvelis 2012). Thus the replacement of fossil fuels with biomass energy is a good way to mitigate the global warming due to greenhouse. In the effort of discovery alternative sources of energy based on the biomass and observing the existence of important quantities from seaweed in several places in Greece, was organized an experimental process that concerns in the potential production of thermal energy with the use of biofuel from seaweed or to use them for wood composite production (Skarvelis et al. 2005).

Seaweed (or more correctly the "algae" - the singular "algae") are actually not seaweed, but evolutionary higher plants, marine plants called Poseidon or Posidonia (scientific *Posidonia oceanica*) (Cocozza 2011). Before about 60 million years this plant lived on land near the coast, and gradually succeeded to adapt to sea. Today, Posidonia lives totally immersed in seawater. Like all higher terrestrial plants, Posidonia has roots, shoots, leaves, flowers and fruits. So the roots anchors in the sand of the seabed. The leaves can be reach 1 meter long and their color is green. But as they become older leaves are dark brown and fall from the plant as it new leads (Wang et al. 2006).

The aged leaves will drift with the tide and running off the beach, and basically it is these brown ribbons often found on beaches. These algae have a huge variety of colors - except brown algae. We can consider the big amount of seaweeds if we understand that a moderately wide (1 km) belt of seagrass may deliver seagrass litter in excess of 125 kg of dry seagrass material per meter of coastline each year (Hennenberg et al. 2009).

There are green, red, yellow, white etc. The forms also vary greatly because there are items like movies or small leaves with fans or parasols, while others resemble jelly (Duarte et al. 1994).

Fig. 1 Posidonia oceanica in the sea

Fig. 2. Posidonia oceanica as seagrass litter

In Greece it is estimated that there are approximately 600 species of algae. The important thing with algae is that they are very good indicators of water purity and used by scientists as biomarkers for monitoring the quality of the sea. The use of algae based on the fact that there are some species found only in clear water and disappear in polluted waters. Posidonia seagrass beds formed in sandy bottoms and it is "home" for hundreds of species of marine animals (eg fish, urchins, octopus, sponges, anemones, sea turtles, etc). Both the Posidonia and algae are necessary to sustain life in sea (and not just because the oxygen release is used by all organisms), and their role is similar to that of forest land for land wild animals. Indeed, Posidonia is now considered by the European Union and the Greek legislation as a protected species and have already begun mapping efforts in Greece.

As scientists are increasingly engaging in "hunting" new energy sources, energy production from algae is gaining interest, Scientists can easily manage these microorganisms, which even show and durability even in an environment characterized hostile to other life forms. The experimental process that will be presented in this paper contains the following stage:

-Evaluate of the energy derivative from the combustion of seaweed.

-Chemical analysis of *Posidonia oceanica.*

-And finally, the possibility of production briquettes or pellets and particleboards based on seaweed.

2. METHODOLOGY

2.1 Sampling

P.oceanica samples were taken from different areas around Volos golf. The places chosen were dependent primarily on the abundance of seaweeds in one particular place.

The collection of seaweeds was done by hand. Specimens adhering to the seaweeds were removed from the seaside and the collected species were wrapped in plastic bags. Samples were analyzed within 24 hours after they were collected and. pH was determined using the pH meter. The following properties moisture content, bulk density, density, ash content, percentage of extracts and calorific value are measured (EN 322/1993).

2.2 Preparation of Specimens for Analyses

The seaweed samples were cleaned with water and a big ammount of sand were removed. Excess water from the samples was then removed by gently pressing the algae against tissue paper.All the collected seaweed samples were sun dried. To determine relationship between calorific value and moisture content during sun-drying of seaweeds, one whole thallus of each species,was sampled for moisture content and calorific values analyses. A total of ten samples were taken from the whole thallus of each species during the sun-drying period and each sample had three replicates.After all the seaweeds were sun-dried, they were stored and cut into small pieces for the proximateanalyses and calorific value determination.

2.3 Preparation of Specimens for particleboard production

The P. oceanica leaves which were collected in Volos golf was washed and rinsed with distilled water in order to eliminate the sand and other soil contaminations. After that was dried at room temperature for 2 month in order to reach the Humidity content of 12%. The ensuing materials were milled and sieved to particles of dimensions between 0.8 and 0.5 mm. Two experimental one layer particleboards of 16 mm thickness were manufactured with 10% seaweeds. The temperature of the press (dynamic) was 180 °C and the pressing time 5 min. The target density for all board types was 0.65 g/cm^3. A commercial liquid UF-resin of E1 grade—which at that time was the most commonly used resin in Greek particleboard industries, at 45% solids, supplied from the same local particleboard industry where the particles were supplied—was applied to particles by spraying. Glue solids was 10% for the boards. No waterrepelling agent was used during the board construction.

The mat configuration was formed by hand distribution after resin application in blender.

Test samples were cut from the boards and the following properties were determined in accordance with appropriate EN and ASTM standards: density (EN 323; 1993) and internal bond (EN319; 1993)

Table 1. Ash content and pH Values of *Posidonia oceanica* and other materials

Material	% ash	pH
Fruit stems	**-**	**-**
Oil-palm husks	**5**	**-**
Oil-palm fibers	**10**	**-**
Maize	**2**	**7,1**
Wood	**1,7**	**4,8**
Posidonia Oceanica	**17,4**	**8,2**

2.4 Calorific Value Determination

In adiabatic calorimetry, direct combustion of the samples is done in a temperature-controlled bomb.This jacket is maintained at the temperature of the bomb throughout the combustion process to eliminatethe heat-leakage. The calorific value of the sample obtained from calorimetry is said to be more accuratethan that obtained from proximate analysis .The calorific value was determined using Parr Oxygen Bomb Calorimeter based on ISO1928:1995 (Determination of gross calorific value by the bomb calorimetric method, and calculation of net calorific value) (Fengel and Wegener 1984).

3. RESULTS AND DISCUSSION

A preliminary run was done to investigate the properties of seaweed species in Greece. In the following figures the results of the calorific value, humidity during the collection, ash content and density are shown (Carefoot 1985).

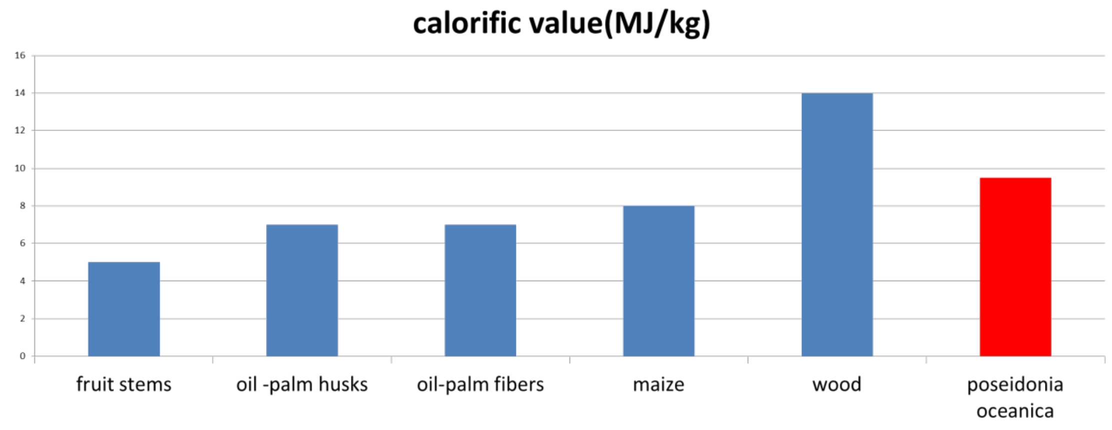

Figure 1. Calorific Values of Different Materials Including Seaweeds

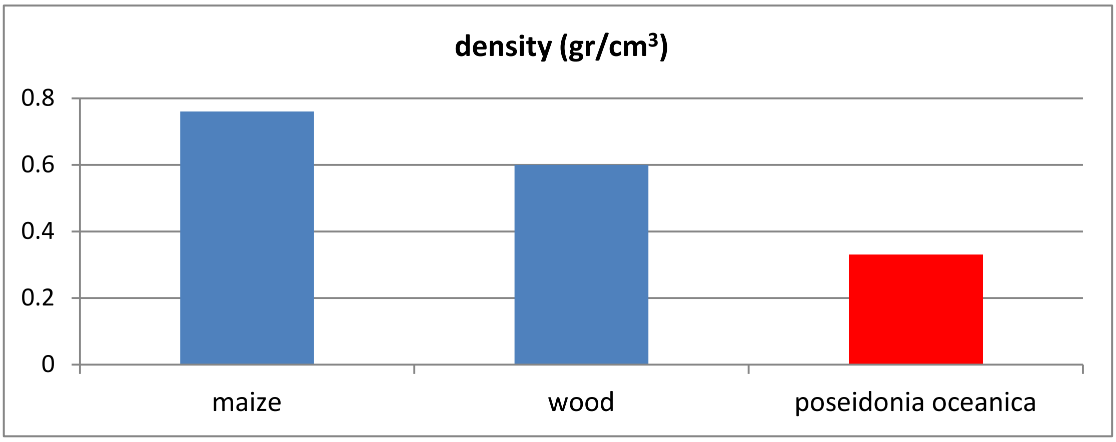

Figure 2. Density of Different Materials Including Seaweeds

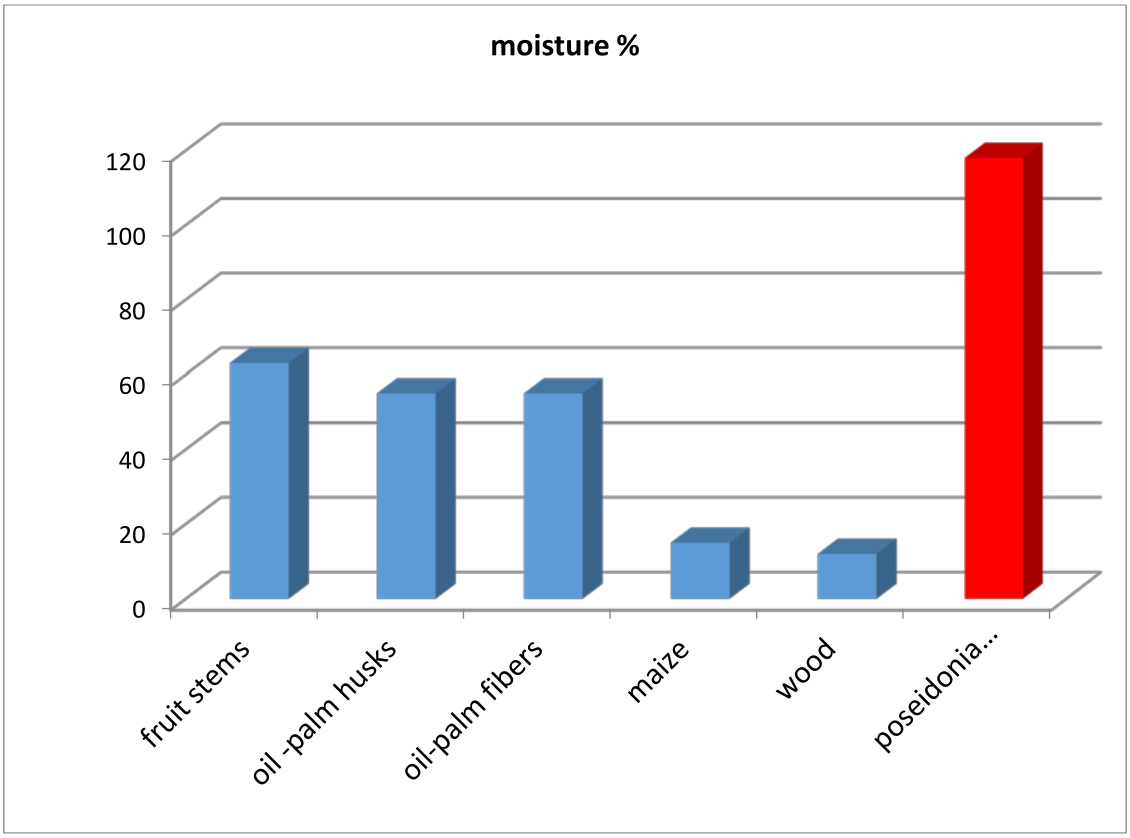

Figure 3. Moisture content of Different Materials Including Seaweeds

As it was shown from the figures above we have comparable calorific values with those of the conventional biomass fuels like bagasse, rice husks and corncobs. The most serious disadvantage of biomass fuel is that they often have high moisture content which contains 110 to 120% water. The best way to recover the lost energy because of high moisture content is through physical drying of biomass under the sun. Another disadvantage is the low density which make the material less cost effective for transportation.

3.1 Properties of experimental particleboards

During experimental manufacture of particleboards using seaweeds (P.oceanica) as raw material, only a few difficulties occurred. The most important was that it was not easy to mix the glue and seaweed particles after the glue applied. In Table 2, the Density of the boards and the Internal Bond of the one-layer boards tested are presented.

Table 2. Density and Internal Bond of one –layers particleboard with wood and *Posidonia oceanica* as raw materials

Material	**Density g/cm^3**	**IB(Internal Bond)N/mm^2**
100% wood	**0,636**	**0,80**
90% wood – 10% Seaweeds	**0,620**	**0,72**

The results indicate that mechanical properties (internal bond) decreased as the amount of seaweeds particles increased from 0 to 10% but it still gives acceptable values for commercial production of particleboards but some more research have to be done.

4. CONCLUSIONS

Seaweeds (*Posidonia oceanica*) have high potential to be used as solid biofuel since it has a little more calorific values to the conventional biomass like bagasse, rice husks and corn cobs and it has less value than wood (Khiari et al. 2010). It can also be used as raw material in small proportions for particleboard production. However in both cases, seaweeds had to be dried from about 110 % to 15% moisture content in order to obtain calorific values close to those of the conventional biomass or to take part in particleboard production (EN 312:1996). The big problem is the extremely high ash content (up to 17%) which will give big problems to stoves if we try to burn it as pellets or briquettes without any previous wood mixing but we can avoid this problem if we wash the seaweeds with water in the same way that we done in particleboard production. On the other hand the quit big amounts of this material on the Greek seacoast is a big challenge

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