

Energy recovery from algal waste

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Abstract—Marine macroalgae are an abundant resource in coastal areas. In most cases, this algal matter is removed from the beaches and treated as waste. The collected algae constitute a source of biomass with a high potential to produce energy. Three possible options for energy recovery from residual algal matter have been analyzed: to obtain biodiesel, bioethanol and pellet manufacturing. The energy recovery from macroalgae confers a saving on current disposal costs as a residue and an environmental benefit because it is Kyoto Protocol compliant. Six different marine algae have been used as raw materials: *Fucus Spiralis*, *Pelvetia Canaliculata*, *Saccorhiza Polyschides*, *Enteromorpha (Ulva)*, *Polysiphonia Lanosa* and *Calliblepharis Ciliata*.

Macroalgae have a high content of carbohydrates and low lignin content, which make them to be a suitable substrate in the fermentation process for bioethanol production. To obtain this biofuel, chemical processes—such acid hydrolysis— and biological processes—enzymatic hydrolysis and alcoholic fermentation— have been tested. Concentrations of sulfuric acid of 0.05, 0.2 and 0.5M have been used in the acid hydrolysis processes. The results obtained show that higher production of bioethanol was achieved with the highest concentration of acid autoclave conducted hydrolysis. A greater amount of ethanol was managed by *Fucus Spiralis* algae when an acid hydrolysis process was followed by a fermentation in an orbital incubator. In the case of fermentation with intermediate enzymatic hydrolysis, the *Calliblepharis Ciliata* algae produces the highest bioethanol amount. On the other hand, very low conversion percentages of oil to biodiesel were determined for all studied algal species.

Finally, with the objective of making pellets and evaluating its burning quality, intrinsic characteristics of each species (calorific value, ash content, volatile content and fixed carbon content) were tested. *Fucus Spiralis*, *Pelvetia Canaliculata* and *Calliblepharis Ciliata* were found as the most suitable species for making pellet. The quality of pellet obtained was similar to that obtained by other raw materials.

Keywords—bioethanol; biodiesel; pellets; macroalgae;