Biomass Energy

Characterization and Application of Oil and Coal Obtained Through Low Temperature Conversion Process Applied to Biomass and Residues

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Abstract:

This work refers to the characterization and application of Oil and Coal obtained through Low Temperature Conversion Process applied to biomass and residues. The products generated in the process (oil and coal) present potential for energy ends. Nowadays, the residues of the most varied economical activities become a great problem. Simultaneously, it happens an increase in the search for alternative sources of energy. The present work seeks to develop solutions for these two problems: the crescent increase of residues and the crescent disputes for alternative sources. The alternative proposal is the generation of electric power starting from biomass and residues, using mainly the Low Temperature Conversion Process. This technology allows the integral use of biomasses and residues transforming them in oil and coal, for subsequent energy use. With the application of the Low Temperature Conversion Process the residue becomes the matter of the process, it stops being a problem and raisin the being an economical solution, eliminating possibilities of soil contamination and susceptible underground waters of happening when disposition technologies are applied. In that way, the central objective of the research is the use of the biomass and residues for energy generation through the Low Temperature Conversion Process. For the accomplishment of this study a Pilot Unit is used in order to produced oil and coal from residues and biomass. Results for LTC process applied to aquatic plants biomass are shown.

Keywords: biomass energy; aquatic plants; low temperature conversion process; oil and coal

1. Introduction

In the region of the river Paraíba do Sul in the state of Rio de Janeiro, Brazil, where they live about 2.4 million inhabitants, the disordered evolution of the urban and industrial development of the area is provoking a great increase of the pollutant load in the river. This increase of the spillings, mainly the one of organic origin on the rivers, it has been provoking the uncontrolled increase of several aquatic organisms (ANA 2002 and SEMADS 2001).
Among the several present species, the *Eichhornia crassipes* it is a peculiar aquatic macrophyte, because it proliferates inordinately in polluted areas. Due to its uncommon

reproduction process, the flotation islands of *Eichhornia crassipes* form great vegetable masses in the water impeding the river traffic, besides hindering the reception of water for treatment stations and turbines of hydroelectric power stations for generation of energy. As form of minimizing these damages provoked by the plants, the governments and the companies are trying to control its proliferation for several means, being used mechanical, chemical and biological methods. The great amount of *Eichhornia crassipes* residues in the water becomes an environmental problem. (Pedrali, 1989).

2. The Aquatic Plant *Eichhornia Crassipes*

When proliferating in surplus in a hydric resource the aquatic plant *Eichhornia crassipes* it can propitiate the proliferation of insects, to reduce the brightness, as well as reducing the tax of oxygen dissolved in the hydric resource, causing ecological unbalance and altering strongly the communities of invertebrate and vertebrates animals (Gopal, 1987).

The growth in surplus of the *Eichhornia crassipes* can be chemically or biologically controlled.

The chemical control, in spite of acting impeding efficiently the growth and development of the biomass of the plant, has as negative factor of altering the quality of the water, causing intoxications or until the aquatic beings' death. Besides, it presents a high cost, depending on the area where is applied.

Being like this several attempts and studies have been made with biological controls that, also, they can bring serious problems, altering the ecological balance of the area.

The mechanical control consists of removing the biomass using a manual process or being used machines. In both cases, great amounts of residues are generated, that many of the times are deposited in the soil without any control and special cares, could cause the contamination of the soil, and, still, to make possible the proliferation of insects. Like this, it becomes essential an appropriate destiny to this biomass.

The Figure 1 shows the handling of biomass of aquatic plants in reservoir.

Figure 1: Handling of aquatic plants biomass

3. Low Temperature Conversion Process

The Low Temperature Conversion Process (LTC) was developed starting from studies about the viability of the biodiesel production starting from mud of stations of treatment of sewers in Germany in the decade of 80. LTC is a thermochemical process, whose main objective is it of enlarging the cycle of life of the residues. LTC has been applied to several biomasses of urban, industrial and agricultural origin, being sought through the thermal conversion to transform them in products of potential commercial value. Depending on the

biomass type used to the process, they are obtained an oil and a coal in variable proportions, besides water and gas. The oil is addressed for studies about the viability of its application as fuel or other composed of possible commercial application (as greases, lubricants, resins etc.) while the coal is addressed to studies of its activation so that it can be used as active coal, besides the possible direct use as energy (Vieira et al. 2001; Vieira et al. 1999; Santos et al. 1999 and Brandão et al. 1999).

4. Material and Methods

The aquatic plants (*Eichhornia crassipes*) were removed of Santana's Reservoir and Vigário's Reservoir of Light Serviços de Eletricidade S.A, located in Piraí, in the State of Rio de Janeiro, Brazil.

The conversion was accomplished in a thermoelectrical reactor (Figure 2) consisting of a furnace marks Haerus with temperature controller. The process happens to 380°C, inside a fixed bed of glass type boron-silicato it marks Pirex with dimensions 1.40 m x 0.10 m (tube converter), coupled with a system for collection of condensed liquids. This system is composed by a condenser of 0.30 m and a decantation funnel of 500 mL associated to the tube converter by glass pieces.

Initially, it occurs a purgative inside the reactor with a constant flow of nitrogen, during about 15 min. The controller is regulated for the process temperature and the fractions are collected after three hours of processing, when then the fractions are collected and directed for analysis. During the whole conversion, the flow of nitrogen is maintained, trying to get in the process an inert atmosphere.

Figure 2: Thermoelectrical reactor

5. Results and Discussion

The efficiency (percentage in mass) obtained through the LTC are shown in Table 1:

Table 1. Efficiency of LTC applied to *Eichhornia crassipes*

Products	**LTC efficiency (percentage in mass)**
Coal	43.6
Oil	10.3
Conversion Water	26.1
Gas	20.0

5.1. Coal characterization

It was made the Elementary Analysis of the coal, being used the LECO equipment, model CHN-600, according to ASTM D5291, as shown in Table 2.

Table 2: Elementary Analysis of the coal of *Eichhornia crassipes*

Elementary Analysis (mass %)	**Coal**
Nitrogen	2.66
Carbon	31.9
Sulfur	1.03
Hydrogen	2.08

The Table 3 presents values of other properties. The heat of combustion was obtained, being used the LECO equipment, model AC350, according to ASTM D1989.

Table 3**:** Properties of the coal of *Eichhornia crassipes*

Properties	**Coal**
Higher Heat of Combustion	3113 kcal/kg
Lower Heat of Combustion	3006 kcal/kg
Humidity	7.5 mass %
Ashes	40.2 mass %

With the comparison purpose, they are presented in the Table 4 values of properties of national coals.

Table 4: Properties of national coals

Coal	**Ashes** mass %	Sulfur mass %	Humidity mass %	**Heat of Combustion** kcal/kg
Mineral: Santa Catarina	31.7	2.0	2.4	5635
Mineral: Candiota - RS	51.4	1.3	15.0	3300
Mineral: Charqueadas – I1F -RS	56.6	1.6	8.0	2930
Mineral: Charqueadas – I2B -RS	45.0	1.2	8.8	3990

Fonte: Garcia 2002

The coal resulting from the LTC applied to the aquatic plant *Eichhornia crassipes*, it presented efficiency of the order of 40%. In relation to the properties, it is observed that the percentage of sulfur (of the order of 1% in mass), the tenor of ashes (of the order of 40% in mass) and the humidity (of the order of 7% in mass) they are below the values found in some national coals. The higher heat of combustion (of the order of 3100 kcal/kg) it is compatible with the mineral national coals.

5.2. Oil Characterization

It was made the Elementary Analysis of the oil, being used the LECO equipment, model CHN-600, according to ASTM D5291, as shown in Table 5.

Table 5: Elementary Analysis of the oil of *Eichhornia crassipes*

Elementary Analysis (mass %)	**Oil**
Nitrogen	4.9
Carbon	52.38
Sulfur	0.24
Hydrogen	6.84

The Table 6 presents values of the heat of combustion, obtained, being used the LECO equipment, model AC350, according to ASTM D1989.

Table 6: Properties of the oil of *Eichhornia crassipes*

Properties	**Oil**
Higher Heat of Combustion	6670 kcal/kg
Lower Heat of Combustion	6318 kcal/kg

With the comparison purpose, they are presented in Table 7 values of properties of national fuel oils.

Table 7: Properties of national fuel oils

Fuel oils	Sulfur mass %	**Higher Heat of Combustion** kcal/kg
1A	3.8	10238
8A	4.8	9995
1B	0.8	10530
4B	1.0	10399

Fonte: Garcia 2002

The efficiency of the LTC applied to the aquatic plant *Eichhornia crassipes*, found for the oil is about 10%. In relation to the properties, it is observed that the percentage of sulfur (of the order of 0.2% in mass) it is below that found in some national fuel oils.
The higher heat of combustion (of the order of 6600 kcal/kg) although inferior to the national fuel oils presents a good energy potential for use.
The LTC has been applied successfully to other biomass and residues for example: petrochemical sludge; sewage sludge; sugar cane bagasse; coconut shell and coffe ground.
In other to improve the oil and coal production a Pilot Unit was constructed and operates in the Plastimassa industry in Magé – Rio de Janeiro.

6. Conclusions

The application of the Low Temperature Conversion Process (LTC) it seems to be a quite viable alternative for the reduction of the damages provoked in the environmental in function of the great amount of biomass of the aquatic plants that are happening along the basin of the river Paraíba do Sul.

They were obtained oil and coal with characteristics that indicate the viability of its use, as for instance, in the generation of energy.

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