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Đánh giá tiềm năng sinh khối tại Bình Định

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TÓM TẮT

Việt Nam là quốc gia đang phát triển và có tiềm năng sinh khối rất lớn để sản xuất năng lượng, nhiên liệu, hóa chất. Nguồn sinh khối đa dạng từ mía, ngô, lúa, sắn,… Trong bài báo này, chúng tôi sử dụng phần mềm GsT (Geospatial Tookit) để đánh giá và ước lượng tiềm năng sinh khối ở mỗi vùng cũng như ở tỉnh Bình Định. Phần mềm GsT tập trung đánh giá nguồn sinh khối trong nông nghiệp và được chia ra làm 5 loại: cây mía, cây lạc, cây sắn, cây lúa và ngô. Tiềm năng năng lượng điện được sản xuất từ phụ phẩm từ cây lúa và cây ngô là 61850.72 and 51892.97 MWh. Công suất thiết kế cho nhà máy với tổng công suất trong sản xuất năng lượng là 8.83 và 7.4 MW cho phụ phẩm từ cây lúa và cây ngô. Ngoài ra, đặc tính nhiệt của trấu, rơm, cùi ngô cho mục đích sản xuất năng lượng cũng được phân tích và thảo luận. Trong quá trình phân nhiệt phân của cả ba loại sinh khối là trấu, rơm rạ và cùi ngô xảy ra được ghi nhận ở khoảng nhiệt độ từ 200^{o}C đến 380^{o}C. Giai đoạn phân hủy nhiệt xảy ra chậm hơn trong khoảng nhiệt độ lớn hơn 400^{o}C và khối lượng mẫu còn lại từ quá trình nhiệt phân của trấu và rơm rạ lớn hơn so với cùi ngô. Kết quả này có ý nghĩa rất lớn trong việc sử dụng nguồn sinh khối cho sản xuất điện, năng lượng và hóa chất.

Từ khóa: *Sinh khối, tiềm năng sinh khối, nguồn sinh khối, phân tích nhiệt.*

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TẠP CHÍ KHOA HỌC
TRƯỜNG ĐẠI HỌC QUY NHƠN

Evaluation of biomass potential in Binh Dinh province

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ABSTRACTS

Vietnam is a developing country and has large biomas potential to produce energy, fuels and chemicals. As an agricultural country, Vietnam has diversified biomass resource from rice crop, corn cob, cassava crop sugarcane bagasse and peanuts crop residues,…etc. In this approach, we used Geospatial Toolkit software (GsT) to evaluate and estimate the potential of biomass in each region as well as Binh Dinh province. GsT focused on agricultural biomass residue and was divided into 5 categories: sugarcane crop, peanut crop, cassava crop, rice crop and corn crop residues. The potential of electric power produced from rice crop residues and corn crop residues is 61850.72 and 51892.97 MWh respectively. Design capacity with draw materials of rice crop residues and corn crop residues can be used for power generation is 8.83 and 7.4 MW. In addition, we aslo analysed thermal gravimetric of rice husk, rice straw and corn cob for energy generation. The initial decomposition of biomass in inert environment was noticed between 200÷380^{o}C. The second decomposition of biomass in inert environment continuously occurred above 400^{o}C and the residue weight from pyrolysis of rice husk and rice straw were higher than of corncob. These results have large significants in production electric, power and chemical from biomass.

Keywords: *Biomass, biomass potential, biomass resources, thermal gravimetric.*

1. INTRODUCTION

In the last decades, large study was dedicated world-wide to the getting back of energy from renewable fuels. Biomass is an alternative and renewable energy source, abundantly available worldwide. The biomass resources of Vietnam is very large. As an agricultural country, Vietnam has the potential of biomass energy. Agricultural residues are the most abundant in the Mekong Delta, with about 50% of the country's and the Red River Delta with 15%.[1] The crop residues can be identified into two catagories – agricultural residues and agricultural products. The total biomass production in Vietnam in 2010 was approximately 104.4 million tons.[2] The main source of crop residues include rice straw (37.6 million tons), rice husk (7.5 million tons), trash corn (15.0 million tons) and bagasse (7.2 million tons)[3] so Vietnam has set a target of 500 MWe capacity biomass in 2020, was raised to 2000 MWe in 2030.[4] According to above statistics, it was found that the biomass resources in Vietnam is regarded as good source, but we have no way to accurately assess the biomass resource at this time. While some traditional methods encounter many problems and the data is not regularly

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updated as well as more than errors. In this approach, we used geospatial toolkit software to support the assessment of biomass resources in remote areas, the data is updated regularly with reliable results by taking into account the peculiarities of climate and terrain as well as the ability to exploit potential resources in the fact.[4] By using geospatial software, we have evaluated exactly a residue of some agricultural sources such as rice, cassava, sugar cane, and the residue of the seeds in each region. The software also provides data on renewable energy sources on the basis of information on geography, population, boundaries, infrastructure, transportation.[4]

Biomass includes three main components such as hemicellulose, cellulose and lignin with traces of minerals and extractive, which exist in the range of 19-25%, 32-45% and 14-26% (by weight), respectively.[1] The percentage of these constituents varies from biomass to biomass. The difference in thermal response exhibited by biomass is due to the varying proportion of these components. Pyrolysis is the thermal decomposition of biomass occurring in the absence of oxygen and is the firt step in any thermochemical conversion process, as gasification or combustion. Thermal behavior of biomass can be investigated applying thermo-gravimetric analysis (TGA). TGA is the thermal analysis technique which is now being widely used to evaluate the thermal behavior of solid fuels such as biomass, polymers, coal.[5,6] In this paper, we also determined the propeties related to thermochemical conversions of rice husk, rice straw and corn cob in nitrogen atmosphere using thermogravimetric technique.

2. EXPERIMENT

2.1. Evaluation a potential of biomass utilization in Binh Dinh

Geospatial is displayed maping tools, developed by National Renewable Energy Laboratory (NERL). This tool helps energy planners, project developers and reseachers to identify a region of the country has the potential for renewable energy projects. This tool also provides data and information on renewable energy sources with information about geography, concentrated residential location, borders, infrastructure, transport and energy. Morever, this tool is integrated with HOMER software, a simulation model to optimize the electrical system, originally developed by NREL and now owned by Homer energy LLC. Homer software integrated with this tools can automatically receive data input, using weather data to help analytically. This tool also shows the results without the need to run HOMER model. In addition, this tool has the ability to calculate potential electricity power to set up project building power plants from renewable energy sources with different scales.

2.2. Thermogravimeric study on biomass agricultural residues

The agricultural residues were collected from field and dried for a period of 2-3 weeks. The samples were kept in closed polyethylene bags to avoid contamination prior to carrying out the tests. The samples were milled to powder and sieved to a particle size less than 1 mm before carrying out the tests. Moisture content was determined using the ASTM E871 standard. The proximate analysis was used to determine the volatile matter, fixed carbon and ash content. Volatile matter was measured by following procedures described in ASTM standard E872. The heating value of the samples was calculated from equation:[7]

$$HHV = 19.2880 - 0.2135 x VM/FC + 0.0234 x FC/ASH - 1.9584 x ASH/VM.$$

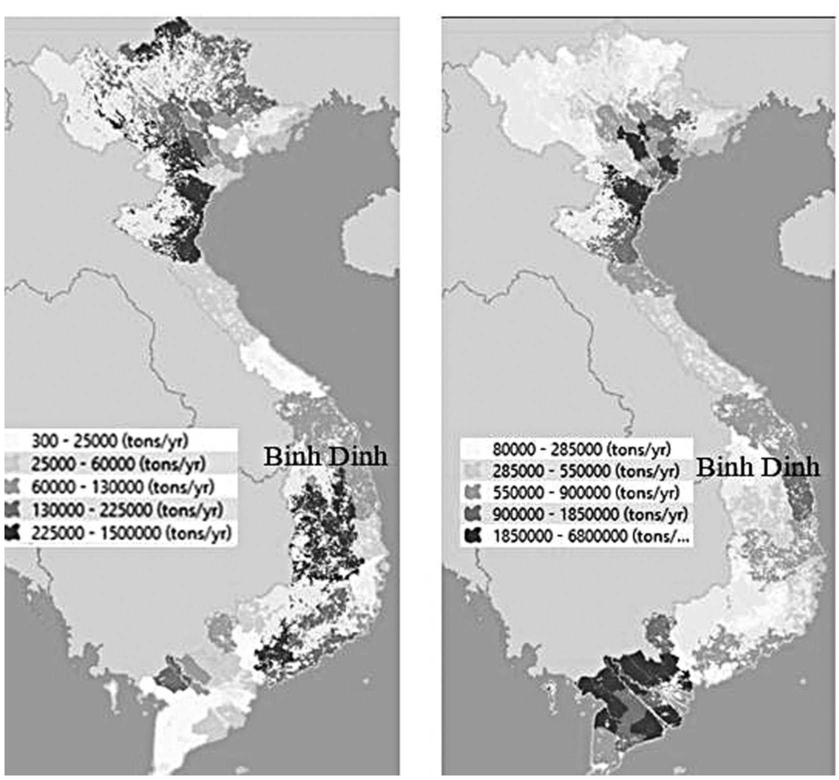
The ash of biomass was prepared according to ASTM 1755, biomass samples were burned in the oven at 575°C until the weight unchanged. Thermogravimetric analysis (TG/DTA) with PerkinElmer PYRIS Diamond model was used for both pyrolysis analysis. 10 mg sample was loaded into an alumina crucible and heated at programmed temperature by the rate of 5 °C/min in nitrogen environment. Fuel properties of biomass can be conveniently grouped into physical, chemical, thermal properties. Important chemical properties of biomass relate to proximate analysis, heating value. Proximate analysis of a biomass fuel sample involves the determination of moisture, volatile matter, ash and fixed carbon content.

3. THE RESULTS AND DISCUSSION

3.1. Potentials of electric energy produced from rice residue in Binh Dinh

Geospatial software that can display a diagram of biological fuels in Vietnam. This number can show us any area of biomass residues from rice, cassava, sugarcane and grains. In addition, this software is capable of identifying a specific reserve biomass of a district, a province or any area. Based on the map of biomass reserves, we see all kinds of biomass reserves in each region are very different. However, Geospatial Software has provided specifically numbers for each area of the province, each volumn of biomass in that province. We can see in central provinces of Vietnam have abundant biomass from sugarcane, peanut, cassava, corn cob, rice husk and rice straw from Quang Ngai, Binh Dinh, Phu Yen. It can be seen that the main biomass residues in Vietnam are agricultural waste and wood fuels. The most important agricultural wastes are rice husk, rice straw, cassava, sugarcane bagasse and trash, corn, maize, sugarcane and grains. The account for about 57% of the total biomass and 93% of agricultural biomass capacities in Vietnam.

By using this GsT, we can evaluate and assess biomass reserves of the province and surrouding area to choose plant location, scale production of material resources. According to Figure 1, the potential biomass of Binh Dinh province is very abundant, especially, with products from Rice because Binh Dinh is one of the largest rice growing provinces in Vietnam so we can utilize rice husk and rice straw for gasification process to produce energy.



(a) Corn cob residues *(b) Rice crop Residues*

Figure 1. Geographical distribution of residue of corn cob (a), residue of rice (b)

Table 1. Proximate analyses of Binh Dinh agriculture residues

Characteristics	Rice husk	Rice straw	Corn cob
Proximate analysis			
Moisture (%)	3.67	12.03	8.45
Volatile matter (%)	62.15	58.74	74.67
Ash (%)	18.01	14.56	2.45
Fixed carbon (%)	16.17	14.67	14.43
HHV (MJ/kg)	17.92	17.97	18.26

The input parameters include buffer distance (km), obtainable (%), energy content of rice husk, rice straw and corn cob (MJ/kg), heat rate (MJ/kWh), then Geospatial Software will calculate the potential power production. After performing Run Query, Geospatial Software will outsome parameters such as Gross Potential Energy, Net Potential Energy, MWh potential, MW potential. From the results calculated by Geospatial Toolkit, electrical potential energy for rice crop residues and corn crop residues is 61850.72 and 51892.97 MWh/year. Design capacity with draw materials of rice crop residues and corn crop residues can be used for power generation is 8.83 and 7.4 MW, we only need to use 50÷60% of total output from rice crop and corn crop residues for electricity generation, the amount of electricity produced is very large.

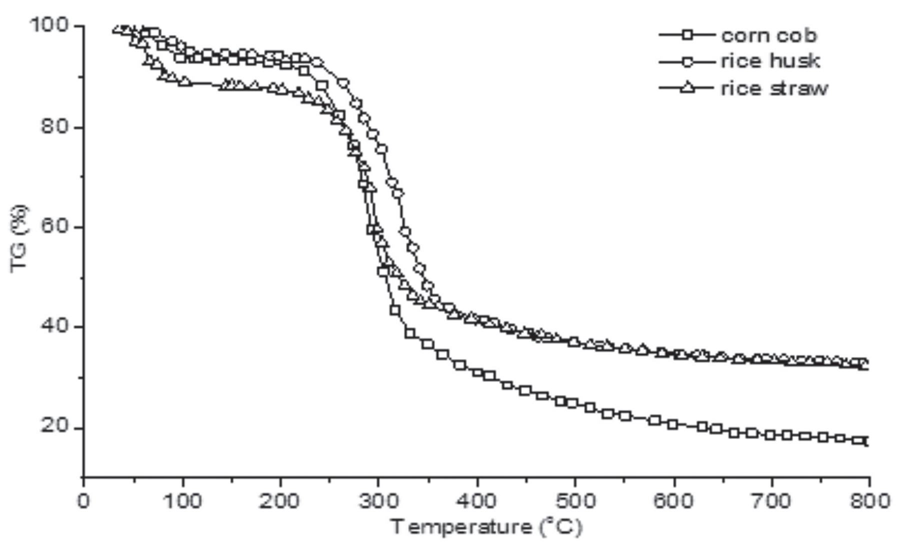


Figure 2. TG curves of biomass samples at heating rate by 5°Cmin^{-1} in nitrogen environment.

3.2. The proximate analysis, ultimate analysis and LHV of biomass samples

The proximate analysis, ultimate analysis and LHV of biomass samples were shown in table 1. In air dry condition, the moisture of rice straw was 12.03% and it higher than rice husk 3.67% and corn cob 8.45%. The rice straw and rice husk has high ash content and it value in a range of 14÷18%. The volatile of rice husk was 62.15% and of rice straw was 58.74%. Fixed carbon of both samples was approximately 15%. The proximate analysis of rice husk was similar to that reported by S.J. Yoon.[8] The corn cob had volatile matter approximately 74.67% and very low ash content. The fixed carbon of corn cob was 14.43%. There weren't significant differences in calorific energy in the different biomass. For the rice husk and rice straw, calorific energy varied

Table 2. Thermal degradation of biomass in nitrogen environment

First decomposition		Second decomposition		Residual weight
Temperature range (°C)	Weight loss (%)	Temperature range (°C)	Weight loss (%)	(%)
218-357	47.9	357-800	12.9	32.9
207-339	41.7	339-800	13.4	32.2
192-329	53.9	329-800	22.1	17.1

between 17.92÷17.97 MJ/kg. The high heating value of corn cob (18.26 MJ/kg) is higher than two kind of biomass. The results of calorific energy analysis of biomass in Binh Dinh could be helpful to turn crop and forage residues into power.

3.3. The thermal degradation of three agricultural residues in the inert atmosphere

The non-isothermal weight loss (TG) curves for threes biomass samples at 5°C/min under nitrogen atmosphere was showed Figure 2. It could be said that their thermal behavior was similar to each other. Three distinct weight loss stages could be identified and it is agreement with other research. The weight loss of each stage was mentioned in Table 2. The first stage corresponding to the demoisturization of biomass. In the second stage (first decomposition), it is a rapidly devolatilisation in a narrow temperature range (approximately 200÷400°C) of biomass. The devolatilisation of biomass started at 218°C, 207°C and 192°C for rice husk, rice straw and corn cob, respectively. There was 47.9% weight loss for rice husk, 41,7% for rice straw and 53.8% for corn cob. Hemicellulose, cellulose and lignin are the major component of this temperature range. Hemicellulose decomposition take place in the range of 200÷350°C, cellulose is decomposed in the range of 350÷500°C and partial of lignin also decomposed in this temperature range.[9] For third stages in the range of 400÷800°C (second decomposition), all biomass samples had a much lower weight loss in comparison to the second stage. The weight loss for corn cob was 22.1%. While for rice husk and rice straw, the weight loss was 12.9% and 13.4%, respectively. For this stage, Sonebe at al reported that the char consists of the residue of lignin and some cross-linking of cellulose with lignin continues to further exothermic polymerization stage of char.[10] The explanation assumes that at the higher temperature, the polymerization of biomass char continuously occurred and the polymerization reaction is depended on the unique properties of biomass char.

4. CONCLUSION

This paper evaluated and estimated the biomass potential of Vietnam as well as Binh Dinh province through the use of Geospatial Software. The results of electrical potential energy for rice crop residues and corn crop residues is 61850.72 and 51892.97 MWh/year, respectively. Design capacity with draw materials of rice crop residues and corn crop residues can be used for power generation is 8.83 and 7.4 MW. This tool helps energy planners, project developers and researchers to identify a region of the country has the potential for renewable energy projects. Proximate and ultimate analyses also showed that all biomass agricultural residues are appropriated for gasification for energy and heating demand. Thermogravimetric analysis (TGA) on three biomass samples (rice husk, rice straw and corn cob) was conduct at heating rate of 5°C/min in an inert atmosphere. The moisture removal occurred below 120°C. The initial decomposition of biomass in inert environment was noticed between 200÷380°C. The second decomposition of biomass in inert environment continuously occurred above 380°C and char from pyrolysis of rice husk and rice straw were higher than of corncob. The tested biofuels the most intensive process should took place in temperature range around 218÷350°C, 207÷339°C and 192÷329°C for rice husk, rice straw and corn cob, respectively. As a result of pyrolysis for this temperature range for tested biomass, a high conversion level of solid fuel into gas and volatilization was obtained.

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