

THE ABILITY TO USE CASHEW NUTS SHELL AS A SOURCE OF ENERGY

● DUONG TRUNG KIEN - NGUYEN THANH TUNG

ABSTRACT:

Vietnam is one of the largest cashew nut exporters in the world and the cashew tree becomes an important cash crop of the country. With the large number of cashew nuts exported annually, an outstanding problem is that the amount of waste from producing cashew nuts would lead to the environment pollution. The shell of cashew nuts account for about 60% of the total production of cashew nuts. Nowadays, the potential of cashew nut shell is exploited. Up till now, cashew nut shell would be burned or pressed to extract oil (CNSL), which are used as a material in manufacturing high quality paint, paint finishes, vecni... With a large quantity of shell, many companies burned them manually. It affects directly to the environment. The article gives some analyses and judgments about the value of cashew nuts through the pyrolysis and the conversion of cashew nuts shell into the bio-coal.

Keywords: Cashew nut shell, charcoal.

I. Overall of cashew industry in Vietnam

Vietnam cashew Association (Vinacas), according to the statistics of Ministry Agriculture and Rural Development, in the end of 2017, the area under cashew in Vietnam is 337.143 hecta, rising by 4.410 hecta compared to 2016. Vietnam has exported cashew to 90 markets and regions over the world, becoming the highest export country with the increasing value.

In 2017, the quantity of cashew nuts exported from Vietnam reached 3,6 billion USD. In addition, the cashew nuts processing industry appears gradually, contributing to create job in cultivation and production for nearly 1 million people.

Like other industries, the cashew nuts industry uses machines, lines in manufacturing, which consume a huge amount of energy from the equipments such as: boilers, peeling machine,

dryer, compressor, lighting systems. This is the important factor needed to be considered by the business.

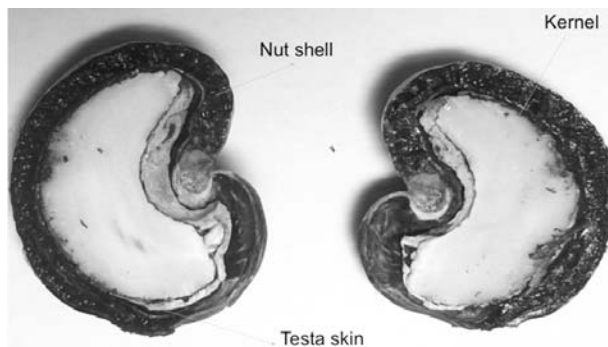
Normally the shell cashew is removed after processing to squeeze the oil, the rest is cashew shell waste. The cashew nut shell is used to burn the boiler with high heating value, but there is a disadvantage that the boiler will break down because the oil still in cashew shell adheres to the heat pipe causing heat loss. Besides, many toxic substances in cashew shell, if burned directly will cause air pollution and environmental pollution.

Cashew nut shell provides many benefits, but there are some disadvantages. Therefore, applying the gasification method to transform the cashew nut shell into biochar is a good way to reduce energy consumption and environmental pollution.

II. Energy from cashew nut shell

Cashew nut shells are one of the most abundant forms of tropical biomass waste which can be used for energy generation. The cashew comprises of approximately 30% nut and 60% shell. While the nut is eaten throughout the world, the Cashew nut shells is very hard to peeling. Cashew shell is usually 0.4 cm thick, accounting for 60% of the grain weight, including three layers: the outer layer is green, smooth. A honeycombed porous layer, in between the outer shell and the inside containing

Figure 1: Structure of cashew nut shell



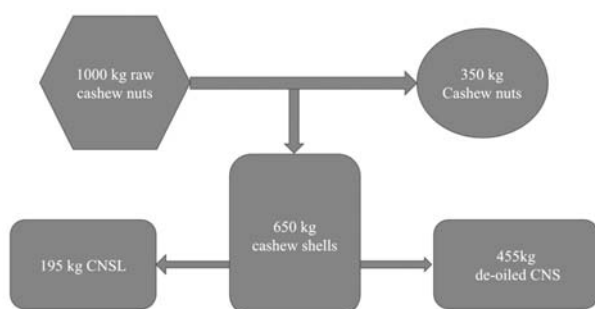
phenolic oil, known as cashew nut shell liquid (CNSL). The shell is gray in color, very hard and covered with silk.

These figures below show the overview of cashew nut shell:

Chemical composition of cashew shell includes: cellulose, sugar, minerals, protein, ash, carbon and cashew nut shell liquid..

- For each 1000kg raw cashew nuts, 35-45% cashew nuts will be gained. Assumed that 350kg

Figure 2: Mass balance cashew nut processing



nuts are harvested, we have the following mass flow of cashew nut processing.

- 25 to 35% of this hard cashew is comprised of Cashew Nut Shell Liquid (CNSL), a viscous and caustic substance. CNSL has a similar quality and heat content to Light Fuel Oil (LFO). Both the CNSL and CNS are used as biomass fuels for clean power generation.

- Biochars are created in the processing of cashew nut shells along with other bioproducts. Biochars have a high carbon content (70-75 wt%) and high heating values in the range of 25-28 MJ kg-1 and can therefore be used as an energy source.

- Bio-oils have been shown to have a higher heating value than biochar with 32 MJ kg-1. Bio-oil is not suitable for use in pure form but can be used in mixtures with Diesel. The gas phase of bio-oil is predominantly CO₂ and CO below 400°C with a greater formation of H₂.

- Gasification is thermo-chemical process that converts carbon-containing fuels into a combustible gas through incomplete combustion

Figure 3: Cashew nut shell non extracted oiled

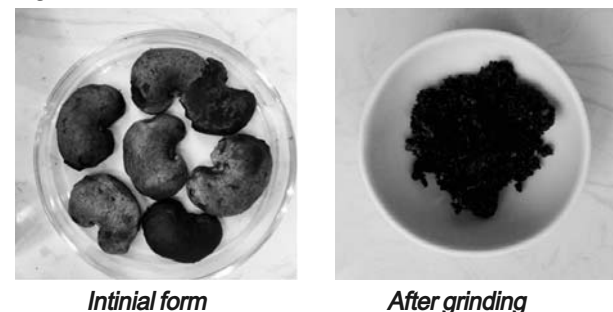


Figure 4: Cashew nut shell after extracted oiled



and reduction. The combustible gas can then be used in internal combustion engines or gas turbines, burned directly or used in the production of methanol or hydrogen.

III. The result analysis the sample of cashew nuts shell from tay ninh district-Vietnam

Cashew nut shell (CNS) used in this study come from Tay Ninh province of Viet Nam. To analyze the properties and composition of the cashew nut shell, we prepared the sample cashew nut shell oil non extracted.

The result obtained from the proximate analysis (fraction of mass of moisture, volatile, ash and fixed carbon) and heating value of cashew nut shell is summarized in table:

Proximate analysis of the cashew nut shell sample shows the suitability of the fuel for gasification. This shows that the average moisture content of the cashew nut shell is 4.4%. The steam content of the fuel being studied is within acceptable limits (less than 15.4%) to ensure free flow and good gas production. The average volatile content of the cashew nut shell was found to be 82.6%. Higher volatile indicated the suitability of

Number	Property	Cashew nut shell
1	Moisture content (% on wet)	4.4
2	Volatile Matter (% on dry basic)	82.6
3	Ash content (% on dry basic)	1.9
4	Fixed carbon (% on dry basic)	11.4
5	High Heating value (MJ/kg)	20.2

fuel for gasification. At the same time, the data show that the average ash content of the cashew

Figure 5: Procuduce charcoal from cashew nut shell



nut shell was found to be 1.9% indicating their suitability for gasification with minimum containment of air and fuel. The most desirable component, which governs the suitability of fuel for gasification, the average fixed carbon content found is 15,4% in the cashew nut shell. The added value of fuel is a key factor in determining the suitability of fuels for gasification. Results showed that the average value of cashew nut shell was 20.2 MJ/kg (4824.69 kcal/kg).

Produce charcoal from cashew nut shell

Experimental sample is cashew nut shell non extracted oiled at different temperature ranges.

The table below shows the results of the first experiment:

Mass of shell before burning (grams)	Time taken (minutes)	Mass of yield produced from shell (grams)	Percentage yield produced
60	30	38	63%

During the experiment, at 200°C the oil in the cashew shell began to be gradually removed. Continuing to increase the temperature to 400°C about 90% of the oil was removed, the shell of the cashew was burned to charcoal: coal has darker color and darker color. Raise the temperature to 600°C, charcoal has been heavily modified in structural composition. Appears many burned links in blue form.

Experimental cashew nut shell with Macro TG machine

+) Pressure of N2 ~ 3 kg/cm² = 2.94 bar (3 bar = 3.06 kg/cm²)

Figure 6: Charcoal at different temperature

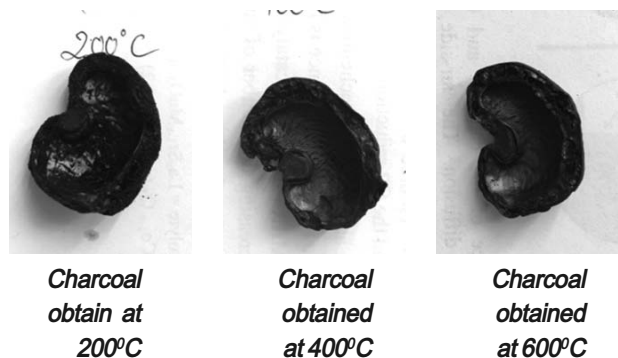


Figure 7: Pyrolysis experiments with Macro TG machine

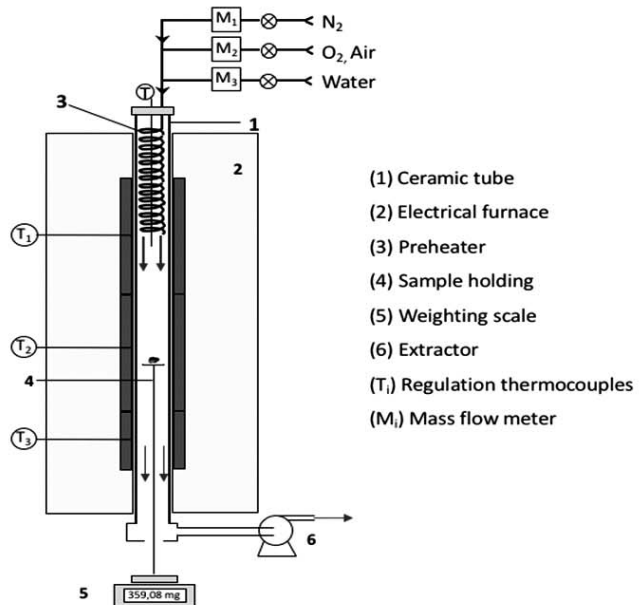


Figure 8: Variation of weight loss of cashew shell with decomposition time

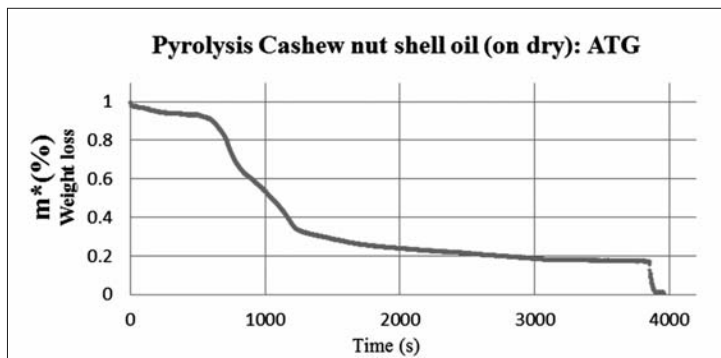
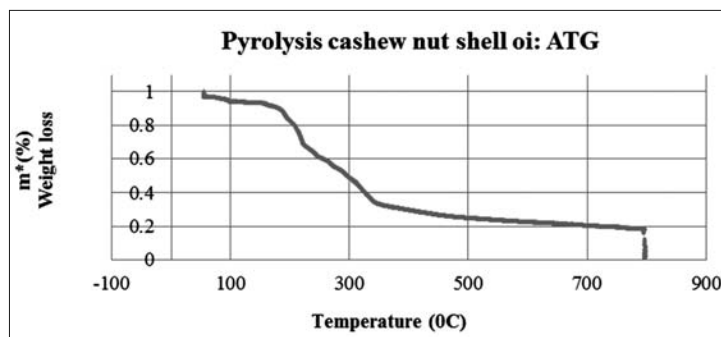


Figure 9: Variation of weight Loss of Cashew shell with Rise in Temperature



+) Put the sample into the reactor with a constant speed

+) Flow rate of N₂: 5 l/min, Heating rate: 3⁰C/min

+) Run with N₂ until the mass of sample is constant

+) Shutdown the condition (valve) of N₂

+) Check and open the valve of the gases O₂ when the temperature at 800⁰C

Sample of cashew nut shell was taken to pyrolysis by MacroTG machine (in Larbotory cleand ED at USTH), and results are shown in Fig:

Heating rate: at 3⁰C/min and flowrate of N₂: 5l/min

From the results of the thermal analysis:

- 55⁰C- 200⁰C Moisture was removed

- The temperature range of 200- 450⁰C is about 67% of the volatiles released in the cashew nut shell.

- Temperature range 200 - 270⁰C, the decomposition of hemicellulose

dominates, whereas from 270 - 450°C is the temperature range where violent decomposition of cellulose, the pyrolysis of lignin in heat range this degree is hardly seen. Thus, after analyzing the shell of the cashew, we find that the cashew nut shell can gasification and have the same characteristics as wood.

IV. Conclusion

- Proximately 2000MJ (exclusive solar energy for drying) needs to process 1000kg raw cashew seeds to 350-450kg cashew nuts and 550-650kg

cashew shells, of which mostly is thermal energy using for steaming cashew seeds. This energy might be covered by renewable energy sources, biomass is one example.

- The results of the cashew shell sample analysis from Tay Ninh province show that cashew shell can be used as a biomass fuel through the transformation process. With high levels of calories and lignin, cashew nut shell can create high quality renewable energy sources and environmentally friendly ■

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TÓM TẮT:

Việt Nam là một trong những nước xuất khẩu hạt điều lớn nhất trên thế giới và cây điều trở thành một cây trồng quan trọng của Việt Nam. Với số lượng lớn hạt điều xuất khẩu hàng năm, một vấn đề nổi bật là lượng chất thải từ sản xuất hạt điều sẽ dẫn đến ô nhiễm môi trường. Vỏ hạt điều chiếm khoảng 60% trong tổng sản lượng điều. Ngày nay, tiềm năng của vỏ hạt điều đang dần được sử dụng. Hiện tại, vỏ hạt điều sẽ được đốt cháy hoặc ép thành dầu ngoại lai (CNSL), được sử dụng làm nguyên liệu trong sản xuất sơn chất lượng cao, sơn hoàn thiện, vecni ... Với số lượng lớn vỏ, nhiều công ty đốt chúng một cách thủ công. Điều này ảnh hưởng trực tiếp đến môi trường. Bài viết đưa ra một số phân tích, đánh giá về giá trị của hạt điều thông qua nhiệt phân, chuyển đổi vỏ điều thành than sinh học.

Từ khóa: Vỏ hạt điều, than.