PRODUCTION OF CHARCOAL AND CHARCOAL BRIQUETTE FROM MANGROVE TIMBERS

การทำถ่านและถ่านอัดจากไม้ในป่าชายเลน

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บทคัดย่อ

บทความนี้ได้รวมเรื่องคุณสมบัติของป่าไม้เลนทางภาคใต้ของประเทศ ที่เหมาะสำหรับเผาถ่าน เปรียบเทียบกับคุณสมบัติของถ่านที่ได้จากไม้ชนิดเดียวกัน และผลการสำรวจวิธีการเผาถ่านไม้ป่าเลนที่ทำเป็นอุตสาหกรรมและผลผลิตถ่านที่ได้ นอกจากนั้นยังได้กล่าวถึงผลกระทบของปัจจัยต่าง ๆ ที่เกี่ยวกับคุณสมบัติของไม้ และที่เกี่ยวกับการเผาถ่านเป็นต้นว่าอุณหภูมิที่มีต่อคุณสมบัติและผลผลิตของถ่าน ในการทำถ่านอัดก้อนได้ศึกษาถึงปัจจัยที่เกี่ยวกับขนาดของผงถ่าน ปริมาณของตัวยึดและแรงอัด ซึ่งมีผลต่อความแน่นของก้อนถ่านอัด และท้ายสุดได้เสนอแนะวิธีที่จะปรับปรุงการเผาถ่านและการทำถ่านอัดก้อนจากไม้ป่าชายเลนให้ดีขึ้น

ABSTRACT

This paper involves: 1) a comparison of the properties of mangrove timbers native to southern Thailand that suitable for charcoal making with that of corresponding charcoal, and 2) the results of a survey concerning methods and yield of charcoal production. The effect of wood density and other factors in charcoal making upon the yield and properties of charcoal is discussed. In addition, the effect of charcoal particle size, amount of binder, and pressure upon the density of charcoal briquette is also presented. Finally the ways to improve the methods of production of charcoal and charcoal briquette from mangrove timbers are proposed.

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INTRODUCTION

Charcoal is carbonized or charred wood, resulting from partial or incomplete combustion. It is made by charring or heating wood in a kiln or pit from which air is exculded.

In Thailand charcoal has been the principal source of unban domestic fuel for many years. Presently it is replaced partly by LPG, but it is still the major fuel for rural houschold cooking. In the 1980 Rural Energy Survey, of the estimated total of 18,440 T cal reportedly used for cooking, 78.8 percent was from charcoal and 19.5 percent from fuelwood. The projected demand for fuelwood and charcoal used by rural households from 1981 - 2001 is summarized in Table 2.

Mangrove forest is one of the main sources of timber for charcoal making and fuelwood. It covers the low muddy seashores and fringe the streams as far inland as the water is brackish of about 2,188.95 square kilometers. Mostly about four-fifths of this area is bound on the west coast of the southern Thailand.

PRODUCTION

The production of charcoal from mangrove timbers was increasing steadily from 1973 to 1979 as shown in Table 2.

Woods used and yields

There are about 30 species of tree in mangrove forest. The most suitable species are those that have wood of great density. These species belong to Family Rhizophoraceae. Woods from other Families that bear high density are Lumnitzera spp. and Xylocarpus spp. (see Table 3). These woods of high density are the best kinds of wood for making high-grade charcoal. The most favorable species are Rhizophora apiculata Bl. and R. mucronata Poir., because they have greater quality and quantity than the other mangrove species.

Table 1. Projected demand for wood for use as fuel by rural households : 1981-2001 (in thousands M^3)

Year	Used directly as fuelwood	Used in form of charcoal	Total wood used as fuel
1981	13,499	109,414	122,913
1986	12,112	121,439	133,551
1991	8,967	134,881	143,848
1996	8,896	149,524	158,420
2001	9,970	165,715	175,685

Table 2. The productivity of mangrove timbers: 1973-1979.

(in thousands M^3)

Province	Volume of extracted timbers						
	1973	1974	1975	1976	1977	1978	1979
Chumphon	1.9	4.4	6.0	2.6	4.4	11.2	13.5
Ranong	103.0	99.5	123.3	151.3	186.0	176.2	192.5
Phangnga	216.7	197.8	202.2	198.2	203.1	210.4	222.1
Krabi	161.1	150.3	149.1	151.1	156.0	159.1	173.0
Trang	99.4	101.3	102.6	107.2	100.0	95.3	95.4
Satun	105.2	80.1	81.2	84.1	84.5	89.1	89.9
Phuket	1.7	5.2	5.5	2.7	3.4	5.8	4.6
Pattani	0.7	1.0	2.2	2.0	2.5	2.2	3.0
Rayong	0.2	0.3	0.7	0.7	0.8	0.7	0.4
Chanthaburi	13.3	12.7	6.6	11.0	13.2	12.7	10.9
Trat	5.1	5.3	6.2	3.5	5.8	5.2	5.2
Total	708.3	657.9	685.6	714.4	759.7	767.9	810.5

Table 3 Specific gravity (based on green volume) of mangrove woods.

No	Family and Species	Specific Gravity
	Apocynaceae	
1	Cerbera odollum Gaertn.	0.38
	Caesalpiniaceae	
2	Insia bijuga Ktze.	0.48
	Combretaceae	
3	Lumnitzera racemosa Willd.	0.85
	Euphorbiaceae	
4	Excoecaria agallocha Linn.	0.46
	Malvaceae	
5	Hibiscus tiliaceus Linn.	0.52
6	Thespesia populnea Soland. ex Correa	0.72
	Meliaceae	
7	Xylocarpus granatum Koen.	0.69
8	X. moluccensis Roem.	0.78
	Myrtaceae	
9	Melaleuca leucadendra Linn var. minor Duthie	0.70
	Rhizophoraceae	
10	Bruguiera cylindrica Bl.	0.89
11	B. gymnorrhiza Lamk.	0.83
12	B. parviflora Wight & Arn. ex Griff.	0.96
13	B. sexangula Poir.	0.80

No	Family and Species	Specific Gravity
14	Ceriops decandra Ding Hou	0.76
15	Rhizophora apiculata Bl.	0.98
16	R. mucronata Poir.	0.83
	Sonneratiaceae	
17	Sonneratia alba Smith.	0.51
	Sterculiaceae	
18	Heritiera littoralis Dry.	0.51
	Verbenaceae	
19	Avicennia alba Bl.	0.61

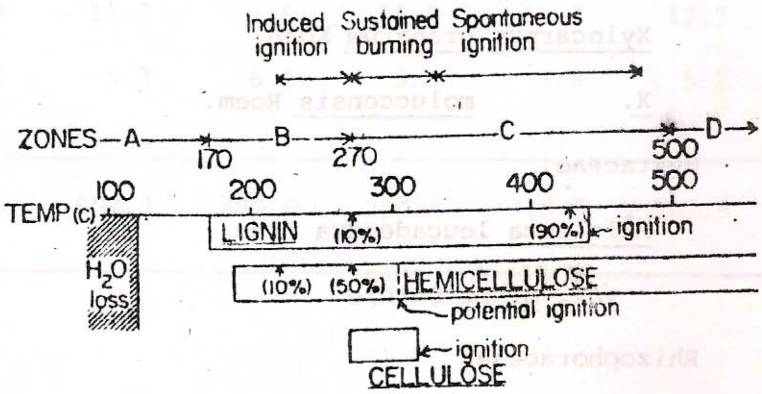

Figure 1. Thermal zones of wood carbonization process.

The yield of charcoal depends on the method and rate of burn - ing, the intensity of heat, the kind of wood, its moisture content, and size of timber. Usually charcoal weighs about one-quarter the original dry weight of wood and occupies one-half the volume of wood.

Processes of manufacturing charcoal

There are several processes of manufacturing charcoal such as pit method, drum method, kiln method and retort method. The pit method was the old time method, but it is still used in the rural comunity nowaday. The only commercial method for charcoal making from mangrove timbers is the chinese-type kiln method. The kiln is in semi-sphere shape, and made up of brick and clay. The capacity of kiln varies from place to place. The capacity of the old kilns range from 80 to 120 cubicmeters. But the new ones are larger. Their capacities are between 120 to 200 cubic meters. There are three chimneys in each kiln. In the front of the kiln there is a door about one meter wide. This door is the only entrance and exit of the kiln and used for setting fire to heat up timbers in the kiln.

The semi-sphere kiln method of making charcoal consists of the following operations. Billets of wood, 1.00 to 1.20 meters or more in length and 2" to 6" in diameter or more usually debarked, are pile on the end. The pieces of wood are pile compactly together. Over the top of the pile, and near the door, the space of about one third of the kiln volume is left to serve as drafts.

After piling is completed. The pile is ignited by means of firewoods of lower quality than those inside the kiln at the door that left open. The ignition is operated continuously all day and all night. The time required depends upon the kind of wood, its size and dryness, the method of piling, size of pile, temperature and weather conditions, and the character of the ground. Experienced worker control the rate of burning by opening on closing the draft holes around the circumference of the kiln. It requires about 10 to 20 days depending on the capacity of the kiln.

When the wood is completely carbonized, the door is sealed off with brick and clay. It takes 15 to 30 days to let the kiln cooled down. After that the door will be opened to carry the charcoal out of the kiln.

Wood Carbonization Process

The process of wood carbonization or pyrolysis of wood can be divided into four thermal zones. Zone A occurs at temperature up to 200°C. At this stage, the surface layer has become dehydrated and produces water vapor, possibly carbon dioxide formic and acetic acids, and glyoxal. At temperatures of 200° - 280° C, zone B pyrolysis has moved beyond the surface with evolution of water vapor, carbon dioxide, formic and acetic acids, glyoxa tand carbon monoxide. Reactions to this point are endothermic, the products are essentially non-condensible, and wood becomes charred. Pyrolysis begins in zone C, between the tempera - tures of 280° and 500° C. Reaction in this zone are exothermic and tem - perature rises rapidly if heat is not allowed to dissipate. Combustible gases such as carbon monoside, methane, formaldehyde, formic and acetic acids, methanol and hydrogen are liberated. The solid residue of zone C is charcoal, and the primary pyrolytic products begin to react with each other before leaving the reaction zone. Carbonization is said to be complete at temperatures of 400° to 600° C. Above 500° C, zone D, the layer of charcoal will be the site of continuous and vigorous secondary reactions.

After water is removed from wood at temperatures above 140° C, four classes of compounds are produced. these are : non-condensible gases (200° - 450° C, maximum at 350° - 400° C; carbon monoxide, carbon dioxide, hydrogen, methane), condensible pyroligneous products (maximized at 250° - 300°C, ceases at 350°C; contains more than 50 % moisture), condensible tar (300° - 400° C; moisture-free) and charcoal.

Propeties of Charcoal

The grade of charcoal depends upon certain properties of charcoal such as the percentage of fixed carbon, the moisture contents, the amount of volatile material, and the ash content. The higher the fixed carbon, the better the quality of the charcoal. Commercial wood charcoal contains about 80% fixed carbon, 1% to 3% ash, and 12% to 15% volatile components. A properly carbonized charcoal has the appearances of uniformly black, broken edges and ends showing shiny surface and free from dust and ash.

The carbonization temperature has great effect on the properties of the charcoal. The carbon content increases sharply with increasing temperature and reaches an almost constant value at about 700°C. The same holds true for the specific weight, but to a much lesser degree. The yield, moisture adsorption, and the hydrogen content decrease continuously with increasing carbonization temperature. The electrical resistance of charcoal is much depending on the increasing temperature. It is 10^6 ohms at a temperature of 600°C but reduces to less than 1 ohm at 800°C. With increasing temperatures, the yield of charcoal not only decreases rapidly but its chemical composition changes increasingly to almost pure carbon. The effect of the carbonization temperature on the propeties of the charcoal is clearly shown in Fig. 2.

The specific gravity of wood and heat value of charcoal from certain mangrove species are showing in table 4.

Production of charcoal briquette

In charcoal making, there are large quantity of fines and broken pieces of charcoal that left unused at the kiln. These charcoal wastes can be saved and made salable by crushing these, mixing with binder such as starch meal and pressing in molds. After drying these charcoal lumps, they become charcoal briquettes that have the same or better quality than charcoal itself.

Table 4. Specific gravity of wood and heat value of charcoal from certain mangrove species.

Species	Specific gravity	Heat value cal/g normal	Heat value cal/g ovendry
Bnuguiera cylindrica	0.89	7,207	7,595
B. gymnorrhiza	0.83	6,749	7,137
B. parviflora	0.96	7,211	7,598
Ceriops decandra	0.76	5,250	-
Lumnitzera littorea	0.74	6,610	7,018
Rhizophora apiculata	0.98	6,354	6,760
R. mucronata	0.83	6,530	6,954

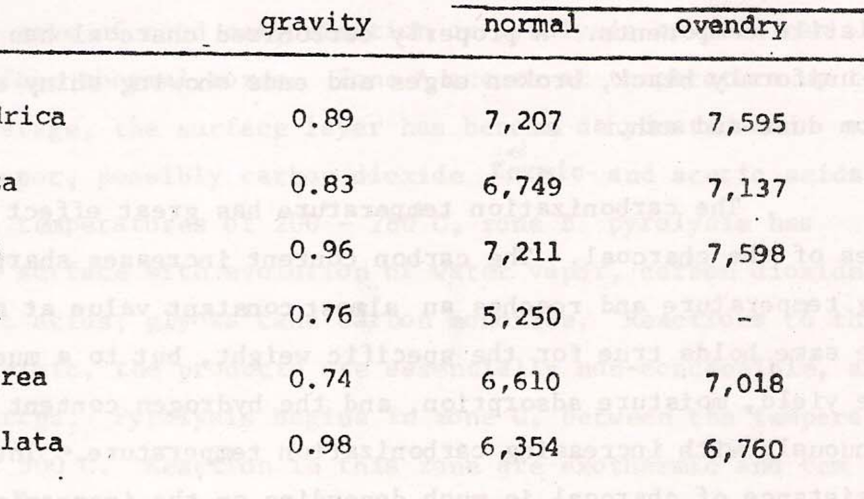

Figure 2. Effect of temperature on charcoal properties.

The study of making charcoal briquette has been done at Department of Forest Products, and found that by grinding charcoal fines to the size of 20 mesh and mixing with cooked casava meal about 2.5% by weight and pressing in molds, the maximum specific gravity of char - coal briquette obtained is about 0.80. The heat value of these experi - mental charcoal briquettes will be evaluated, and the machine for making charcoal briquette in small scale will be designed.

Proposed improvement for charcoal production from mangrove timber.

The typical commercial charcoal kilns require very long time more than a month in making charcoal. This long period of time can be reduced by using new types of kiln such as the Uganda Mark V kiln which requires lower investment and less time than the conventional kiln. It is also possible to make charcoal form root wood and branch wood that are not used in the conventional kiln. The investigation on the char - coal making from this new type of kiln, as well as yield and quality of charcoal will be done in the near future.

Wood distillation is another point of interest, because the other valuable products such as tar, methanol, and acetic acid are ob - tained besides charcoal. Wood distillation is done by heating wood in closed retorts. The vapors produced are condensed to give a tar and pyroligneous acid. A fraction of the vapors are non-condensible (wood gas), and charcoal is left in the retort. Further processing of pyrolig- neous acid produces methanol and acetic acid, the latter usually re - covered as the calcium salt. Wood distillation requires more invesment than ordinary charcoal kiln. Therefore the economical aspects of this kind of industry should be carefully considered.

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