Commercial Scale Carbonization of Briquetted Tropical Wood Sawdust

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ABSTRACT: This paper outlines a commercial scale carbonization system that rapidly carbonizes briquetted sawdust from tropical wood species at 850° - 875°C. The various issues involved in the carbonization process and the steps taken to overcome problems encountered are discussed. To date the plant is able to produce briquetted charcoal for export. The qualities of the product are as follows: Moisture content 5.0 - 9.5%, Volatile Matter 6.3 - 9.0%, Ash 1.1 - 2.5%, Fixed Carbon 82 - 92%, Calorific Value 7200 - 8500 kcal/kg.

INTRODUCTION

Tropical rainforests are home to hundreds of tree species. In Malaysia some of these species are harvested for their timber. The harvested trees are processed into sawn timber or plywood. In the process large quantities of wastes such as bark and sawdust are produced. Lim et al (1) estimated that in 1995 the timber industry in Malaysia generated roughly 0.226 million dry tonnes of sawdust. Cipta Briquettes Sdn. Bhd., located in Bintulu, Sarawak was set up 5 years ago to capitalise on the large quantities of sawdust produced by the sawmills in and around Bintulu. The sawdust gathered by Cipta Briquettes come from about 30 - 40 wood species and are used for the production of charcoal briquettes, most of which are then exported.

THE CHARCOAL PRODUCTION PROCESS

As mentioned, the raw material used in Cipta's factory is sawdust from various species of tropical wood. The moisture content of these green or fresh sawdust varies from about 40 - 50%.

The green sawdust are first screened to remove contaminants and oversized particles. They are then dried to a moisture content of about 8 - 10% in an impulse dryer with hot air that is generated using wood wastes. The fairly dry sawdust are then fed into a screw type briquetter (Shida, Taiwan) for compaction into briquettes. The density of the briquettes formed is around 1200 kg m^{-3}. The briquettes that leave the briquetting machine are hot and slightly roasted on the outside. As such they have to be left in the open to cool. The cooling process further enhances the binding between the sawdust particles. In Cipta's factory, briquettes with 2 types of cross-sections are produced, namely hexagonal and square with a circular hole in the centre (see Fig 1).

Before carbonization, the dimensions of these 2 shapes of briquettes are as follows in *Table 1*.

Table 1:

	Hexagon (mm)	Square (mm)
Length	410	410
Width	52	50
Diameter of central hole	22	15

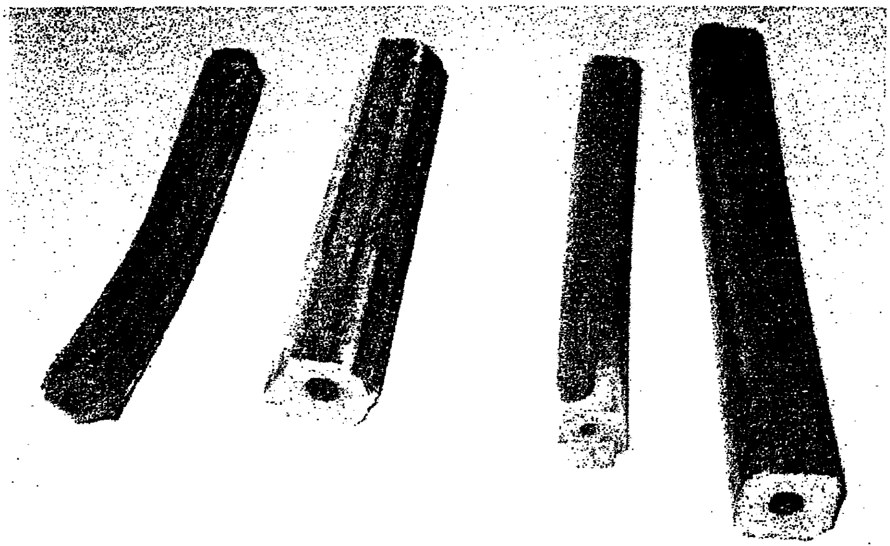

Figure 1: Sawdust briquettes before (brownish) and after carbonization (dark grey).

The sawdust briquettes are then neatly arranged on a bugee which is an open cart with only 2 end walls, with air flow holes at the lower portion and rollers at its undersurface (see Fig. 2). Each bugee which is made of steel and refractory cement can hold about 3000 pieces of briquettes. The loaded bugees are then pushed into the carbonization kilns. This motion is guided by 2 parallel steel rails embedded on the floor of the kiln.

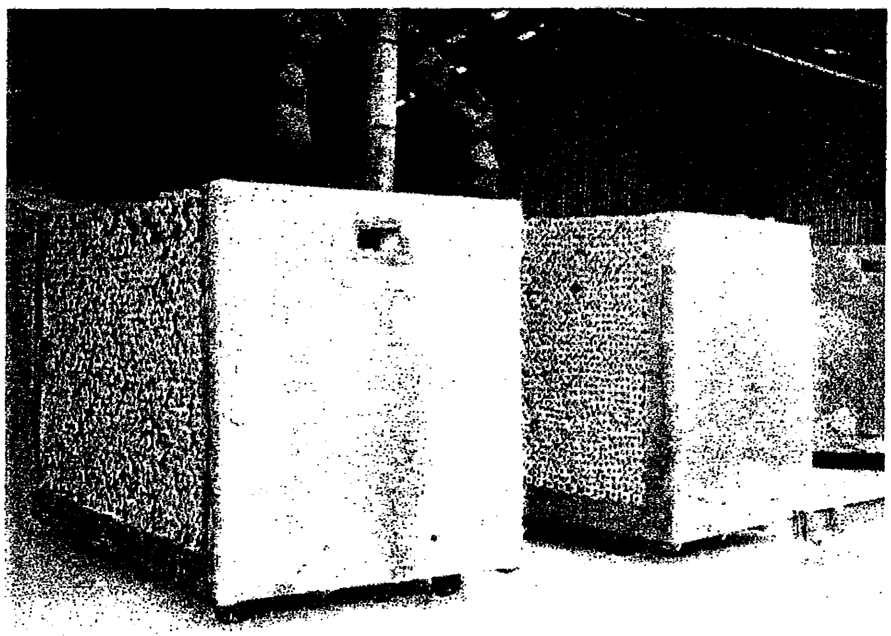

Figure 2: Sawdust briquettes loaded onto bugees.

Fig. 3 is a picture of one kiln before the bugee is pushed in. The internal dimensions of the kiln are roughly 1.5 m wide, 2.4 m deep and 1.5 m high and the height of the curved roof is about 0.2 m. The walls of the kiln are constructed from refractory fire bricks sourced locally while the kiln floor is of concrete of high grade cement. The roof of the kiln on the other hand is of mild steel cast with refractory castable cement. The kilns are constructed in rows with outlets for the escape of emissions built into one side - wall. This arrangement allows 2 adjacent kilns to share one emission outlet while 1 chimney is shared by 4 kilns (see Figs. 4 and 5).

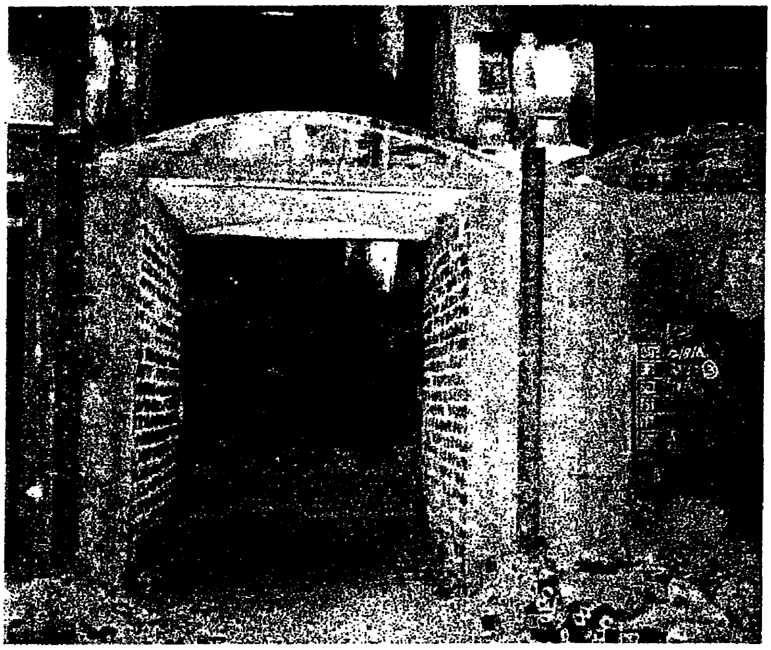

Figure 3: Picture showing the kiln used for carbonization.

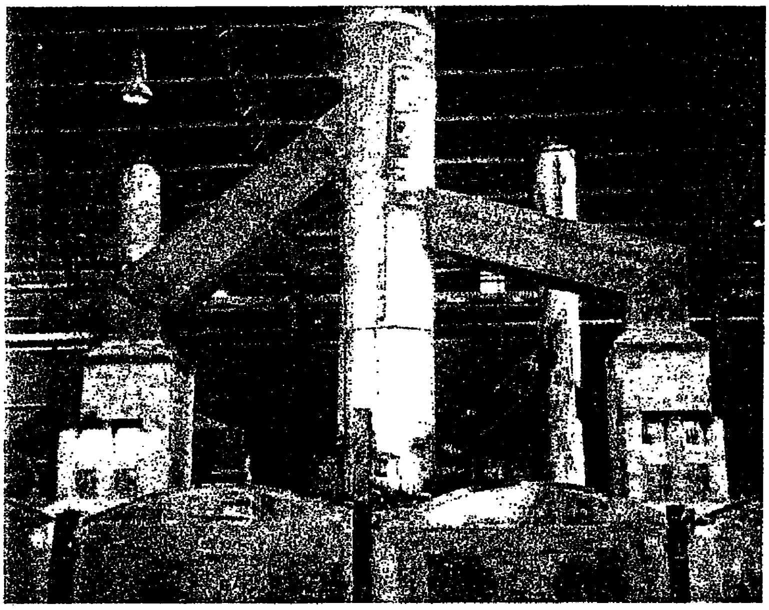

Figure 4: Emissions from 2 adjacent kilns are connected to a common outlet which is then connected to a chimney that serves 2 other kilns. Thus one common chimney serves 4 kilns. Note the flame that burns off most of the combustible emissions.

After the bugee is pushed into place inside the kiln, the kiln is then sealed. The carbonization process is started by putting a few pieces of lighted briquettes on top of the pile before the bugee is pushed into the kiln. The sawdust briquettes are carbonized at a temperature of 850 - 875°C for 108 hours with air flow that is controlled at various stages of the process. A good control of the air-flow is essential in ensuring that good quality charcoals are produced.

Some of the emissions from the carbonization process are combustible and these are burnt as they exit the kilns as shown in Figs. 4 and 5. Rejected briquettes are used for this purpose. As most of the combustible emissions from the carbonization process are burnt before they reach the chimney, the system adopted by Cipta is therefore fairly free of pollutants when the final emissions are allowed to escape into the atmosphere.

When the carbonization process is complete which is indicated by the emissions from the chimneys becoming invisible, the bugees with the red hot charcoal inside are removed from the kilns and immediately covered with steel boxes which are then completely sealed with sand to avoid any entry of air (see Fig. 6). The steel boxes with their contents are then allowed to cool for 24 hours after which the charcoals are ready for packaging (Fig. 7).

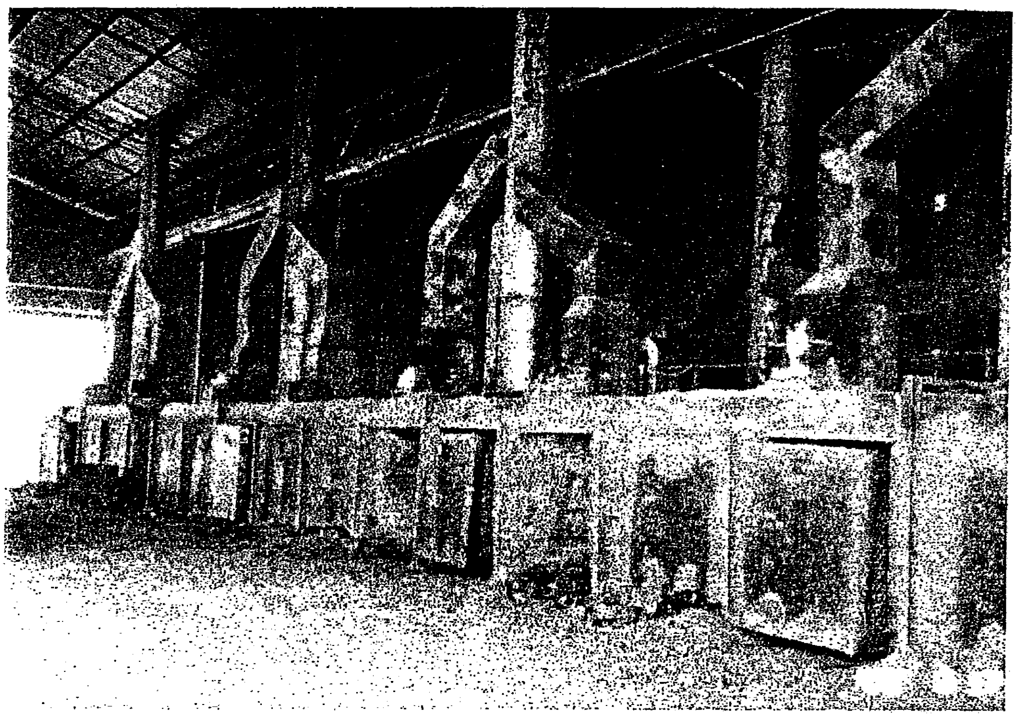

Figure 5: A row of kilns, showing some empty, some with bugees inside but unsealed and some already sealed.

Figure 6: A row of cooling boxes.

THE CHARCOAL PRODUCT

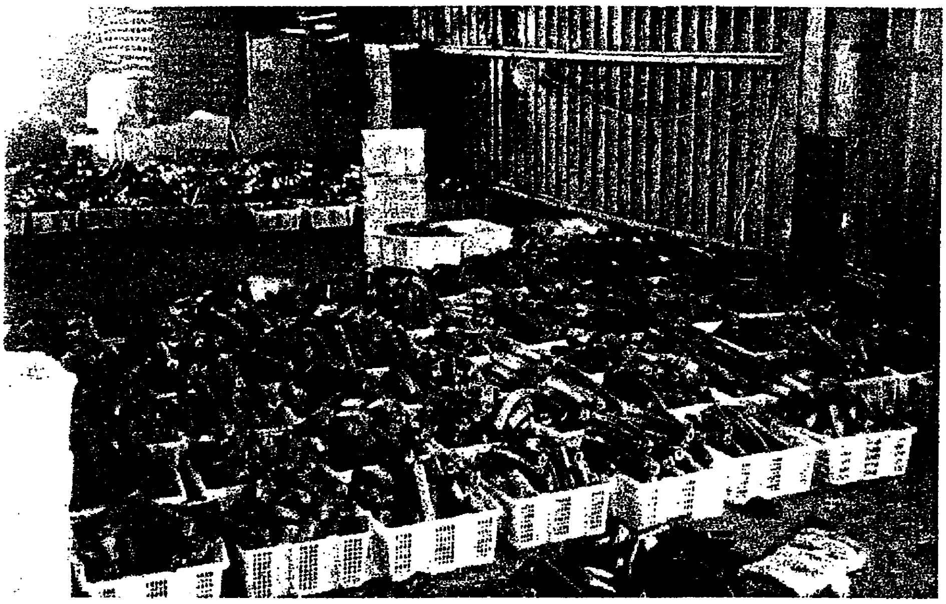

Figure 7: The charcoal product.

After undergoing carbonization, the sawdust briquettes were observed to have shrunk in size as can be seen in Fig. 1 and Table 2 below:

Table 2

	Hexagonal cross-section Briquettes (in mm)		Square cross-section Briquettes (in mm)	
	Before carbonization	After carbonization	Before carbonization	After carbonization
Length	410	350	410	350
Width	52	40-42	50	37-39
Diameter of central hole	22	15	15	11

When the product was targeted for the Korean market, charcoal briquettes of hexagonal cross-section and having the following qualities were produced.

Moisture content	8.8 - 9.5%
Volatile matter	6.3 - 9.0%
Ash	2.0 - 2.5%
Fixed carbon	82 - 89%
Calorific values	>7200 kcal/kg

The Japanese consumers however prefer charcoal briquettes with a square cross-section and having the following qualities:

Moisture content	5.0 - 8.0%
Volatile matter	6.3 - 9.0%
Ash	1.1 - 2.0%
Fixed carbon	85 - 92%
Calorific value	>8200 kcal/kg

Cipta is able to produce both the above market requirements (2). With 28 briquetting machines and 90 kilns, Cipta processes 100 tonnes of green sawdust per day or 2800 tonnes per month. This amount of green sawdust results in the production of about 558 tonnes of charcoal a month. Taking into consideration that about 5% of the raw material are lost during the screening process, the carbonization yield works out to be roughly 35% of the weight of sawdust briquettes used.

Of the 558 tonnes of charcoal produced a month, roughly 15% cannot be exported as they do not meet the desired specifications. These then end up as charcoal scraps which are then sold to local consumers. Presently Cipta exports monthly about 474 tonnes of charcoal briquettes to Japan.

CONCLUDING REMARKS

When Cipta started operations about 5 years ago, not all were smooth sailing. The company encountered numerous problems that prevented export quality charcoal to be produced. Among the numerous obstacles encountered, the following were the more major ones:

(1) Some species of wood sawdust were found to be unsuitable for quality charcoal production. These were therefore not further used as raw material.

(2) The variation of moisture in fresh sawdust resulted in uneven drying and this in turn affected the quality of the sawdust briquettes produced in that more cracks were observed. As a result the drying temperature needed more constant adjustments.

(3) The length of screw and profile of screw fins in the briquetter were observed to affect the density of the sawdust briquettes produced. After some R&D work, the problems were overcome.

(4) It was found that natural draught was not the most suitable for the carbonization process as it was affected by chimney height as well as weather conditions. Forced draught, which would increase cost, would be preferred. However by a suitable choice of chimney height, Cipta continued using natural draught.

(5) Air input control was found to be essential and this was done at various stages during the carbonization process.

Even though there were problems in Cipta's initial stages of operation but through R&D activities as well as trial and error operations, most of the problems were overcome and now Cipta is proud to say that the company currently has a long term supply contract with the Japanese. This is indeed an achievement as we are all well aware of the demand for quality by the Japanese consumer.

Besides Cipta, there are 9 other similar operations in the country and together Malaysia exports some 2000 tonnes of charcoal from sawdust briquettes a month.

Besides Malaysia, as far as the authors are aware, charcoal from sawdust briquettes are also produced by China, Indonesia, Japan, Korea, Myanmar and Vietnam.

REFERENCES

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