BRIQUETTING OF EMPTY FRUIT BUNCH FIBRE AND PALM SHELLS USING PISTON PRESS TECHNOLOGY

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Being among the world's largest palm oil producers, Malaysia generates huge quantities of oil palm biomass. The oil palm biomass, in particular mesocarp fibre, empty fruit bunches (EFB) and palm shells, generated from the milling process has long been identified and utilized as a sustainable renewable energy (RE) fuel in the country. To enhance fuel quality and for logistic purposes, EFB and palm shells can be mixed and further treated to become a uniform solid fuel via the briquetting process.

Briquetting is a mechanical treatment to upgrade loose biomass into a higher density and uniform solid fuel via compaction. This approach improves the physical characteristics, enhances the combustion efficiency and expands the use and marketability of palm biomass fuel either for domestic or export markets. MPOB, in collaboration with Global Green Synergy Sdn Bhd (GGS), has successfully developed a process system for briquetting EFB fibre and shells using a piston press technology (*Figure 1*).

THE TECHNOLOGY

This technology offers a process system for the commercial production of palm biomass briquettes from EFB fibre and palm shells using a piston press technology. The production of palm biomass briquettes involves two main processes, namely, pre-treatment of EFB and the briquetting process itself. Pre-treatment of EFB is a vital and most crucial process to prepare suitable feedstock for the production of palm biomass briquettes. EFB is pre-treated by a series of mechanical processes to reduce size and moisture content, prior to mixing and briquetting with palm shells using a piston press technology. Basically, in a piston press, the palm biomass is pressed in a die by a reciprocating ram at a very high pressure and moderate temperature. The process flow of the technology and general specifications of the raw materials are illustrated and summarized in *Figures 2* and *3* and in *Table 1*.

Figure 1. Piston press technology used in the production of palm biomass briquettes.

A unit of a briquetting machine with a designed capacity of 1.5 t hr^{-1} was installed in a palm oil mill. From the commercial trials, the piston press technology is capable of producing palm biomass briquettes either from 100% EFB fibre or mixed with shells, at a certain proportion. An optimum blending ratio of EFB fibre and palm shells is an important parameter for commercial production and to ensure that the energy content of the product is comparable to that of commercial coal.

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TABLE 1. GENERAL SPECIFICATIONS OF RAW MATERIALS USED IN THE PRODUCTION OF PALM BIOMASS BRIQUETTES

Raw material	Average size of materials (cm)	Calorific value (kJ kg^{-1})	Moisture content (%)	Ash content (%)	Volatile matter (%)	Fixed carbon (%)	Specific density (kg m^{-3})
EFB fibre	< 5.0	17 500	< 20.0	6.43	80.21	13.03	< 200
Palm shells	< 4.0	18 500	< 10.0	4.36	77.36	17.01	> 900

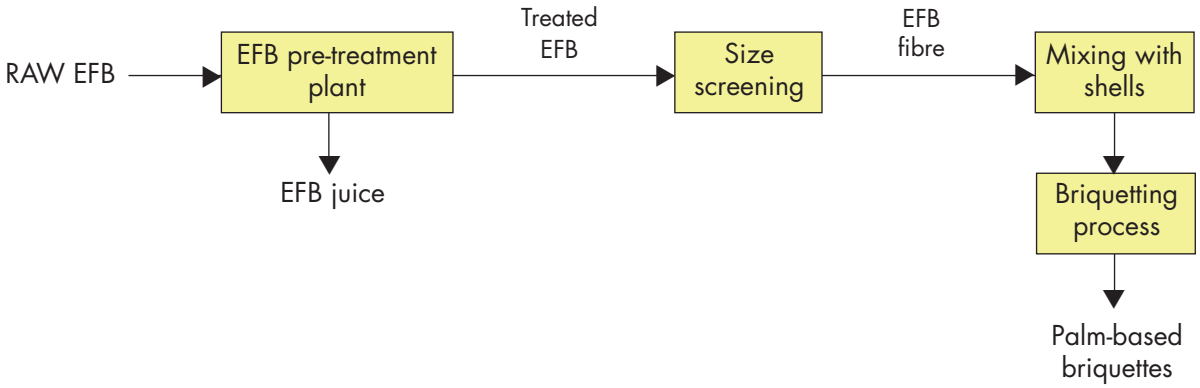

Figure 2. Process flow diagram for the production of palm biomass briquettes.

Figure 3(a). Palm shells.

Figure 3(b). EFB fibre.

THE PRODUCT

Binderless palm biomass briquettes derived from blending EFB fibre and palm shells can be produced using the piston press technology (*Figure 4*). Besides increased density, the particular blending ratio of shells with EFB fibre also increases the calorific value (CV) of the palm briquettes, therefore making it comparable to the minimum CV of commercial coal. The product is in cylindrical logs, 90-95 mm in diameter, 300 mm long and weighing about 2.25 kg each. However, the length of the product can be customized based on request.

Table 2 shows the technical specifications of the product. The properties of the palm-based biomass briquettes are comparable to those of commercial sawdust briquettes and meet the minimum requirements of DIN 51731.

COMMERCIAL BENEFITS AND ECONOMIC ANALYSIS

Oil palm biomass briquettes can be used as coal and as a petroleum oil substitute for combined heat and power plants (*Figure 5*). With the increasing global interest for renewable energy fuels and

TABLE 2. GENERAL SPECIFICATIONS OF PALM BIOMASS BRIQUETTES MADE FROM EFB FIBRE AND SHELLS AND SAWDUST BRIQUETTES

Raw material	Calorific value (kJ kg^{-1})	Moisture content (%)	Ash content (%)	Volatile matter (%)	Fixed carbon (%)	Specific density (kg m^{-3})
Blended EFB fibre and palm shells	17 895-18 235	< 8.0	6.12	79.53	13.5	1 150 - 1 250
Sawdust (commercial)	18 930	5.82	3.2	-	-	>1 300
DIN 51731	> 17 500	< 10.00	<1.00	-	-	-

Figure 4. Palm biomass briquettes made from EFB fibre and palm shells.

Figure 5. Combustion of palm biomass briquettes in a boiler.

the decreasing sawdust supply in the country, EFB fibre and palm shells are potential raw materials for the production of palm biomass briquettes. To make the production more economically viable and sustainable, EFB treatment and briquette plants can be integrated into existing palm oil mills. This approach would significantly reduce the production cost of commercial palm biomass briquettes, mainly on the raw material and utility costs. It is estimated that the specific energy requirement is less than 200 kWhr for 1 t of palm briquettes. The potential estimated annual production of palm briquettes from a 60 t hr^{-1} mill is summarized in *Table 3*.

The trading price of briquettes is determined by their energy content and the market price of commercial coal. At a CV of 18 000 kJ kg^{-1} or 4300 kcal kg^{-1} which is equivalent to a minimum CV of coal, EFB-shell briquettes can be sold around the current price of coal which is at USD 60-70 t^{-1}. Based on 25% thermal efficiency, 1 t of palm briquettes can generate about 1.25 MWhr. Utilization of palm biomass briquettes as fuel for power generation may be entitled for additional profits via RE incentives or tax exemptions in many countries, and also to carbon credits under the Clean Development Mechanism (CDM).

The investment cost for a 1 t hr^{-1} briquetting machine is estimated at RM 500 000 excluding the pre-treatment plant for EFB. Six machines are required to be installed in a 60 t hr^{-1} mill for a production volume of 38 448 t yr^{-1} or 3204 t mth^{-1} from EFB fibre and shells. The total investment and payback period for the technology to be installed in a 60 t hr^{-1} mill are estimated at less than RM 7 million and two years, respectively.

INTELLECTUAL PROPERTY AND COMMERCIAL LICENCES

This intellectual property is jointly owned by MPOB and GGS. The technology is licensed to GGS, who is responsible for promoting and marketing the technology to interested investors.

TABLE 3. ESTIMATED ANNUAL PRODUCTION OF BLENDED EFB-SHELL BRIQUETTES FROM A 60 t hr^{-1} MILL

Raw material	Quantity (t yr^{-1})
Fresh fruit bunches (FFB) processed annually	288 000
Raw EFB produced (at 23% of FFB) annually	66 240
Treated EFB (at 10% moisture content)	29 808
Shells produced (at 6% of FFB) annually	17 280
At 50% of shell usage for briquettes	8 640
Potential production of blended EFB-shell briquettes	EFB: 29 808 Shells: 8 640
Total	**38 448**

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