IMPROVED PROCESS FOR THE PRODUCTION OF LOW-ASH EMPTY FRUIT BUNCH PELLET

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The use of oil palm biomass, in particular empty fruit bunch (EFB) as a source of renewable energy (RE) provides an alternative long-term approach in reducing dependency on fossil fuel and environmental impact. Raw EFB is abundant in palm oil mills. It is known for its high moisture content (>65%) and bulky, leading to low energy content, thus contributing to logistics, storage and handling problems. This has limited its potential use for direct energy applications. Pelletisation is one of the solutions to improve its physical characteristics for value-added applications. However, this process faces challenges such as high ash content and is energy intensive. To make the process cost-effective, the Malaysian Palm Oil Board (MPOB) in collaboration with Global Green Synergy Sdn Bhd (GGS) has developed an improved process of EFB pelletisation system (*Figure 1*). An EFB pellet plant (1 t hr^{-1}) was built in Mambau, Negeri Sembilan to demonstrate the techno-economic viability of producing high quality pellet with low ash content.

TECHNOLOGY AND PRODUCT

Pelletising of EFB consists of three main processes, namely a cost-effective pre-treatment of raw EFB, compacting of treated EFB using a ring die technology and post-treatment of produced pellet (*Figure 2*). The pre-treatment of EFB involving five steps, *i.e.* double stage press cum shredder, sieving, second stage shredding, drying and grinding can efficiently reduce the size and moisture content as well as remove foreign materials in processing EFB into fibre (< 1 cm in size and moisture content < 15%) as a feedstock for pellet production.

As drying is energy intensive (Selivanovs *et al.*, 2012), the use of hot gases from the combustion of the syngas produced from oil palm biomass-based gasifier is adopted to reduce the production cost. The EFB fibre (*Figure 3*) is then fed into the ring die pelletiser where the EFB is compacted and extruded from the inside of a ring-shaped die by pressure caused by the motion between the

Figure 1. A 1 t hr^{-1} EFB pellet plant in Mambau, Negeri Sembilan.

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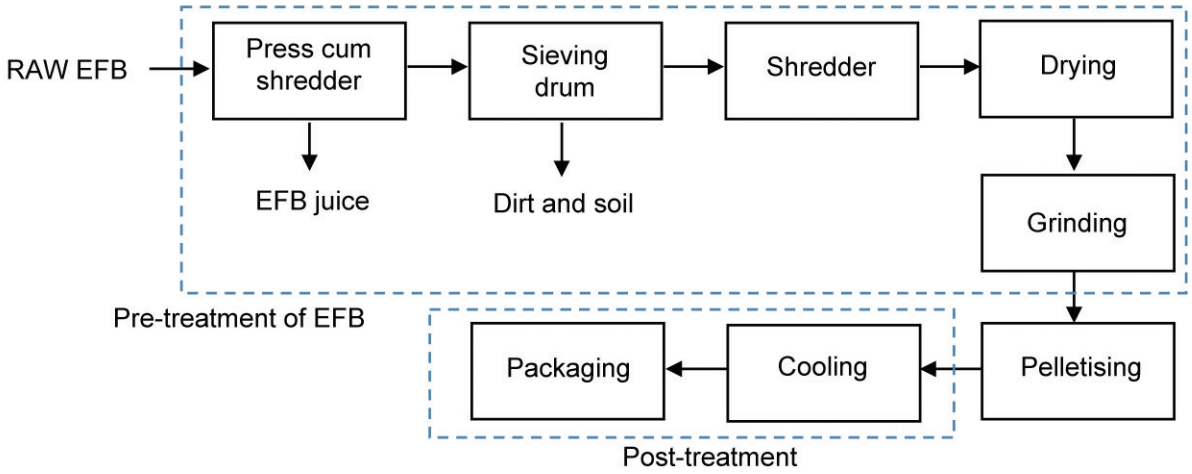

Figure 2. Process flow diagram for the production of low ash EFB pellet.

Figure 3. Treated EFB fibre as feedstock.

die and the roller (Larsson and Rudalfsson, 2008, Azeus Pellet Mill, 2015). The pellet produced from the die is relatively hot and soft, therefore it is cooled and dried using blowing air in the pellet silo before packaging.

The EFB pellet produced is low ash (<4%) compared to 5% - 6% in typical commercial production. The pellet is cylindrical, 8 mm in diameter, 30 – 40 mm in length and 2.3 – 2.7 g in weight (*Figure 4*). The pellets are usually packed and sold in 800 kg jumbo bags. The properties of the EFB pellets are comparable to those of commercial wood pellets, and meet the minimum requirements of European Standard on wood pellets, EN 14961-1 (*Table 1*). The EFB pellet can be used as an alternative fuel for biomass-based combined heat and power plants to produce heat and power either for industrial use or grid connection. It also can be co-fired in the coal-based power plant.

COMMERCIAL BENEFITS AND ECONOMIC ANALYSIS

Commercial trials using pressed EFB as the starting raw material showed that this technology was technically and economically viable to be set up either as a stand-alone production plant or integrated with the palm oil mill. The commercial production of palm pellets will be more economically attractive and sustainable if the plant could be set up and integrated into the existing palm oil mill (*Table 2*). This would significantly reduce its production cost mainly on raw material, transportation, storage and utility.

Figure 4. EFB pellets.

TABLE 1. COMPARISON OF SPECIFICATIONS OF THE RAW MATERIAL AND EFB PELLET WITH EUROPEAN STANDARD ON WOOD PELLETS

Samples	Moisture (%)	Volatile (%)	Ash (%)	Fixed carbon (%)	Calorific value (kJ kg^{-1})
Pressed EFB	69.85 ± 0.66	25.13 ± 0.47	0.58 ± 0.01	4.44 ± 0.33	7831.2 ± 563.41
EFB fibre (after pre-treatment)	13.54 ± 0.12	69.09 ± 0.29	2.78 ± 0.08	14.59 ± 0.16	16781.3 ± 109.7
EFB pellet	8.24 ± 0.19	71.57 ± 0.45	3.63 ± 0.09	16.56 ± 0.36	17585.9 ± 53.9
EN 14961-1 (standard)	< 10.00	-	0.7	-	16500 - 19000

Note: EFB = empty fruit bunch.

Based on the selling price of USD 100 t^{-1} EFB pellet, the annual gross profit is estimated at RM 2 million and the payback period is one year.

A 60-t hr^{-1} palm oil mill has the potential to produce an estimated 27 000 t of EFB pellets a year (*Table 3*). These pellets can be supplied to overseas markets with the global pellet demand projected to grow to 33 million tonnes and 50 million tonnes in 2015 and 2024, respectively (Junginger, 2012 and Walker *et al*., 2014). Of the 33 million tonnes projected market demand in 2015, some 76% will come from European countries, 15% from North America and the remaining 9% from a combined demand from South Korea and Japan (Statisca, 2015). Owing to a different set of quality standards on pellet adopted by importing countries, EFB pellet is likely more suitable for the Asian market that has less stringent standards requirements compared to European and North American countries.

INTELLECTUAL PROPERTY AND COMMERCIALISATION

The intellectual property of the pellet production technology is jointly owned by MPOB and GGS. MPOB has granted license to GGS to promote, market and commercialise the technology to interested investors.

TABLE 2. ECONOMIC ANALYSIS FOR A 2 T HR^{-1} EFB PELLET PRODUCTION PLANT

Description	RM
Investment cost (excluding EFB press)	1 300 000
Annual production @ 4800 hr yr^{-1}	9 600 t
Assumption: Gross Income @ USD 100 t^{-1} (RM 368.95 t^{-1})	3 541 920
Annual OPEX (raw material, utility, manpower and maintenance cost @ RM 164 t^{-1})	1 574 400
Annual gross profit	1 967 520
Payback period	< 1 year

TABLE 3. ESTIMATED ANNUAL PRODUCTION OF EFB PELLET FROM A 60-T HR^{-1} PALM OIL MILL

Raw material	Quantity(t yr^{-1})
Fresh fruit bunches (FFB) processed	288 000
Raw EFB produced (at 23% of FFB)	66 240
Treated EFB (at 10% moisture content)	29 808
Potential production of EFB pellet (at 90% production)	26 827
Proposed production capacity of EFB pellet	6 t hr^{-1}

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