


Chapter 6

Design and Development of Small-Scale Oil Palm Waste Shredder for Achieving Environmental Sustainability

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ABSTRACT

This chapter presents the design and development of an economically and technically feasible small-scale oil palm waste shredder to contribute to oil palm waste management. Most available oil palm waste shredders are unaffordable due to high initial investment cost, large, heavy and unportable, which have been the drawbacks for small and medium enterprises to participate in the industry that relates with oil palm waste management. To address this issue, a low-cost and small-scale oil palm waste shredder were designed and produced. The central design concept deduced is to compromise acceptable efficiency with an affordable price by integrating all mandatory components of oil palm waste shredder into a comparatively small and portable support structure. The innovations made in the design are size reduction and adoption of double-shafts cutters with seven jaws technology. Preliminary calculations supported the design. The cutting force produced is up to 19.45kN with safety factor of 4.5. This design can handle other oil palm wastes as oil palm frond is harder than other oil palm wastes.

DOI: 10.4018/978-1-7998-4921-6.ch006

BACKGROUND

Oil palm tree, with species name given as *Elaeis Guineensis Jacq.* emanated from West Africa and has been well-known as one of the most precious gifts from nature in agricultural world. The reason behind is that the palm oil, extracted from its fruits is the most popular edible plant oil used in food preparation which its consumption can be traced back to 5,000 years ago and nowadays, palm oil is consumed by more than three billions people over 150 nations in the world (Azhar, 2009). Since Malaysia is located near the equator, the strategic geographical factor has made the climate in the nation excellent for cultivation of oil palm. Malaysian palm oil industry has been the economic pillar of agricultural sector since the launching of the New Economic Policy (NEP) in 1970s which aimed to eradicate rural poverty by diversifying commercial crop rather than solely dependent on rubber (Otieno et al., 2016). On top of that, the palm oil industry has experienced significant growth under the implementation of three consecutive Industry Master Plans (IMP1~IMP3) until the nation being the first-runner-up of palm oil producer in global today. Despite the prosperity encompassed by the palm oil production, the rapid development of oil palm plantations and palm oil mills also come with a drawback, which a vast scale of waste is generated from both plantation and milling activities (Sukiran et al., 2017). All plantation and milling activities which result in the production of different types of solid waste are presented in Figure 1.

All of the solid wastes produced are organic waste which own high potential for harnessing biomass energy because they are made up of lignocelluloses (Hassan & Abd-aziz, 2011). These solid wastes are generated from both plantation and milling activities which are known as oil palm frond (OPF), oil palm trunk (OPT), empty fruit bunch (EFB), mesocarp fiber (MF), palm kernel shell (PKS) and palm kernel cake. These solid wastes are generated in a substantial amount annually as their production comprises of two stages. During the first stage, OPF and OPT are produced massively in pruning and harvesting, as well as replanting activities respectively. During the second stage, palm oil mill activities such as oil extraction, FFB pressing and nut cracking etc. produce EFB, MF and PKS abundantly (Hassan and Abd-aziz, 2011). Availability of each type of solid waste together with corresponding characteristics are tabulated in Table 1.

Table 1. Production quantity of each solid waste (Adapted from Goh et al., 2010)

Types	Quantity (ktonnes)	Moisture Content (wt%)	Dry Weight (ktonnes)
EFB	18,022	65.0	6,308
OPF	46,837	60.0	18,735
OPT	10,827	75.9	2,609
MF	11,059	42.0	6,414
PKS	4,506	7.0	4,190

From Table 1, it is prominent that EFB and OPF have a lion share in overall solid waste production. Since OPF and EFB are the main oil palm solid wastes, the management or treatment methods of these wastes are essential to be implemented properly to ensure the sustainability of palm oil industry.

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