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How to increase the efficiency of Palm Oil?

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Abstract: *Land and air play an important role in the growth and development of palm seeds and its yield. Therefore, first of all, palm trees in Mediterranean climates give good results and soil has a great impact on its growth and yield. The dose of soil that we plant in the palm grove should be evaluated beforehand for the important chemical elements present in the soil. Crude palm oil (CPO) is produced in palm oil mills (POMs) using fresh fruit bunches (FFBs), harvested from oil palm plantations. FFB passes through multiple unit operations in the milling process, each consists of different technologies. Palm oil millers have tried to improve the milling technologies collectively and individually to enhance the extraction efficiency, meeting the process and product requirements. However, oil lost in the milling process remains the major issue in POM and leads to heavy loss of profit. In order to address such issue, oil recovery technologies were intr----oduced and implemented in the current POM. Nevertheless, such technologies come with additional capital investment and operating costs that may outweigh the profit generated. Therefore, in this work, a systematic approach is presented to synthesise the palm oil milling processes with oil recovery technologies which is technically and economically feasible.*

Key Word: *COP Crude Palm Oil, MPO, Malaysian, Palm, Oil board, POM, Palm oil, Mill, EFB, Fresh, Fruit, Bunch, EFB, Empty, Fruit Bunch, PK Palm Kernel.*

1. INTRODUCTION:

The palm oil industry is an important commodity sector in Malaysia. Oil palm tree originated in West Africa and was planted in Peninsular Malaysia as earlier as 1917. Significant growth in the plantation area was observed in the 70s, following the collapse of the global price of rubber (which was the main agricultural output of Malaysia back then). The Malaysia Palm Oil Board (MPOB) reported that in the year 2017, Malaysia had 5.81 million hectares of oil palm planted area and produced approximately 20 million MT of crude palm oil (CPO).Total exports of oil palm products (palm oil, palm kernel oil, palm kernel cake) were reported at 23.97 million MT, contributing to the total export revenue increasing to RM 77.85 billion (approximately USD 19.5 billion).The three main export markets for Malaysian palm oil are India (2.03 million MT, 12.2% of total palm oil exports), the European Union (1.99 million MT, 12.0%) and China (1.92 million MT, 11.6%). On the other hand, the EU was the major export market for palm kernel oil (0.25 million MT, 25.9%), followed by China (0.17 million MT, 17.6%) and Turkey (0.08 million MT, 8.3%). For palm kernel cake (PKC), the major export markets in 2017 were New Zealand (0.65 million MT, 29.4% of total PKC export) and the EU (0.48 million MT, 21.9%). Even though the trading records have seen a healthy growth in the long run, the palm oil industry does suffer some recurring issues, such as low oil extraction rate (MPOB reported the 2017 national oil extraction rate as 19.7%), labor-intensive and some controversial issues on sustainability, e.g. deforestation. It is also worth noting that the availability of cheap foreign labor has suppressed the initiative for innovation in the palm oil industry.

2-BACKGROUND:

Soil characteristics important for the oil palm

The oil palm is fortunately not very demanding in its requirements, as it tolerates quite wide variations in soil acidity and in water status, but there are some soil types on which it may not thrive. Olivin (1968, 1986) produced the earliest systematic method for assessing oil palm soils (Table. 1) (Hartley, 1988). This was combined with a prediction of the expected FFB yield on each soil class, with various levels of water supply (Hartley, 1988). The system is very simple but does not allow fine distinctions. Basically, a good soil is one with little gravel, a texture that allows reasonable drainage, but has still retained enough exchangeable cations, and contains a good level of soil organic matter to supply nitrogen. The details of the system contain definitions of seven textural classes. [5].

3-SYSTEM OF PARAMANANTHAN:

Paramananthan (2000a) has given a detailed set of criteria (Table 4.5) of suitability for oil palm cultivation or land characteristics (also Paramananthan, 2011). These are designed for South East Asia but would probably be applicable in reasonably similar climates and soil types. The classification system is not fully quantitative and depends on judgement and experience to a significant extent. [3]. The first criterion is topography (see Sections 4.3.8 and 9.4.5). The 'wetness' criterion selects land that is neither excessively or insufficiently drained nor prone to flooding. Drainage has been defined in terms of ten classes (Paramananthan, 1987b). A hydromorphic (anoxic) condition may be produced in a soil either by flooding due to a high water table or because the low hydraulic conductivity of the soil prevents the water moving down the profile sufficiently fast. The 'physical' criteria are general soil conditions arising from the texture of the soil material and the topography, and there are also barriers that prevent roots passing, such as solid rock, compacted gravel or soil, or toxic chemical conditions such an acid sulphate horizon. These physical criteria determine the stability of the soilstructure.In oxisols and ferralsols, there is a great deal of free ferric oxide, and the soil structure consists of small but stable aggregates that give excellent drainage and a very beneficial structure. A poorly drained histosol will be hydromorphic, the iron will be reduced and leached away, and the structure will be compact or massive. The nutrients in the soil are given little attention in Table 4.5; in general, these can be managed by an appropriate fertiliser regime. [2]

Table 1. Classification of topography, soil wetness, physical and rooting conditions and chemical conditions in terms of suitability for oil palm cultivation

Soil characteristic	Suitability class:					
	Degree of limitation:	Not limiting	Minor limitation	Moderate limitation	Serious limitation	Very severe limitation
Topography Slope (%)		0-4	4-12	12-23	23-38	>38
Slope (°) Wetness		0-2	2-6	6-12	12-20	>20
Drainage class		Moderately well to imperfect	Well to somewhat excessive	Excessive or almost poorly drained	Poorly drained	Very poorly drained
Flooding		Not flooded	Not flooded	Minor flooding	Moderate flooding	Severe flooding
Physical soil conditions Texture/structure		Cs, SC, CL	Co, L, SCo, SiCL S	SCL, Cm, SiCs	SiCm, SL, LfS	LcoS
Depth to root restricting layer (cm)		>100	75-100	50-75	25-50	<50
Thickness of organic soil (cm)		-	0-50	50-200	200-500	>500
Base saturation (%) A horizon		>50	35-50	<35		
Soil fertility conditions Weathering stage (effective CEC) cmol(+)/100 g clay		>24	16–24	<16		
Organic carbon (%) A horizon		1.5–2.0	2.0 or <1.5			
Salinity (millimohs S) 50 cm depth		0-1	1-2	2-3	3-4	>4
Micronutrients			Deficiency	Mild toxicity	Toxicity	

4-Development in Palm Oil Milling Processes:

Figure 2 shows a typical process flow diagram of palm oil milling process. As shown, the process can be generally divided into several unit operations.Firstly, FFB is sterilised to ease the separation of fruitlets and EFB. Most of the POMs in Malaysia are using horizontal cylindrical vessels with three bar steams for sterilisation process [6]. Since the last decade, continuous sterilizer [26] and tilting steriliser [8] were introduced to improve milling efficiency by lowering labour and maintenance cost.However, the capital cost of the new type of steriliser is higher comparing to the conventional horizontal steriliser. Depending on the type of sterilisation technology and availability of steam, several sterilisation patterns from single- to triple-peak steam cycles are practised [9].By using different patterns of sterilisation process, the oil yield will be improved. Upon sterilisation, the fruitlets and EFB are threshed via rotating or fixed drum equipped with rotary beater bars [10]. Meanwhile, POME and EFB are generated in sterilisation and threshing process respectively. [4] The separated fruitlets, which consist of palm nuts and mesocarp fibres, are then sent to the digestion process. Under the high-pressure condition in a steam-jacket drum, fruitlets will be digested in which oil is released through the rupture of oilbearing cells [49].Next, the digested fruitlets go through a pressing system to squeeze out the oil from mesocarp fibres in the fruitlets. Mechanical screw press is commonly used in the pressing process. Double screw press with twin screws rotating in opposite directions was introduced to increase the pressing efficiency [47]. Due to its larger capacity and shorter processing time, double screw press is favourable in the milling industry [22]. During the pressing process, solid and liquid products are generated. The solid product consists of a mixture of mesocarp fibres and palm nuts. Meanwhile, a mixture of water (45–55%), palm oil (35–45%) and fibrous materials are also produced [8]. For the solid products, the fibres and palm nuts can be separated via inclined rotary separator [45], or depericarper which based on air floatation concept [20]. Maycock [38] introduced ripple mill cracker where the palm nuts were cracked and air cyclone is used to remove the dust particles of the cracked mixture [24]. The cracked mixture from the palm nuts, which consist of PK and PKS is separated via clay bath or hydrocyclone based on the difference in specific gravity [21]. Meanwhile, a new cracking process known as Rolek nut cracker [50], followed by a multiple-staged winnowing system [51] with higher efficiency were introduced.

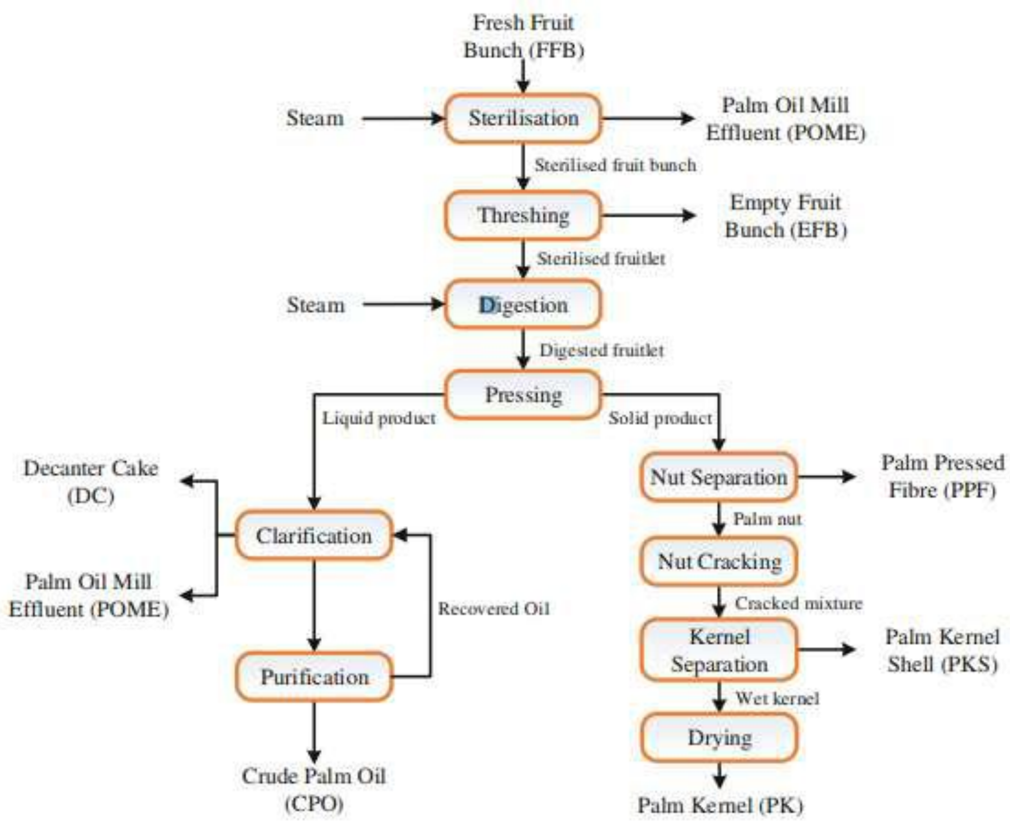

Figure 1. Typical Palm oil mill Processing unit operation [18]

To improve the removal efficiency of the entrained impurities (water and fibrous materials) from the oil, hot water is added in clarification tank [6]. Jorgensen and Singh [25] proposed to combine a two-phase decanter with a rotate drum drier to reduce the amount of water needed. Recently, three-phase decanter is introduced to replace clarification tank and sludge centrifuge [20]. In this process, the entrained solid particles are removed as DC while water is removed as POME. The oil is then further purified into CPO through centrifugal and drying operations. In order to minimise deterioration in oil quality, the purified CPO must be stored between 32 and 40 °C [21]. Based on above discussion, it is noted that there are many alternative technologies that can be used to improve the overall efficiency of POM. Note also that throughout the milling process, various by-products are generated with oil being trapped and remains unrecovered. For example, 10.6 g/L of oil and grease were trapped in POME [5]. Meanwhile, EFB and PPF contains approximate 3–4% [18] and 1.8–3.96% [59] (wet basis) of residual oil respectively. According to [7], an estimation of 10% oil lost across multiple unit operations in the milling process. Therefore, oil loss is a critical issue in POM as it causes a significant impact on the economic performance of POMs. To overcome this issue, various research and development works were conducted to recover the oil from by-products. For instance, EFB screw press and three-phase decanter were introduced to recover oil from EFB and improve the overall oil extraction efficiency. However, most technology providers only focused on individual equipment or process. The oil balance for the entire milling processes is not being assessed. Hence, this is the subject of this work. It is important to synthesis and optimize the entire milling process simultaneously to maximize oil recovery in POM, thus achieving a greater economic performance. Material and energy flows of the entire process as well as expected productivity of the developed POM flow sheet can be determined. Based on the proposed approach, aspects such as process synthesis (e.g. system configuration and technology selection) and design optimization (e.g. capacity, number of units) within the milling process can also be identified. Flow sheet Synthesis and Optimization of Palm Oil … 11 The following section clarifies the developed model, the parameters and the variables involved in a more descriptive manner. The equations formulating the optimization model are clearly presented and defined methodically to deliver a smooth learning of the constructed model.

5. **Physical-Chemical Treatments:**

Some examples of physical and chemical approaches are simple skimming devices [8, 9]; land disposal [10]; use as animal fodder [25, 26]; chemical coagulation, flocculation and flotation [27]; electro flotation [35]; membrane technology [28, 29]; evaporation [30]; and adsorption [26]. However, very few have implemented such systems at full-scale operation because of their unsatisfactory performance, high capital investment, high operating and maintenance cost as shown in Table 2. Moreover, most of these approaches can only be adopted as pre-treatment or tertiary treatment steps for POME as they are still required to couple with other treatment system in order to meet the discharge limit.

6-Biological Treatment:

Biological treatment includes anaerobic and aerobic processes. They are more promising and sustainable technology for POME treatment. With its high organic content, POME is a good source of nutrients for microorganisms and therefore, production of methane generated from anaerobic digestion is highly potential. With appropriate analysis and environmental control, almost all wastewaters containing biodegradable constituents with a BOD/COD ratio of 0.5 (or greater) can be treated easily by biological means [36]. As shown in Table 1, BOD: COD ratio of raw POME is approximately 0.5, implicating that POME is suitable to be treated by biological processes. The principal processes used for the biological treatment of wastewater can be classified with respect to their metabolic function as aerobic, anaerobic, and combined anaerobic–aerobic processes.

7-Conventional Anaerobic Treatment Methods:

In general, aerobic systems are suitable for the treatment of low-strength wastewaters (biodegradable COD concentrations less than 1000 mg/L) while anaerobic systems are suitable for the treatment of high strength wastewaters (biodegradable COD concentrations over 4000 mg/L) [33]. Therefore, the very high level of organic matters in POME requires the adoption of anaerobic digestion as the primary treatment process. More than 50% of palm oil mills in Malaysia have adopted ponding system, involving anaerobic digestion for the treatment of POME (Fig. 2). This is mainly due to their low capital costs, simplicity and ease of handling [32]. Normally, the anaerobic digestion is operated at low rate, with organic loading rate (OLR) of 0.2–0.35 kg BOD/m3.day [34]. Open digesting tanks are used for POME treatment when limited land area is available for ponding system. It has been reported that open ponding system is capable in reducing the concentration of pollutants such as COD (100–1725 mg/L), BOD (100–610 mg/L) and ammoniacal nitrogen (100–200 mg/L) [37, 38]. However, these conventional methods have several drawbacks, such as long hydraulic retention time (HRT; 45–65 days), large areas of lands, and consistent desludging of the settled POME. More importantly, the treated effluent fails to meet the discharge standard consistently [24]. Besides, the potential for biogas utilisation is often being overlooked by the palm oil industry. The produced biogas from anaerobic digestion process emits directly to the atmosphere, posing a detrimental greenhouse effect on the environment [39, 40].

8. CONCLUSION:

Although palm acids and some of the damage to the soil can be tolerated, soils are different in terms of composition of organic matter and acidity. Which cannot tolerate some shortcomings, we have to do several different evaluation methods on the raw before planting.In this work, a systematic approach for synthesis and optimisation of palm oil milling process with maximum oil recovery is presented. A systematic approach is adapted to simplify the overall formulation without losing the insights of interest for the effective design, synthesis and integration of the process. Various technologies currently available in the market were taken into consideration in developing the case study. The optimisation objective is to maximise EP generated based on a fixed amount of fruit available (60 t/h of FFBs).

SUGGESTION:

- Jalabad is one of the hot provinces of Afghanistan the soil and climate are favourable`` for planting palm trees. Farms should be established here.
- Establishment of soil testing laboratories, where the soil should be tested for nutrients for plants in this laboratory once a year.
- Construction of an oil production factory next to Palm agricultural farm

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