Feature Article

Palm Oil Mills and Oil Extraction Ratio

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SYNOPSIS

This article that appeared in the *Engineering Bulletin No. 70* has summarised the gist of the dilemma faced by palm oil millers from day one the modern palm oil mills made their debut in Malaysia or for that matter anywhere in the world. The refusal of some planters to accept the reality of where the mill oil is coming from, the national oil extraction rate (OER) will remain low. It is absolutely pointless to expect the fruit bunches to create more oil than what it contains. As far as oil synthesis is concerned, the moment a bunch is harvested, it cannot produce any more oil. Despite the oil palm planters having this knowledge, they still continue to point their fingers at the mill and put the blame on them when the mill OER drops. If we are sincere in our efforts under the National Key Economic Area (NKEA) to increase our national OER, the focus has to shift from the mill to the estate. This article is republished so that the industry can use the information to increase the national OER. The millers are kindly requested to convey the information to all the contributing estates.

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INTRODUCTION

Palm oil mills do not make palm oil. Oil is made in the field. Plantation management can maximise the oil content of the bunches by good agricultural practices. Palm oil mills however, can reduce the oil losses to a minimum but not eliminate them entirely.

This article is intended to clear the misconception that the palm oil mills are solely responsible for the OER. Many plantation owners and investors surprisingly are led to believe the myth that efficiently operated mills are capable of extraction ratios far in excess of the actual oil content of the bunch itself. Can the plantation management be so ignorant that they actually believe the mill is capable of synthesising oil from the biomass that they send to the mill. It is unlikely that they believe in it. Nevertheless, it is not unusual to hear comments like a certain mill operates efficiently (efficient manager) compared to another mill (inefficient manager) coming from them. The basis is of

course the efficiently operated mill gives an OER of 21% and the inefficiently operated mill gives only 18% OER despite the glaring fact that the former mill has 1.8% oil loss to fresh fruit bunch (FFB) compared to the less fortunate mill giving only 1.3%. Even the mill managers who later become controllers or directors think alike as can be seen by the way they set OER targets for the mills under them. The figures seem to be plucked from the air rather than based on scientific principle.

FACTORS AFFECTING MILLING OER

This information will be very useful for the new planters who wish to understand the fundamentals involved in oil extraction. Let us analyse the various factors affecting the mill OER which the planters must be aware of. The mill OER is very much related to the following factors and possibly other unknown factors.

***Fruit type*. i.e. dura, tenera, etc.** Although DxP is the planting material predominantly planted in Malaysia, there are significant quality variations from one breeder to another. The percentage of *dura* contamination also vary from one plantation to another and possibly from one field to another and these have significant impact on the mill OER.

Age of the palm. There are differing views on this. Palm age may or may not have a significant impact on the oil content of the fruit other than the inevitable loss of loose fruits in the field due to the scattering effect of the fruits to a wider area in the field resulting from the landing of usually very large bunches from the tall palms.

Pollination efficiency. This affects both OER and kernel extraction rate (KER). Under pollinated bunches will give low fruit content in bunches. Heavy rainfall can reduce pollination efficiency as the weevils may take cover in heavy downpour and reduce their pollination activity.

Bunch ripeness. It is a well acknowledged fact that ripe bunches have more oil content in them than the unripe ones. The oil content in the crop is proportional to the percent of ripe bunches in them. The newly recruited harvesters are sometimes unable to detect ripe bunches and during their initial job engagement tend to harvest unripe and under ripe bunches.

Loose fruit collection. The loose fruits in the field are generally expected to be in the region of 10% - 12% and well operated plantations may deliver about 8% but there are plantations which deliver as low as 2% loose fruits to the mills and such mills have to be content with low OER performance.

The trash content. The loose fruit consignment delivered to the mills may sometimes contain as much as 10% trash and the additional weight of the trash in the form of sand and stones will depress the mill OER significantly. No system of weight compensation exists yet in any plantation company. Most plantations appear to be comfortable with the bonus offering of the extra weight added on their actual bunch weight.

Fertiliser application. During lean periods of depressed palm oil pricing, the small plantation companies tend to cut fertiliser application by half like one application instead of the two applications for the year. This lowers the mesocarp thickness of the fruit and the resulting consequence is low OER.

Soil type where the palm is planted. This is related to the fertiliser available for the palm. In some soils the plant nutrition is already present in large quantities like volcanic soils in which case higher yield and good mesocarp development can be expected.

Intensity of rainfall in the field. Palms thrive well if there is sufficient rainfall throughout the year. Very low rainfall can depress the OER a few months later. Hence, the impact on OER is significant.

The mill management has absolutely no control over any of the above factors. The plantation management is fully aware of these factors, yet they seem to be closing their eyes on these. As most of the top management positions, like directors level, have been and still are exclusively reserved for the plantation personnel, perhaps this misconception is a convenient tool to continue the culture.

The OER of a fruit bunch depends on:

- all the above factors; and
- the mill oil extraction efficiency.

The oil extraction efficiency of a mill is determined by analysing the various oil losses during processing. The typical data of a well-operated mill are given in *Table 1*. The desired values are obviously the lowest in the range and it is impossible to achieve them as there are such performers in Malaysia.

The oil loss due to spillage is measured by sampling the mill effluent leaving the mill to the effluent ponds. The difference between this value and the total oil losses in the mill is classified as spillage even though physically no such spillage need to occur in the mill. However, occasionally spillage may take place arising from leakage, tank overflows, cleaning of machines *etc.*

OIL LOSS COMPUTATION TECHNIQUES

The oil losses appearing in the mill process control records can be very confusing to planters, the owners of the company and anyone else other than the millers. These values are absolutely useless to them as they fail to convey any message to them. It can only serve the mill for implementing remedial actions in process control. The owner only wants to know the OER and the oil loss as a percent to the FFB processed. He is not interested in knowing the oil losses as a percent to dry matter as he cannot translate them into ringgit and sen. The oil loss presented as a percent to dry matter can only serve to frighten the owner.

In this context, it is interesting to note that some laboratory supervisors and to some extent even the mill managers do not seem to know how to convert oil losses expressed as percent of dry matter to percent of the FFB processed. In this computation, a number of assumptions are made and they can cause errors in the values obtained. The usual assumptions (not necessarily very accurate) are the ratio of different components of the bunch as a percent by weight to the FFB processed (*Table 2).*

METHOD TO DETERMINE OIL CONTENT OF FRESH FRUIT BUNCHES (FFB)

The most practical method of determining the oil content of FFB is to compute the mill OER and add to this all the known oil losses expressed as a percent of FFB. This is due to the very large variation of FFB received by the mill each day. A statistically significant sample size required to extract oil in the laboratory is very large and as such is not practical.

TABLE 1. SOURCES OF OIL LOOSES IN A PALM OIL MILL
(% to fresh fruit bunch)

Source of oil losses	Desired values	Typical range
Steriliser condensate	0.10	0.10-0.12
Empty fruit bunches	0.40	0.40-0.45
Press cake fibre	0.37	0.37-0.60
Nuts	0.08	0.08-0.10
Separator sludge	0.45	0.45-0.60
Spillage in the mill	0.00	0.00
Total	1.40	1.40-1.87

TABLE 2. APPROXIMATE RATIOS OF FRESH FRUIT BUNCH (FFB) COMPONENTS

Bunch components	% to FFB	Common
Steriliser condensate	10-15	10
Empty fruit bunch	21-23	23
Cyclone fibre	12-14	13
Nut	11-13	12
Oil	19-21	20

If the potential oil content of a bunch is 25%, then why no palm oil mills are capable of achieving this ratio? This is due to the oil loss in the plantation and mill.

Oil Extraction in a Palm Oil Mill

At present, palm oil is extracted from FFB by mechanical means. All liquids from the FFB bunch are squeezed out and the oil separated from the solids and other liquid matter. As the oil extraction process basically is a mechanical process, we can never achieve an extraction efficiency of 100% unlike the solvent extraction process that can give almost 100% oil extraction.

Mills with oil losses at 1.3% and an extraction ratio of 20% can get an extraction efficiency of about 94%. Some studies have shown that the maximum possible extraction efficiency in a mill seldom exceeds 92%. The OER in the mill depends to a large extent on the oil content in a FFB bunch and the oil loss in the mill. Mill management has no control on the total oil content in a bunch, except control the oil loss.

Therefore the only way to measure the efficiency of a palm oil mill is by examining the oil loss in the mill, and not by the OER. This means that a mill with a lower OER is not necessarily more efficient than a mill with a higher OER. *Figure 1* shows oil loss and OER of a mill.

In *Figure 1*, the variation of oil loss in the mill (red line) is not related to the OER (orange line) but OER is very closely related to the total oil in FFB (blue line). The mill manager is responsible for the oil loss in the mill and the plantation manager responsible for the OER and FFB. If the above statement is true, why the palm oil mill managers do not calculate the total oil loss to FFB?

There are a few reasons and these could be:

- mill managers do not know how to calculate the total oil losses to FFB;

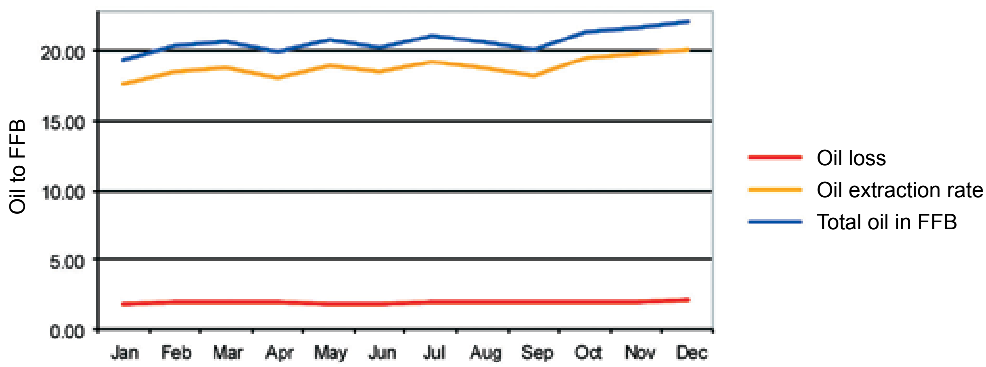

Figure 1. Oil loss and oil extraction rate of a mill.

- mill owners do not want to spend money for process control equipment required to measure mass flow that is required to calculate oil loss to FFB; and mill managers do not have a clear understanding of palm oil processing and process control.

CONCLUSION

The authors would like to suggest to mill owners and senior plantation management to look at the real causes and responsibilities of low oil extraction to enable them to focus on the correct issues to increase OER in the industry. Finger pointing at others does not produce the correct result.

The mill can only strive to bring down the oil loss to FFB shown under (a) in *Table 3* but the gain in OER will not be significant.

Mill managers should strive to upgrade their knowledge on process control or suffer the consequence of being blamed for things that they have no control of. Excellent process control knowledge is available from many publications.

TABLE 3. MONTHLY OIL LOSSES AND OIL EXTRACTION RATE (OER) IN A MILL

Months	Oil loss to FFB (a)	OER % (b)	Total oil to FFB (a) + (b)
Jan	1.80	17.67	19.47
Feb	1.90	18.50	20.40
Mar	1.92	18.80	20.72
Apr	1.95	18.06	20.01
May	1.80	19.05	20.85
Jun	1.75	18.53	20.28
Jul	1.89	19.21	21.10
Aug	1.87	18.80	20.67
Sep	1.91	18.26	20.17
Oct	1.92	19.50	21.42
Nov	1.90	19.80	21.70
Dec	2.00	20.12	22.12

Note: FFB – fresh fruit bunch.