Guidelines on Assessing Palm Oil Mill Extraction Efficiency

Jack Maycock

RINGKASAN

Prestasi sesebuah kilang tidak boleh dilihat dari segi kadar perahan minyak sahaja. Kaedah yang paling sesuai ialah dengan membezakan antara kehilangan minyak dan isirong. Kertas ini memberikan garis panduan bagi menilaikan keefisienan perahan di kilang.

INTRODUCTION

"Good quality palm oil is made in the field not in the mill and this should not be overlooked when studying the efficiency of palm oil production".

No matter how well processing is done in the mill, the quality of the oil cannot be improved beyond that of the oil in the fruit entering the mill. The mill staff can only minimize the quality degradation which occurs subsequent to crop receipt. Also, the mill cannot produce more oil than what is coming in with the fruit bunches; the mill can only strive to minimize the processing losses.

REVIEW OF METHODS OF CALCULATING EXTRACTION EFFICIENCY

In many seed crushing operations – such as the milling of palm kernels – it is normal practice to weigh the raw material, to determine its oil content by the analysis of a representative sample and to weigh the quantity of oil produced. The ratio of oil produced to oil content when expressed as a percentage is known as the efficiency of extraction – or more precisely the "analytical" efficiency of extraction since it is based on the oil content of the raw material as determined by analysis.

In the very early days of palm fruit milling the raw material was all of one type and fairly uniform in quality and with care it was possible to obtain a reasonable idea of its average oil content by analysis and so to calculate the analytical efficiency of oil extraction.

In modern mills the raw material is in the form of fruit bunches which are weighed on entering the mill. It is not too difficult – though it is a lengthy process – to analyse an individual fresh fruit bunch and to determine its oil content. Unfortunately, however, the bunches arriving at the mills vary so much in type, weight and ripeness that to analyse one bunch would be of very little value. In fact the number of bunches that would need to be separately analysed to estimate the average oil content of the raw material with adequate accuracy would be so large that it would be impractical to consider doing this.

Another approach would be to sample the sterilized fruit over a period as it comes from the stripper and to analyse this. Such samples would show less variation in oil content than do individual bunches. Even so, bearing in mind the fact that although a large sample may be taken originally it must be quartered down to quite a small size for analysis, it is fairly obvious that a considerable number of such samples would need to be analysed daily in order to obtain a reasonable estimate of the oil content of the stripped sterilized fruit.

A further complication is that in order to estimate the oil content of the bunches in this manner it is also necessary to measure the percentage of stripped sterilized fruit to bunch. This is fairly straightforward at mills equipped with continuous weighers installed between the stripper and digesters but such mills are rare. The alternative is to estimate the weight of stripped sterilized fruit by deducting the weight of stalks and the loss of moisture during sterilizing from the weight of fresh bunches. This requires special tests and the results are seldom very reliable partly because some further moisture loss occurs between weighing the sterilized bunches and weighing the stalks.

Because it was found in practice that measurements of mill efficiency by the analytical method described above were not very trustworthy this system, which was used for a number of years, was abandoned early in the 1950's and replaced by estimation of what is known as the "known losses" efficiency. This was done following careful studies and the development of simple weighing devices (known as basculators) which make the method a practical one and much to be preferred for process control purposes to the analytical method.

EFFICIENCY OF EXTRACTION BY KNOWN LOSSES

The efficiency of extraction by known losses is defined in the same way as the analytical efficiency *i.e.* it is the ratio of the oil produced to the oil content expressed as a percentage. The only difference is that instead of measuring the oil content directly by analysis it is measured indirectly as the sum of the oil produced and the oil lost during processing. This is a valid approach if care is taken to measure the losses and in practice it is easier to obtain a meaningful efficiency figure in this way than by bunch analyses – largely because the material that must be sampled and analysed is so much more uniform.

The losses that are measured occur at the following points:

(a) **On the bunch stalk.** This is the oil that has been absorbed from the fruit during the course of sterilizing or stripping.

(b) **In the press fibre.** When the digested sterilized fruit is pressed a small amount of oil always remains in the press fibre and is measured by sampling the cake and analysing the fibre.

(c) **On the nuts.** The surface of the nuts in the press cake is in contact with the oily fibre and a very small amount of oil becomes absorbed on the surface of the nuts and must be measured.

(d) **In the waste water from the clarification section.** This water always contains a small proportion of oil most of which is absorbed on the finely divided non-oily solids present.

It may be argued that there is a further oil loss in processing *viz* that lost in the sterilizer condensate. This is correct but the loss is fairly small and usually it is excluded from the list of "known" (*i.e.* measured) losses used to calculate the efficiency. Although this is perhaps unjustifiable in theory, in practice it is satisfactory. This is because it is very difficult without special facilities to measure the quantity of sterilizer condensate produced during the course of a sterilizing cycle and just as difficult to obtain an average sample for analysing since the rate of flow and the oil content of the condensate varies so widely from moment to moment.

It is probably better to omit the relatively small sterilizer condensate loss altogether from the calculation than to include estimates which may vary greatly from day to day for no other reason than the extreme difficulty in making the measurement. Because of this omission the efficiency as calculated will necessarily be a little high.

An objection that is sometimes raised to the use of the "known losses" efficiency is that there might be some "unknown losses" in the form of oil accidentally discharged into a drain or even deliberately removed from a point in the process or from storage and yet such unmeasured losses would not affect the recorded efficiency. This is quite correct and if the analytical efficiency could be measured sufficiently accurately it would indeed reflect any "unknown losses" of this sort.

In spite of this shortcoming the known losses efficiency is a valuable check on the way the process itself is being conducted and any substantial drop constitutes a warning signal that some part of the process requires investigating.

Unmeasured losses in the form of oil leaving the mill in the clarification section drain due to mal-operation very seldom occur and if they do no oil is normally lost because there are oil traps to prevent this. If the quantity of oil should be so substantial that the traps overflow and pass oil into the field drain or stream the fact is immediately obvious and steps are taken to prevent it continuing and to recover the oil lost if possible.

Vigilance at all times is needed to prevent unmeasured losses though, as explained above, they seldom occur. Although the known losses efficiency figure will not reveal them should they occur, any substantial losses would result in a reduced percentage of oil extraction to bunch. This could, of course, also be caused by a reduced oil content in the bunches so interpretation would need to be made with care.

Finally, it should be pointed out that a drop in the oil content of the bunches will itself lead to a small drop in the efficiency of extraction. Hence a reduced efficiency may, on occasion, be due to this and not due to any lowering in the standards of processing. This is simply a consequence of the fact that for bunches of low oil content the losses represent a greater proportion of the oil content than in the case of bunches of high oil content.

In order to provide a permanent record of the milling operations a Monthly Milling Summary should be prepared on the lines of the attached specimen – Appendix "A".

Full details of the test procedures, preparation of samples and instructions for completing the summary are given in PORIM's publication "Palm Oil Factory Process Handbook – Part 3".

Every endeavour should be made by the mills to keep their processing losses within the following limits:

Oil losses

(i) Stalks (EFB)	2.22% to 2.44% oil to total oil
(ii) Press Fibre	3.20% to 3.72% oil to total oil
(iii) Nuts	0.49% to 0.50% oil to total oil
(iv) Waste Water	2.09% to 2.34% oil to total oil

Kernel losses

(i) Shell	2.16% to 3.20% kernels to total kernels
(ii) Cyclone Fibre	3.42% to 4.15% kernels to total kernels
(iii) C M Blowings	0.42% to 0.65% kernels to total kernels

These losses will give the following efficiencies by know losses:

Oil Extraction	between 91 and 92%
Kernel Extraction	between 92 and 94%

CONCLUSION

It must be appreciated that the mill's performance cannot be judged by oil extraction rates and there is only one satisfactory system and that is comparison of the oil and kernel losses. It should also be realised that a drop in the oil content of some of bunches milled, *i.e.* not completely ripe, will lead to a small drop in the efficiency of extraction.

Appendix A

MILLING SUMMARY FOR THE MONTH OF......... 19......
FOR .... OIL PALM ESTATE

SECTION A (Production weights)	**THIS MONTH**	**TWELVE MONTHS TO DATE**
1. Tonnes of fresh bunches milled 2. Weight of oil produced 3. Weight for kernels bagged		
SECTION B (Extraction) 1. Percentage oil extracted to fresh bunch 2. Percentage kernels extracted to fresh bunch		
SECTION C (Efficiency of extraction) 1. Percentage efficiency of oil extraction by known losses. 2. Percentage efficiency of kernel extraction by known losses.		
SECTION D (Quality of Products)	**THIS MONTH**	**TWELVE MONTHS TO DATE**
1. Oil produced: Tonnage, FFA, % Moisture, % Dirt 2. Oil despatched: Tonnage, % FFA, % Moisture, % Dirt		
	THIS MONTH	**TWELVE MONTHS TO DATE**
3. Kernels bagged: % Moisture, % Dirt, % Broken Kernels		

SECTION E (Oil losses)	**THIS MONTH**		**TWELVE MONTHS TO DATE**	
	% Oil to N O S	% Oil to Fresh Bunch	% Oil to Total Oil	% Oil to Total Oil
1. On stalks 2. In press fibre 3. On nuts 4. In waste water TOTAL:				
SECTION F (Kernels losses)	% Kernels in Sample	% Kernels to Fresh Bunch	% Kernels to Total Kernels	% Kernels to Total Kernels
1. In Shell 2. In cyclone fibre 3. In C M Blowings (if not included in 1.) 4. In final cleaning reject TOTAL				

Figure 1. Specimen of a Monthly Milling Summary.

Appendix A

MILLING SUMMARY

MILL:
MONTHS:

SECTION G (Results of Analyses)	**THIS MONTH**	**TWELVE MONTHS TO DATE**
1. Stalks: Total Weight in tonnes		
% Oil		
% Water		
% N O S		
% Fruit		
2. Press Cake:		
% Nuts		
% Wet Oily Fibre		
3. Wet Oily Press Fibre:		
% Oil		
% Water		
% N O S		
4. Nuts: Total Weight in tonnes		
% Oil on Nuts in Cake		
% Nuts to Bunch		
5. Waste Water: Total Weight in tonnes		
% Waste Water to Bunch		
% Oil		
% Water		
% N O S		
6. Shell to Boiler:		
% Free Kernels		
% Kernels with small pieces attached shell		
% Split Nuts		
% Uncracked and part cracked nuts		
Total % Kernels in Shell to Boiler:		
SECTION H (Nut breakage in press cake)		
1. % Whole Nuts to Cake		
2. % Broken Nuts to Cake		
3. % Free Whole Kernels to Cake		
4. % Free Broken Kernels to Cake		
5. % Free Shell to Cake		
6. % Free Kernels to total Kernels		

SECTION I (Pressing Rates)						
1. Serial Number of Press	No. 1	No. 2	No. 3	No. 4	No. 5	Total
2. Nominal Pressing Rate in tonnes Bunches per hour						
3. Actual Pressing Hours						
4. Hours lost due to Press or Kettle breakdown.						
5. Hours lost due to other mechanical breakdowns.						
6. Hours lost due to delay in receiving fruit.						
7. Potential Pressing Hours (*i.e.* 3 + 4 + 5 + 6)						
Tonnes Bunches Milled per Press per Actual Pressing Hour:						

Figure 1. (con'td)

Appendix A

MILLING SUMMARY

MILL:
MONTH:

SECTION J (Main Engine Hours)	**THIS MONTH**
1. For hoisting and digestion. 2. Between start and close of pressing. 3. For emptying Depericarper at close of pressing. 4. For Milling in addition to above. 5. Total Main Engine hours for Milling during month. 6. Tonnes of Bunches Milled per main Engine hour.	

SECTION K (Utilization Factors)	**THIS MONTH**	**TWELVE MONTHS TO DATE**
1. Factor A (Percentage Actual to Nominal Pressing Rate) 2. Factor B (Percentage Actual to Potential Pressing Hours) 3. Factor C (Percentage Actual to Potential Tonnage Pressed) 4. Factor D (Percentage Acttual tonnage in month to Potential Tonnage in 400 Pressing Hours)		

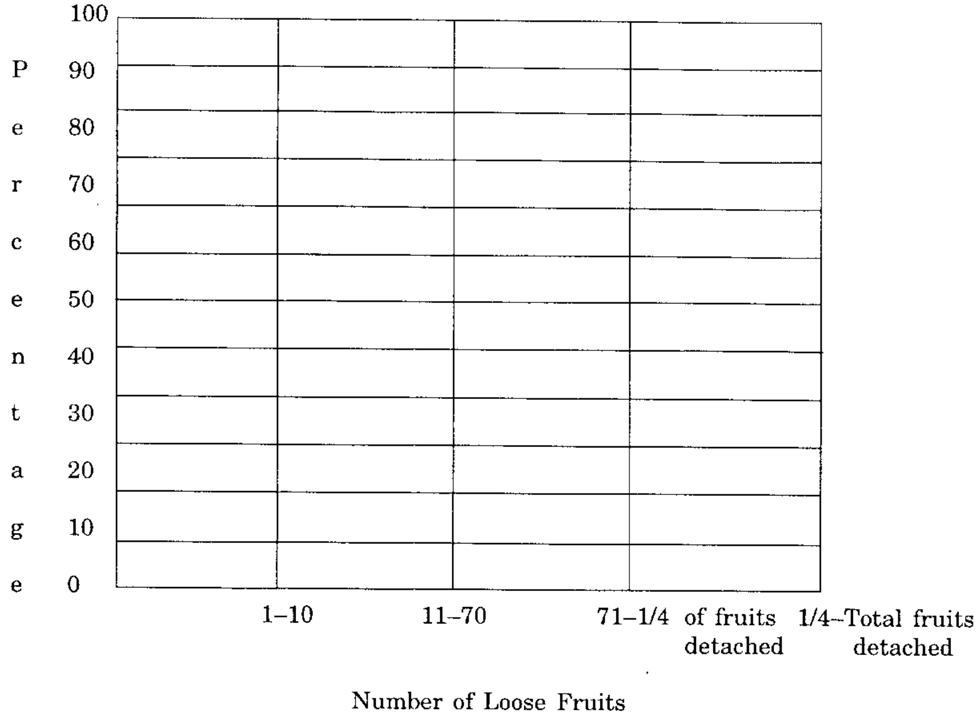
SECTION L (Miscellaneous)	**THIS MONTH**
1. DXP Area Bunches: Tonnes Bunches from DXP Areas % DXP Area Bunches to Total 2. Purchased Bunches: Tonnes Purchased Bunches to Total 3. Hard Bunches: % Hard Bunches by Number 4. Shell Fractions: % C M Blowings to Total Shell % Shell ex Hydrocyclone to Total Shell 5. Nut Analysis: % Shell to Nuts % Kernels to Nuts Ratio Shell to Kernels in Nuts	

Figure 1. (con'td)

Appendix A

MILLING SUMMARY

SECTION M (Bunch Ripeness Curve) % Tenera Bunches = %



SECTION N (Remarks and Signature)

Figure 1. (con'td)