A Critical Look at the Palm Oil Operations

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INTRODUCTION

This article is a repeat of the article previously published. As I felt that it contains some important points that will not get dated anytime in the near future, the millers are requested to read it through to improve the milling activity in their mills. The fabricating industry should also be well versed with what the millers seek so that they can fabricate machinery to fulfil the requirements of the industry.

FOCUS AREAS

The following tips are intended to direct the attention of the process engineer or the mill manager on the often neglected relatively obscure corners of the process flow system. A thorough knowledge of the intricacies associated with it would make processing operation more scientific and extraction rate more profitable. An engineer or for that matter a process supervisor, who take the trouble to grasp the fundamental basics, would be able to perform better than others, who lack the knowledge, provided of course, the infrastructure like the process control laboratory and the process operators are reliable and committed. Let us now look at all the process areas including the hidden areas of the processing plant. Only two of them play a significant role, are highlight: (a) process control dilemma and (b) practical actions for controlling product losses.

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WEAKNESS IN PROCESS CONTROL SYSTEM

The analysis of samples provides the evidence of whether the processing had been efficient or otherwise. But do they really represent the actual processing? Can any mill engineer honestly declare that his mill laboratory analysis give a good indication of the actual operation of his mill? No matter how accurate the analysis, the result becomes meaningless if the sampling is erratic. Who checks on the sampling and how it is being performed? Do they follow all the guidelines all the time? Let us look at them critically.

OIL LOSS IN STERILISER CONDENSATE

The steriliser condensate flows into the steriliser condensate pit and from there it is pumped out separately into the final

effluent pit. After this, no oil is pumped into the process system as it is deemed to be off-quality. How a representative sample is to be taken from this pit is a big question mark as the oil usually floats in the pit but small particles will not rise to the surface. If we take a mixture of samples from the top and the bottom will it be a representative sample? Some mills have solved the problem by pumping the top layer of the condensate oil for press crude oil dilution. Does this mean that there is no more oil loss here? This unethical practice has almost become a regular feature now, encouraged by the lucrative crude palm oil price.

OIL LOSS IN EMPTY FRUIT BUNCH

It is almost impossible to obtain a representative sample from empty fruit bunch. Here, bunches will have varying degrees of oil content depending on the degree of ripeness and the threshing they are subjected to. The oil loss may vary widely and even can reach 1% (% to fresh fruit bunch) but such high figures are usually rejected by the mill as an odd figure. The sampling method is also some what odd. Usually one bunch is selected from every 300 bunches moving along the conveyor and if that happens to have absorbed the least oil, the oil loss in empty fruit bunch will be low for a prescribed period of time. This trial is conducted once in every six months or none at all. Those who do not conduct this trial adopt an arbitrary figure close to 0.45% (% to fresh fruit bunch) as a normal value, even though the actual loss could be as high as 0.6% (% to fresh fruit bunch) or even more. Some mills do not consider this as a loss at all, when computing total oil loss to fresh fruit bunch. Empty fruit bunch is like a bloating paper and it really absorbs oil - probably more than any other bunch component – yet the least importance is given to it. This is a vast contrast to the oil absorbed by the nut surface at only 0.08% (% to fresh fruit bunch) for which more attention is given by the process control and the mill management.

It is difficult to give a figure that will reflect the actual oil loss in empty fruit bunches with reasonable degree of accuracy to satisfy a serious process engineer. A simple and practical compromise seems to be to conduct trials at least once a month supervised by the process engineer.

OIL LOSS IN CYCLONE FIBRE

The cyclone fibre (mesocarp fibre) may be defined as the lignin components of the press cake containing, when fresh, some residual oil and moisture with nuts at a slightly lower proportion by weight in the press cake. As no mechanical processes can extract all the juice from the mesocarp it is important to handle the pressing operation with considerable care to ensure that the two vital process-sensitive parameters are under good control. They are: (a) the residual oil in the mesocarp fibre and (b) the nut breakage.

In most mills, sufficient attention is not given to these important requirements. Some process operations and the corresponding results are tabulated in *Table 1.*

The moisture and the oil content in the fibre can vary if wrong process option is chosen. The accuracy of sampling can play a vital role in the accuracy of the results. In fact, the majority of the mills may fall under this category in the absence of external process audits. The samples taken from the bottom of the press are usually oily, while that of the top are dry. The oil loss can vary widely in both samples. The accuracy in such cases will depend on a proper mixing and quartering of samples.

PRACTICAL ACTIONS FOR CONTROLLING PRODUCT LOSSES

Sterilisation

The steriliser temperature has to remain high, preferably above 140°C for a number of reasons. The mill engineers are fully

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TABLE 1. SOME COMMON OPERATIONS AND THEIR CONSEQUENCES

Common operations	Options	Digester (°C)	Results
Poor digester drainage Low pressing pressure	A	> 90	High nut breakage often exceeding 15% Oil loss in fibre also will be high
Poor digester drainage High pressing pressure	B	> 90	High nut breakage often exceeding 15% Oil loss in fibre also will be high
Good digester drainage High pressing pressure	C	> 90	High nut breakage often exceeding 15% Low oil loss in fibre
Good digester drainage Low pressing pressure	D	> 90	Low nut breakage Low oil loss in fibre
Good digester drainage Low pressing pressure	E	<85	Low nut breakage High oil loss in fibre
Poor digester drainage High pressing pressure Low digester temperature	F	<85	High nut breakage High oil loss in fibre

aware of this. The main reason is not sterilisation *per se* as that will require only 60°C for a few minutes to inactivate lipase but for conditioning the pericarp and nuts for subsequent process activities. The correct terminology for this is pressure cooking.

Impact of De-aeartion

Admitting 3 barg steam into the steriliser, while half of it still contains air will not give satisfactory cooking. If for example, it contained one-quarter air and three-quarter steam, the partial pressure of steam, according to Daltons Law of Partial Pressure is only 2 barg and the corresponding saturation temperature will be based on 3 bara, *i.e.* 133.5°C instead of 143.6°C expected of steam at 4 bara. The 10° difference is significant in terms of fruit conditioning and oil loss.

Proper Sterilisation

If serious attention is given to remove as much air as possible from the steriliser chamber, mills will not have to install double stripping. If bunches are heated to a temperature that is above 140°C, fruits will detach from the bunch without the need for double stripping. Air is continuously released by the bunch, when it is subjected to heating and its evacuation is accomplished by the continuous bleeding of the condensate. Double stripping is akin to fighting consequences rather than the cause.

Clarification Oil temperature

The clarification tank temperature has to be close to or above 90°C, if high oil extraction rate is the priority. But unfortunately, at high process temperatures, the DOBI value will drop. A compromise has to be made here. The difference in oil extraction rate can be quite significant when processing at high or low temperatures.

Press Cone

There is no established data on the effectiveness of the mild steel plate that now seem to have replaced the once popular conical plug, for constraining the free discharge of press cake. In all likelihood, the conical plug could get better results than a flat plate as in the former case, the press cake can flare out evenly.

Digester Drainage

The press feed should not contain too much oil as this will cause the feed to be slippery. On the other hand, if most of the oil has been pre-extracted, then with low pressing pressures, the remaining oil can be extracted. There is no benefit in increasing the press cone pressure indiscriminately to excessive pressures like 60 - 80 bar with the intention of extracting more oil. What will generally happen is very high nut breakage, which should not be permitted to exceed 15%. In their eagerness to increase the oil extraction rate, some mills resort to even 80 bar cone pressure without any consideration for excessive nut breakage. Considerable oil can be drained off from the digester by installing a good drainage box that works under all conditions.

Pressing Pressure

Using high cone pressure in a press would also cause an increase in the production of solids that in turn will absorb oil. For improving oil separation in the digester, a few fundaments have to be adhered to. They are: (a) the digester must be at least three-quarter full, (b) the temperature must be at least 95°C, (c) the digester tip clearance should be a minimum and (d) the inter-blade vertical constraint bars on the inside digester chamber wall must be in place as without which digester will not be effective.

Crude Oil Dilution

The crude oil extracted by the press by itself is ready for clarification without any water dilution as at virgin state the moisture level in the crude palm oil is ideal having the least viscosity with ideal separation properties. Dilution is carried out primarily for promoting the flow of crude palm oil through the gutter into the vibrating screens as otherwise it is too thick to flow. This could have been resolved by installing an auger to push it through the gutter but an erratic step was initiated then and to this day it holds good as an integral process step. The current water addition regime is about 41% of the press liquor so that the final oil content in the diluted crude is 39% from the original 55% in crude oil.

Crude Oil Pump

The crude oil transportation from the crude oil tank to the clarification tank originally was done using a positive displacement screw pump like Mohno pump. Now almost all mills have shifted to centrifugal pumps because they are cheap and easy to maintain. But its defects, for pumping crude oil, are not well publicised. The churning effect of the centrifugal pump causes the formation of emulsion, which once formed, remains inseparable from one another. That is why, for maximum oil recovery, positive displacement pumps were recommended. The sub-micron oil droplets generated by the centrifugal pumps are too small to possess sufficient buoyancy to rise in the clarification tanks and they will easily find its way to the effluent stream without being captured by the sludge centrifuge.

Rotary Brush Strainer

Another equipment that seem to have gone out of fashion is the rotary brush strainer, which has a real function to play. It imparts a shearing force to the sludge so that oil separation in the separator is more efficient. It should not be trimmed to make rotation easy within the brush chamber as which in case it will not be serving any purpose at all.

Sludge Separator

Simple logic says that the smaller the nozzles the better oil recovery or inversely when the nozzle size enlarges the oil loss will tend to rise. The separator also must run full for good oil recovery. This can be done by having a ring type sludge header that can supply feed to all separators equally so that no separator will be subjected to partial starvation. These are reasonably well established factors which most millers are likely to be well-versed.

Impact of Excessive Dilution

Apart from the above, it is important to recognise the volume of sludge that the sludge separators are required to handle. If the oil losses ex-sludge centrifuge is x%, it will not change if the sludge feed is diluted excessively or otherwise, *i.e.* if 100 litres of sludge is fed into the separator and the oil loss in the discharge outlet is 0.6%, it will remain the same. If the sludge is diluted 100% and the volume has now become 200 litres. In both cages, percentage oil loss will remain the same but the absolute oil loss will become double. By dilutions the % oil retained by the waste water is not reduced. Hence, dilution will actually promote oil loss.

KERNEL LOSSES

De-pericarp Column Setting

The fibre/nut separator or the de-pericarp column as it is popularly known can contribute significantly towards the loss of kernel, simply because the adjustable velocity of the separating column is set erratically and no one has the equipment to measure it. The mill only has to make an opening in the ducting to insert the measuring instrument that can give the velocity of air flow within the column that ranges from 12.5 to 15 m^{-1}. By careful adjustments, the optimum velocity suitable for the cracked mixture could be selected by adjusting the throat area of the separating column.

Separation Velocity

The exercise should be carried out on a routine basis so that there is no deviation of separating velocity for prolonged periods of time as the losses could then be significant. At least there should be a weekly velocity monitoring instead of the present once in a lifetime measurement and this can be done and recorded by the process assistant or the plant operator. The throat velocity can vary due to many reasons like fan blade erosion, accumulation of fibre inside the ducting of the chute or even a puncture along the product flow line. The measurement will throw some light on any of the defects that could have developed during processing due to one reason or other. As the gains far outweigh the investment cost of RM 600 to RM 800 for the purchase of this equipment, millers are encouraged to consider the purchase of one such equipment.

NUT LOSSES IN CYCLONE FIBRE

Separation Column Setting

It is common to see small nuts being lifted and carried along with the cyclone fibre. While it may not be possible to prevent the flow of all nuts, considerable control of this loss can be achieved if the lifting velocity at the separating column is maintained at an optimum level, to cater for free kernel and large or medium pieces of shell to be held in suspension under the action of the induced draft fan. The normal lifting velocity is about 12 m^{-1} but may vary depending on the size of nuts. This optimum velocity has to be established by trial and error, guided by the free kernel and small nut losses in cyclone fibre and may have to be re-established again, preferably on a yearly basis. Therefore, it is not a waste to purchase the very useful velocity measuring device.

THE FOUR-STAGE WINNOWING SEPARATION SYSTEM

MPOB initiated dry separation system, now undergoing intensive development work for perfecting the equipment and optimising process parameters, has to depend a great deal on the optimum velocities at many critical points, where separation will take place. Mills using this system will gain maximum benefit if they monitor the lifting velocities at all the required points or otherwise kernel losses may take place without detection. The dry separation system is targeted to do away with the production of effluent and all mills in Malaysia are expected to adopt it as it offers many positive benefits including better kernel extraction and zero effluent production that no other system can offer.