Clarification Station Operation (currently on-going)

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INTRODUCTION

I am sure that most millers will concede that the clarification operation in a palm oil mill plays an important role in efficient oil extraction. But whether all millers are really concerned about this is questionable as in some mills despite the oil losses being higher than the normal values, no positive action seem to have been undertaken to remedy the situation.

Let us take a close look at the oil extraction operations from the digester onwards culminating at the storage tank. The operation can be sub-divided into the following process constituents.

DIGESTER DRAINAGE

Most millers do not seem to understand why it is necessary to drain as much oil as possible from the digester. If most of the oil is drained off at the digester itself, the press fibre will have less oil resulting in less slippery fibre. This will not only improve the efficiency of the pressing operation but the pressing itself can be done at a lower pressure. Some mills use a very high pressing pressure like even 80 bar against the normal pressure of about 20 bar. This will most certainly cause high nut breakage in the press. High nut breakage also can lead to high broken kernel that again will result in poor kernel quality. Resolve the problem at the source rather than fighting the consequences. The gap between the expeller blades and the bottom perforated drainage plate is critical (not many millers realize this) as severe nut breakage also can be caused by the wrong setting of this gap. This is primarily due to the lodging of nuts in the gap and nut breakage take place when the expeller arms rub against nuts. Mill's maintenance personnel generally do not check this gap during digester liner or blade renewal. The problem can be solved in two ways; either set a wide or a narrow gap and monitor the nut breakage.

PRESSING

Presses have undergone some minor changes for the bad. The conical restraining plug at the front has now been converted to a flat one because it is easier to make. Those who did this must have assumed that the designers who initially designed the press would never have thought about the simple flat plate. There were good reasons for doing what they did. There is a difference between the profile of the press cake issuing out of the press when using the conical plug and a flat plate. The pressure distribution on the cake might be the same when a flat plate is used.

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Water injection in the press is useful to wash off the oil from the cake during pressing. Some engineers may have a doubt on how the water at a relatively low pressure can possibly flow into the press chamber where the press cake experiences a pressure of 30 bar. However, note that the whole chamber is not under 30 bar pressure, it is only the press cake that experiences the pressure brought about by screws. The water will still flow into the press chamber. Water addition at this point is preferable to water addition at the crude oil gutter as this will help to wash off the oil from the press cake.

CRUDE OIL DILUTION

This is a field that needs a great deal of intensive study as there are a number of misconceptions among millers about the right approach in clarifying the oil. The three phases that exist in the crude oil issuing out of the screw press does not offer a simple solution for the complete separation of phases. The current method of dilution criteria although based on the sound principles of fluid mechanics does not seem to have considered the impact of solids on clarification in a three phase mixture. This fact has been highlighted in the *Mongana Report.* The solids generated during pressing are a big obstacle for efficient oil separation.

The crude oil issuing out of the press has the least viscosity and at this point, the separation is most efficient. When this is diluted, solids in the crude oil absorb the water and begin to swell until they are saturated at about 50% dilution at which point the viscosity is maximum. After this point, no further water absorption takes place and the viscosity starts to decrease and at 200% dilution the viscosity drops to the same value as when the oil is discharged from the press. Almost all mills operate by adding about 43% water, when the viscosity is most unfavourable. This is a very strange way to operate the clarification station.

Let us look at how a better system can replace the existing system. One fundamental thing to remember in any industry is as far as possible do not add water as whatever water is added it has to be rejected at the end of the processing operation. Besides it is a source of effluent that we are trying our best to avoid. We have recognized that solids are a nuisance as it promotes viscosity. So the logical thing to do is to remove it first before commencing oil separation.

There are many methods of doing this. Decanters can separate the solid phase and the oil and water phase can be lumped together or separately recovered. The solids can carry a fair amount of oil if not properly set. On the other hand if water and solid phases are separated out together and the oil phase with some water separated as one phase oil losses can be minimized. The water from the heavy phase can be evaporated out and solids recovered. The oil phase without the usual solids and very little water can be clarified in a series of clarifiers and finally in a purifier. There are other options as well like coalescence plate separator that can separate the two phases efficiently. Another option is to use a second decanter for the separation of water from the mixture of lighter phase oil and traces of water discharged from the first decanter.

PUMPING

This is another area where the processing techniques took a reverse path and gone for the worse. It is a well-known fact that a centrifugal pump will churn up the oil when it is used for pumping oil. It is basically the characteristics of the oil. This was recognized as far back as more than 50 years ago and most mills were religiously using positive displacement pumps for pumping dilute crude oil to the clarification tank.

As no one could directly see the impact of the centrifugal pumps on the actual efficiency of separation, millers decided to opt for the cheap centrifugal pumps to replace the positive displacement pumps they already had. Another reason was that the positive displacement pumps and their spare

parts were more expensive. This encouraged millers to phase them out. It is also unfortunate that most millers do not know how to operate and maintain positive displacement pumps like Mohno pumps.

These pumps should not be allowed to operate with a negative suction head. If operated under suction head, the rotor and stator life will be drastically reduced. Another operational error is the rotor speed which should not be allowed to exceed about 600 rpm The combined effect will bring the life of the rotor and the stator to only two to three months compared to two to three years under positive head. Once the oil is churned by the centrifugal pump, it is likely to attain some of the properties of an emulsion leading to a hindrance to oil separation. If we wish to carry out proper clarification we have to re-establish the original concepts as they were founded on scientific principles.

HEATING

Crude palm oil heating has its advantages and disadvantages. It is a question of higher oil extraction rate at the expense of quality and low oil extraction rate with better quality. Higher oil temperature for prolonged duration tends to bring down the DOBI value of the oil and *vice versa.* The best approach is a compromise. A clarifier temperature of about 90°C-95°C is ideal for oil separation. If this is below 90°C, the oil loss can be quite significant. Even though this temperature is very critical, it is surprising that thermometers installed in the clarification tanks of most mills in Malaysia are defective. If they are in working order, they are installed far away so temperature readings are not visible from the ground level with a naked eye.

OIL SEPARATION

For 99.3% of the oil to separate and rise to a height of 900 mm, the time needed is only 2 hr. The oil particles not separated during this time are unlikely to rise to 900 mm irrespective of the settlement time because these particles which are usually below 15 microns in size do not have the buoyancy to rise to this height. *Table 1* gives a relationship between the time taken and the quantity of oil droplet risen to 900 mm.

The conclusion that can be drawn from this is that it serves no purpose using large clarifier tanks capable of giving very high retention times. It does not serve any purpose in extra oil recovery. A reasonable retention time is 2.5 hr. For a 60 t hr^{-1} mill at 65% dilute crude oil, a 120 t capacity will give a comfortable retention time of 3 hr. It is not unusual to find 90 t hr^{-1} mills having 300 t capacity clarification tanks. Very large tanks like this will have wide range of temperature profile at different points within the tank.

OIL DRYING

The initial drying takes place in the clarification tank. Further evaporation of moisture can take place in purifiers. Finally, the remaining moisture has to be flash dried in a vacuum dryer. In most mills, the operators of this station are not well versed with vacuum drying as they do not seem to know what the ideal vacuum should be. This applies to even the mill process supervisors who are unable to say the units displayed in their vacuum gauges. Unless they acquire the right knowledge, it will be difficult for them to appreciate their vacuum drying system.

TABLE 1. QUANTITY OF OIL SEPARATED AND THE TIME TAKEN TO RISE TO A HEIGHT OF 900 mm IN A CLARIFICATION TANK

Min	Quantity separated (%)
20	95.9
40	97.6
60	98.3
120	99.3

OIL PURIFICATION

There is a tendency now for millers to do away with the purifiers as they find a series of heating tanks with heating coils could give the same result in terms of moisture content. But millers have to remember that prolonged exposure to heat can cause DOBI deterioration. This does not happen when purifier is used. This is something to watch out. If in any mill, the DOBI value dropped after the system alteration at least they know what could have triggered it.

PUMPING OF OIL INTO THE STORAGE TANKS

Ideally the oil should be cooled to about 40°C using a plate heat exchanger before the oil is pumped into the storage tank. Only very few mills in Malaysia still carry out this good practice. This is intended to minimize oxidation of the oil.

OIL STORAGE

Ideally, the storage tanks should be made of stainless steel if prolonged storage is required. But presently oil is not stored for long durations and as a result mills seldom resort to stainless steel tanks. The tank interior surface also is not coated even though at the bottom portion where the water condensation takes place could promote corrosion if the steel plates are not coated. It is therefore preferable to have epoxy or other coating 3 m from the bottom so that the risk of iron contamination is minimized.

CONCLUSION

Clarification operation is an important processing step that should be carefully handled with as much care as possible. As this is where the oil quality and part of the oil losses come into play, an in-depth knowledge of the clarification operation would be beneficial to the mill engineers.

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