

FEASIBILITY OF FILTERING CRUDE PALM OIL SLURRY

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ABSTRACT

This paper presents the results of an initial investigation on the viability of filtration in replacing the current clarification process in crude palm oil slurry separation. Initial investigation were done using laboratory size filter press to determine the CPO filtration characteristics and the suitable filter media.

INTRODUCTION

Clarification is one of the vital processes in crude palm oil (CPO) production as the quality of the produced CPO from the mill depends heavily on the performance of the clarifier unit. Inefficient clarification results in poor quality of oil such as high moisture, solid and free fatty acid content. Also one of the problems occurring as a result of inefficient clarification is the production of highly contaminated wastewater which requires extensive treatment before it can be discharged to the environment or recycled back to the mill. In the clarification process, the crude palm oil (CPO) slurry which consists of a mixture of solid, oil and water is separated to get clear CPO needed for the refining process.

The sequential steps of the conventional clarification process of CPO in the mill are as follows:

- dilution of CPO slurry
- screening
- slurry separation
- centrifugation
- drying

The settling speed of the slurry depends on the amount of solid content of the slurry which usually differ according to the method of extraction (1). The addition of hot water for dilution speeds up the settling rate, however it also increases the amount of wastewater produced. Even though it is not toxic, the palm oil mill effluent containing BOD of about 25,000 mg/l, is very polluting. The palm oil mill wastewater has been identified as one of the largest contributor to the water pollution in Malaysia (2).

The screening process is necessary to remove coarse particles present in the slurry which if not removed can interfere with the settling process.

In the clarification tank the slurry usually requires 4 - 8 hours of residence time before the oil and water phase can be completely separated. Long residence time coupled with the heat applied to reduce the slurry viscosity cause the oil to be more susceptible to degradation.

In view of the increase of palm oil production each year and also a more stringent regulation on the quality of effluent discharged by palm oil mill, a new and more efficient system in CPO slurry clarification is necessary. The system will hopefully reduce the quantity of wastewater (less pollution) and oil loss especially during peak production period. So far, in palm oil industries, filtration is already being used in the olein-stearin separation in palm oil refinery. In the present study, filtration is considered for the separation of the oil and water phase of CPO slurry

where conventionally this process is conducted using sedimentation process in a settling tank.

The proposed filtration process of palm oil involves the separation of slurry directly from the extraction process without going through dilution and screening processes. During filtration two distinct layers of filtrate were formed, the oil and the water layer. These layers can be easily separated out because the solid content in the filtrate is now very low and its viscosity is reduced.

The coarse particles present in the unscreened CPO slurry could prevent the cake formed out of the filtration process from being too compact. This will reduce the possibility of the cake from completely blocking the flow of filtrate. In addition to this, it indirectly acts as a filter aid in the filtration process.

The determination of palm oil filtration characteristics were done using laboratory scale pressure filter at an operating temperature of 90°C. Several filter media namely felt, multifilament and three different grades of monofilament media (Nylon 70, Nylon 30 and Nylon 4) were tested to determine their suitability in palm oil filtration.

RESULTS

The composition of water, oil and solid in the slurry used for the experiment ranges from 36-47%, 43-55% and 7-14% respectively. The particles present in the slurry were divided into two categories; firstly, large particles consisting of up to 2 cm size of palm oil fibres and shells fragments and secondly, small particles that consisted of sand, vegetative tissues or cell and shell fragments varying from 0.9 - 110 microns, the average size of which is 20.6 microns (See Figure 1).

The flow of the filtrate indicated a decreasing pattern after a few minutes of filtration due to the formation of cake on the medium surface. The filtrate flow also depended on the pressure applied into the pressure chamber. Figure 2 shows the filtrate flow pattern relative to three different pressures. At high pressure a higher filtration rate was obtained during the initial filtration period. However, this rate dropped tremendously after several minutes.

Figure 3 depicts the plot of filtration rates using different filter media versus time. As expected, the monofilament media yielded the highest filtration rate when compared to the multifilament and felt

The fibrous particles and vegetative tissues found in the CPO slurry caused the formation of highly compressible cake. Table 1 represents the specific resistance, α , and the medium resistance, R_m , for all the medium that were tested during the experiment. For an applied pressure ranging from 4 - 6 bars, α varied from 0.2 -

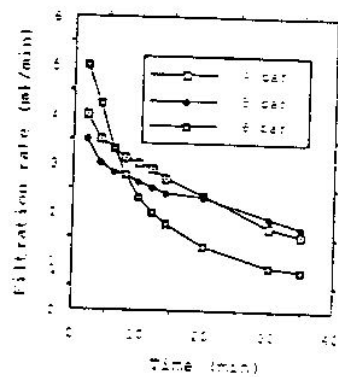


Fig 2: Filtration Rate vs Time at Different Pressure

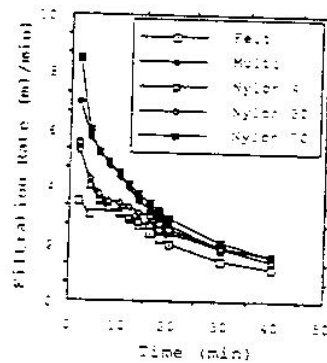
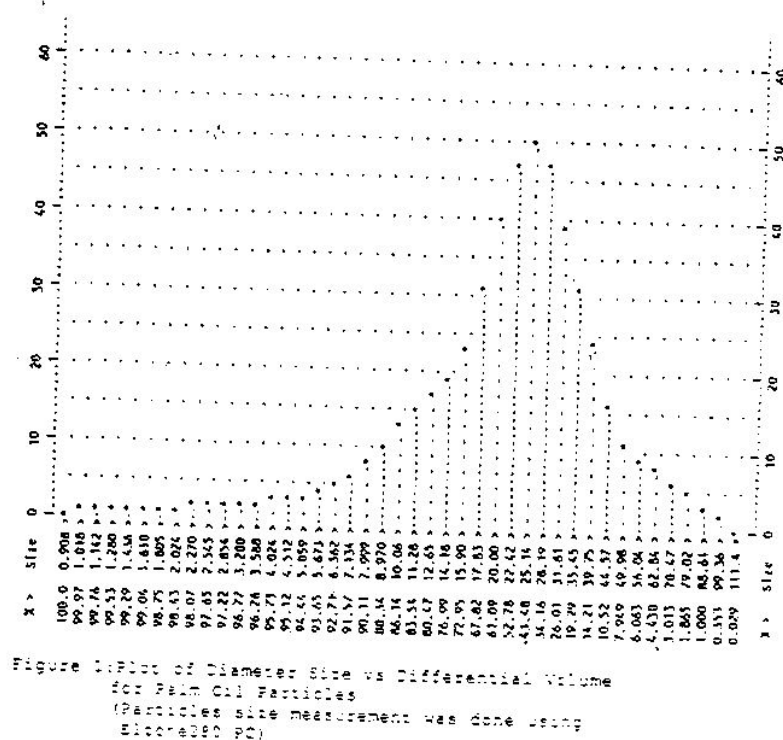


Fig 3: Effect of Filtration Rate vs Time Using Different Filter Media



$4.0 \times 10^{12} \text{ mkg}^{-1}$. The compressibility factor, n , of the palm oil cake has been found to be greater than 1 (3), indicating that the specific resistance increases as the pressure increases.

Despite the use of similar medium, the value of medium resistance fluctuated due to the deposition of particles into the pores and compression of the cloth fibre. A wide range of R_m could be seen in the filtration using felt medium because fine particles could be easily trapped inside the medium fibre.

Table 1: Specific Cake Resistance, α , and Medium Resistance R_m

Medium	$\alpha, \times 10^{12}$ (mkg^{-1})	$R_m, \times 10^{12}$ (m^{-1})
Felt	1.0 - 4.1	1.2 - 13.1
Multi	0.2 - 3.1	0.02 - 1.6
Nylon 4	1.1 - 2.5	0.08 - 0.9
Nylon 30	0.8 - 1.6	0.7 - 1.0
Nylon 70	1.1 - 1.8	0.1 - 0.5

Table 2 shows the quality of the oil and water layer of the filtrate produced in the experiment.

Table 2: Filtrate quality in Weight Percent

Medium	solid(%)	Oil Layer moisture(%)	Water Layer	
			Solid(%)	Oil(%)
Felt	0.04 - 0.09	0.7 - 1.2	0.1 - 1.0	0.9 - 2.9
Multi	0.7 - 1.7	0.8 - 4.1	0.8 - 2.4	1.1 - 9.7
Nylon 4	0.1 - 0.2	1.6 - 7.0	0.4 - 1.7	1.6 - 11.0
Nylon 30	0.06 - 0.1	1.1 - 6.4	0.2 - 1.9	0.5 - 13.0
Nylon 70	0.1 - 0.3	1.1 - 3.8	1.9 - 2.4	12.8 - 13.0

The Malaysian Standard (4) for the maximum content of moisture and dirt in CPO is 0.25%. It appears that the moisture and dirt content in the oil layer from the experiment was higher than the Standard requirement since it did not undergo a drying process after filtration. To comply with the Standard requirement, it is necessary to install drying equipment after the filtration unit.

The oil content in the produced wastewater was slightly higher for filtration using monofilament medium when compared to the other media. This was caused by the bleeding of solid through the monofilament media into the filtrate. It formed an emulsion layer between the oil and water layer which complicated the separation process. Even so, the solid content in the water phase of filtration process was lower when compared to the waste effluent from the conventional clarification method after undergoing desanding and centrifuging processes (1).

DISCUSSIONS

The proposed filtration process as an alternative to the current method of clarification has one distinct advantage, i.e. the reduction of the amount of wastewater produced by the mill. From this respect, the operating cost is reduced since the waste treatment process becomes simpler.

By using filtration the number of equipment in the clarification unit can be minimized as depicted in Figure 4. The elimination of screening and dilution process can reduce the oil losses and operation time. The elimination of dilution implies that smaller equipment sizes are needed as the volume of slurry to be processed is reduced.

The choice of a suitable filter media is one of the major concern in the filtration process. The selection of media for palm oil filtration should be based on:

1. The quality of filtrate produced - low content of solid particles in both the oil and water layer.
2. Good filtration rate
3. Low clogging
4. Easy cake removal and easy cleaning

However, in meeting all the criteria specified above, a compromise has to be made. Even though the felt media tested yielded the best filtrate quality, it exhibited the lowest filtration rate and possessed a very low used to clean ratio. This means that there is a high degree of clogging inside the medium pores which making it very difficult to clean (5). The multifilament or fine grade monofilament media is much more suitable for CPO filtration. It is not very thick and easier to clean.

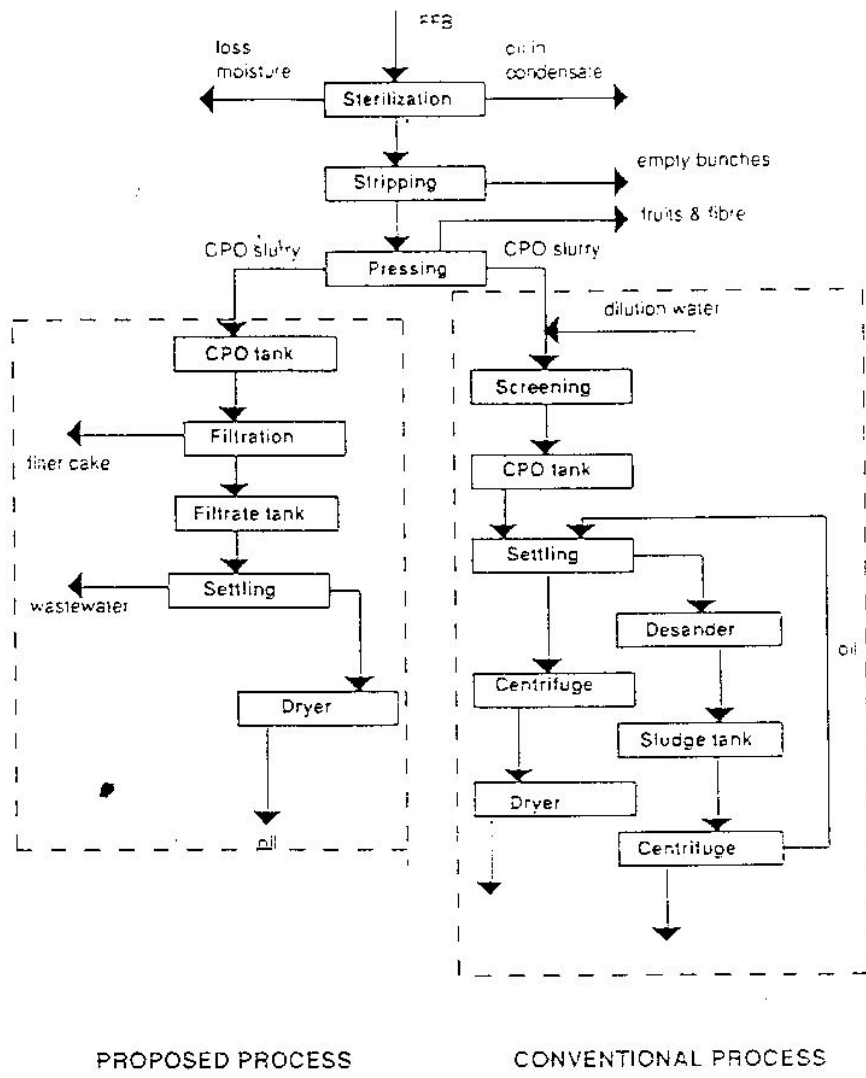


Figure 4: Process flowsheet of the propose and conventional process

One of the problems that has to be solved in palm oil filtration is the high content of oil in the filter cake. The cake contains about 16 - 18% of oil by weight which comprises about 7 - 10% of the total oil content in the feed slurry (6). Filter equipment which has squeezing mechanism or washing facilities may be used to reduce the oil losses to the cake. More research should be conducted to determine the suitable filtration technique for CPO filtration so that optimum production can be achieved.

The specific resistance of CPO slurry falls within the region of hard to filter material. Materials such as palm shell or fibre can be used as a filter aid to lower the specific resistance. Besides that, it can also reduce the blinding problem. Filter aid can also enhance the filtrate quality by trapping the fine particle which bleeds through the medium pores. In addition, it also protects the surface of the filter medium. By using the waste materials such as the shells and fibres, no additional cost is expected to be incurred.

CONCLUSIONS

Filtration can be used to clarify CPO because it produces a better filtrate quality, reduces equipment size and lower the content of pollutant in the wastewater. However, more research work has to be performed in order to determine the suitable technique of filtration to overcome several problems associated with filtration. For instance, the media blinding, sudden drop in filtration rate, high cake resistance and high oil losses to the cake.

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