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CRUDE PALM OIL CLARIFICATION BY MEMBRANE FILTER PRESS

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INTRODUCTION

The scope of providing new technologies in palm oil mills has broadened in recent years because of the demand to minimize the milling cost while reducing crude oil quality deterioration. Furthermore the water pollution abatement regulations now demand a more effective control strategy to treat waste water discharged from palm oil mills to meet the legal standards. Thus a new process called CONCEPT-P filter system which is based on membrane filter press technology is now available to meet these demands. The process was jointly developed by PORIM and CONCEPT Engineering Sdn Bhd and a pilot unit evaluation was successfully conducted in a palm oil mill with encouraging results.

PRESENT SITUATION IN CRUDE PALM OIL CLARIFICATION

In the conventional process of clarifying crude palm oil, the diluted crude slurry produced by mechanical pressing of the cooked fruitlets is settled in a vertical or horizontal clarifier. The oil layer which is separated from sludge under gravitational force occupies the top portion of the tank. The oil is then continuously withdrawn from clarifier by a skimmer. The sludge phase which is compacted at the bottom of the tank is comprised of water (83%), solids (7%) and oil (10%). The oil in the sludge phase is then recovered by a disc-stack centrifuge, leaving water and solid as final sludge. In all instances, hot water is used to improve the settling behaviour of oil particles while the disc centrifuge operations require water input to balance the process dynamics in the bowl. Under these circumstances, tremendous quantity of water is used and discharged into waste treatment plant. It is estimated that 430 tonne per day of waste water is discharged by a typical palm oil mill with throughput capacity of 40 tonne fresh fruit bunches (FFB)/hr (0.67 tonne for every tonne of FFB processed). The major contributors of liquid effluent are sterilizer condensate (12%), hydrocyclone water (5%), waste water from oil room (50%) and other sources including general washing water (33%). It is a well known fact that the raw effluent from the mills is highly polluted by the organic constituents. It is estimated that 30 kg of Biological Oxygen Demand (BOD), 65 kg of chemical oxygen demand (COD) and 25 kg of suspended solids are being loaded into the treatment plant for every tonne of FFB processed by the mill.

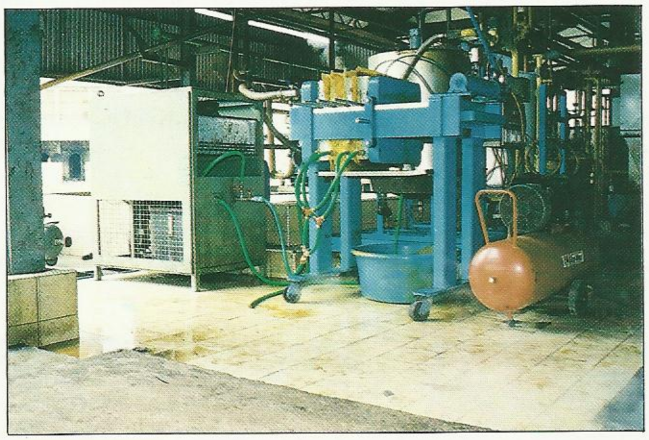

Figure 1. Pilot scale of a membrane filter press.

Another disadvantage of the conventional process is the slow settling rate of the oil particles which requires large settling area for effective oil separation. Standard design of oil clarifier allows oil to settle within 4 to 7 hours under the normal 30% hot water dilution. Under these circumtances, the oil is easily susceptible to hydrolysis, oxidations and other chemical reactions which deteriorate the final crude oil quality.

In quite recent developments, decanting centrifuges were used for solid recovery prior to oil clarification and also for simultaneous solid recovery and oil clarification. With the two phase type, the main objective of the process was to capture the organic solids responsible for high BOD load into effluent ponds. Attempts to apply the three phase decanter for simultaneous solid recovery and oil clarification have not been successful, since only 30% of the solids (as non-oily solid) were recoverable by the process. The heavy phase, while being somewhat reduced in BOD and COD by this process, still contains a high percentage of oil which has contributed to a certain degree of oil loss.

The other disadvantage of this process is that it requires high G-force, in the region of 3000 rpm of the bowl speed for effective oil separation from sludge which then resulted in tremendous wear and tear on the schroll components of the centrifuge. Continuous erosion of the schroll will gradually reduce the transportation rate of the solids, as indicated by the increase of solid content in the oil phase. Reconditioning of the schroll can be very costly and return on investment for such process is hardly justifiable.

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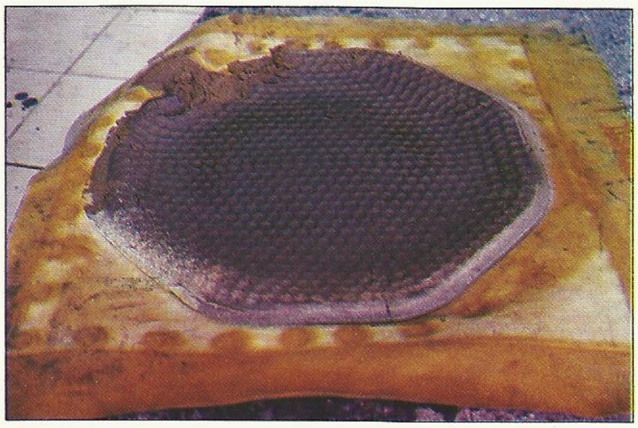

Figure 2. Filter cake.

Unlike other types of solid-liquid separation equipments which rely on centrifugal force or gravitational force to drive solid-liquid separations, CONCEPT-P membrane filter press utilizes filter cloth to collect almost all particles from processing streams thus eliminating the requirement for desanding and screening in the process. With this type of filter press, dewatering of crude slurry is affected in two steps, *i.e.,* filtration followed by squeezing. Generally, squeezing step is initiated soon after filtration has reached the terminal pressure. The membrane plates are generally designed to have cavities or voids in the plate adjacent to the dewatering chambers. The membrane chambers begin to expand when water or compressed air is introduced into it which squeezes the cake and drives additional filtrate out of the cake. Terminal squeezing pressure may range from 6 to 16 kg/sq.cm depending on the process requirements.

Our trial results indicated that oil losses in the cake ranged from 15% to 35% on dry matter depending on the squeezing pressure and squeezing time. Oil losses were further minimized by reslurrying the cake followed by refiltering the water phase after oil recovery. The cake is now drier than before and it contains less oil. It is estimated that this filter system was able to reduce the oil losses to 3.5 kg/tonne FFB (the conventional losses is 5.0 kg/tonne FFB). Moreover this system does not require sludge centrifuges for additional oil recovery step thus making the entire calrification process simple and easy to operate. Almost all the solids as non-oily solid were recoverable by the process (98 %). Therefore it helps in reducing the BOD to the level below 15000 mg/l. The cake which now contains less moisture (40%) is relatively easy to handle and it can be used as compost fertilizer when mixed with other solid wastes generated by the mills. The reduction in processing time offered by the system will definitely improve the oil quality.

PROJECTED ECONOMICS OF A FULL SCALE SYSTEM

Our scale-up design indicated that a full scale system may comprise 80 membrane plates of 1200mm X 1200mm . This system is designed for a 40 tonne FFB/hr with the total installed cost of approximately RM ..8 million. The cost is less if compared to the cost for the conventional system of the same milling capacity (RM 2.3 million). Therefore it provides 25% saving in oil room cost if the new palm oil mill is constructed with CONCEPT-P filter system. A payback period of 3-4 years is expected when the filter system is installed in the existing oil room set-up. The water after oil recovery can be recycled into the system thus reducing water requirement for the milling process.

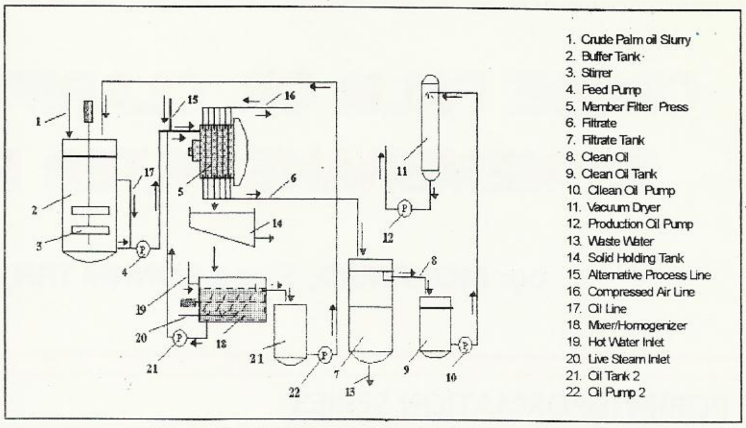

Figure 3. Process for clarifying crude palm oil by membrane filter press.

CONCLUSION

From our pilot study it can be concluded that the membrane filter press is a technically viable system for solid removal from the crude palm oil slurry while improving the overall oil recovery. The economics of the system as projected are cost-competitive.

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