FEATURE ARTICLES

EXTRACTION OF PALM KERNEL OIL

The palm kernels as produced from palm oil mills contain approximately 50% of oil and this oil is commercially extracted by two methods, i.e. mechanical expression or solvent extraction.

1. Mechanical Expression

Figure 1 shows the flow chart of a simple kernel crushing plant using mechanical expression. The process is relatively simple and consists of four steps as follows:-

i) Size Reduction

This is achieved by first passing the kernels through a hammer mill and then passing the discharge from the hammer mill to a set of rolls. The diameter of the rolls is generally between 200 to 400 mm with a width of about 1 metre. The first pair of rolls are generally fluted while the pairs that follow are smooth. By varying the speed of the individual rolls a tearing and crushing action is exerted on the kernel particles. The crushed kernel particles are generally referred to as "meal". The reason for size reduction is that the oil in the kernels is contained in a large number of oil bearing cells and the amount of oil that can be extracted is proportional to the surface area of the meal. Therefore, by reducing the size of the kernel the surface area is increased and so is the oil recovery.

ii) Cooking

This is the most important step as it serves to regulate the moisture content of the meal, render the cell walls porous thereby affording a better outlet for the oil, rupturing of the cell walls by steam generation within the cell and coagulation of the proteins so that the final step of filtration is made easier.

The cooker, or heating kettle, is generally an integral part of the expeller and consists of a steam jacketed vertical vessel divided into a series of horizontal compartments. Each compartment is fitted with an open steam ring and stirring arms. The meal is fed into the top compartment of the cooker and passes, progressively, down through the cooker until it as finally fed to the expeller. The temperature of the meal is maintained between 100 to 110°C and cooking time is about 15 to 20 minutes.

iii) Expelling of Oil

This is carried out by a continuous screw press, commonly known as an expeller. The expeller consists basically of a perforated cylindrical cage in which runs a worm or screw. The discharge end of the cage is fitted with an adjustable cone which restricts the discharge opening of the cage. The rotation of the worm transports the meal towards the outlet end of the perforated cage and as the outlet is restricted by the cone a pressure is built up in the cage thus causing the oil to be squeezed out of the meal. The internal pressure in the cage is regulated by adjustments to the outlet cone. The extracted oil flows through the perforations in the cage whilst the solid matter, or cake, is discharged from the opening around the cone. When efficiently operated the residual oil in the cake is small (between 5 to 6%).

iv) Oil Filtration

The oil from the expellers contains impurities such as dirt, insoluble carbohydrates, insoluble proteins,gums and resins, etc. If these impurities are not removed, fermentation will take place causing the oil to become rancid. The coarser impurities are generally removed by simply allowing the oil to settle and the coarse impurities, or foots, are returned to the cooker. The settled oil is then passed to a filter press. The filter press consists of a series of vertical plates and hollow frames mounted on two parallel horizontal bars and clamped together. The surface of each plate and frame are such that there is a perfect fit when they are clamped together. The hollow frames are covered both sides with a filter cloth and are clamped together, alternatively, with vertical plates thus forming a series of filter cells. An opening in the corner of each plate and frame serves as a feed channel into the filter cells. The outlets for the oil are arranged in the vertical plates.

The settled oil is pumped to the filter press and as the oil is forced through the filter clothes the sediments are collected on the clothes in the form of a cake. As the cake builds up the resistance to the oil flow increases and it is therefore necessary to increase the pumping pressure. When the pumping pressure reaches the maximum working of the filter press it is necessary to stop the feed to the press to remove the cake. After the cake has been removed the clothes are cleaned, the press reassembled and the filtration operation restarted.

After filtration the oil is pumped to the storage tanks

to await despatch to the refinery.

From the kernel crushing plant there are two products:

i) palm kernel oil and
ii) palm kernel cake ex the expellers. This cake is a valuable product for the animal feed industry.

2. Solvent Extraction

The solvent extraction process is more complicated than the mechanical expression method, see simplified flow chart given by Figure 2, and the cost of products per tonne of seed is normally higher but this can be offset by the higher percentage of oil recovery.

The process can be divided into four main operations as follows:-

i) Size Reduction

This operation is similar to the process adopted for mechanical extraction. (see paragraph 1 (i) above).

ii) Oil Extraction

This can be achieved by three methods:
(a) Percolation
(b) Immersion
(c) Combination of percolation and immersion

In the percolation process the solvent is first sprayed from the top of the vessel and allowed to trickle through the meal under gravity.

In the immersion process the seed mass, or meal, is completely immersed in the solvent and the phases separated after a certain time.

It appears that the percolation system is normally adopted by the Malaysian companies.

From the oil extraction process two products are obtained, (i) a wetmeal and (ii) a mixture of solvent and oil, normally referred to as "miscella".

iii) Separation of Oil and Solvent from the Miscella

This is usually carried out in three steps; filtration, pre-concentration, and distillation. The filtration step is to remove the fine solids. Pre-concentration is carried out by distilling under vacuum and the final distillation is carried out at a temperature of 100°C with steam stripping to remove the last traces of solvent from the oil. The oil is then pumped to the oil storage tanks and the recovered solvent returned to the system for further use in the oil extraction process.

The extracted meal contains solvent which must be removed, or recovered, to effect economies in the operations and this is normally carried out in a "desolventizer". The desolventizer works on the principle of heating and agitating the extracted meal until all the solvent has been evaporated off. The desolventized meal is then pelletised, bagged and then stored. The recovered solvent is cleaned and returned to the system.

3. Operating Cost Comparison between Solvent Extraction and Mechanical Expression

It is extremely different to make an exact comparison between the operating costs of the two methods but the table below gives census of the opinion.

	Processing cost ratio Solvent Extraction/ Screw Press	Per cent of total cost	
		Solvent Extarction	Screw press
Labour	1.78	35.0	22.7
Power	0.67	17.5	30.0
Steam	1.70	32.0	21.7
Maintenance, Repair	0.64	13.0	23.6
Supplies, expense	1.50	2.5	2.0
TOTAL	1.15	100.0	100.0

Supervision and depreciation charges, omitted from the table above, are probably similar for both types of plants. Insurance costs are higher for solvent extraction plants when an inflammable solvent is used, but this extra cost is too small to disturb the overall picture.

4. Final Note on Palm Kernel Oil Extraction

There are some kernel processing plants which use a combination of mechanical expression and solvent extraction.

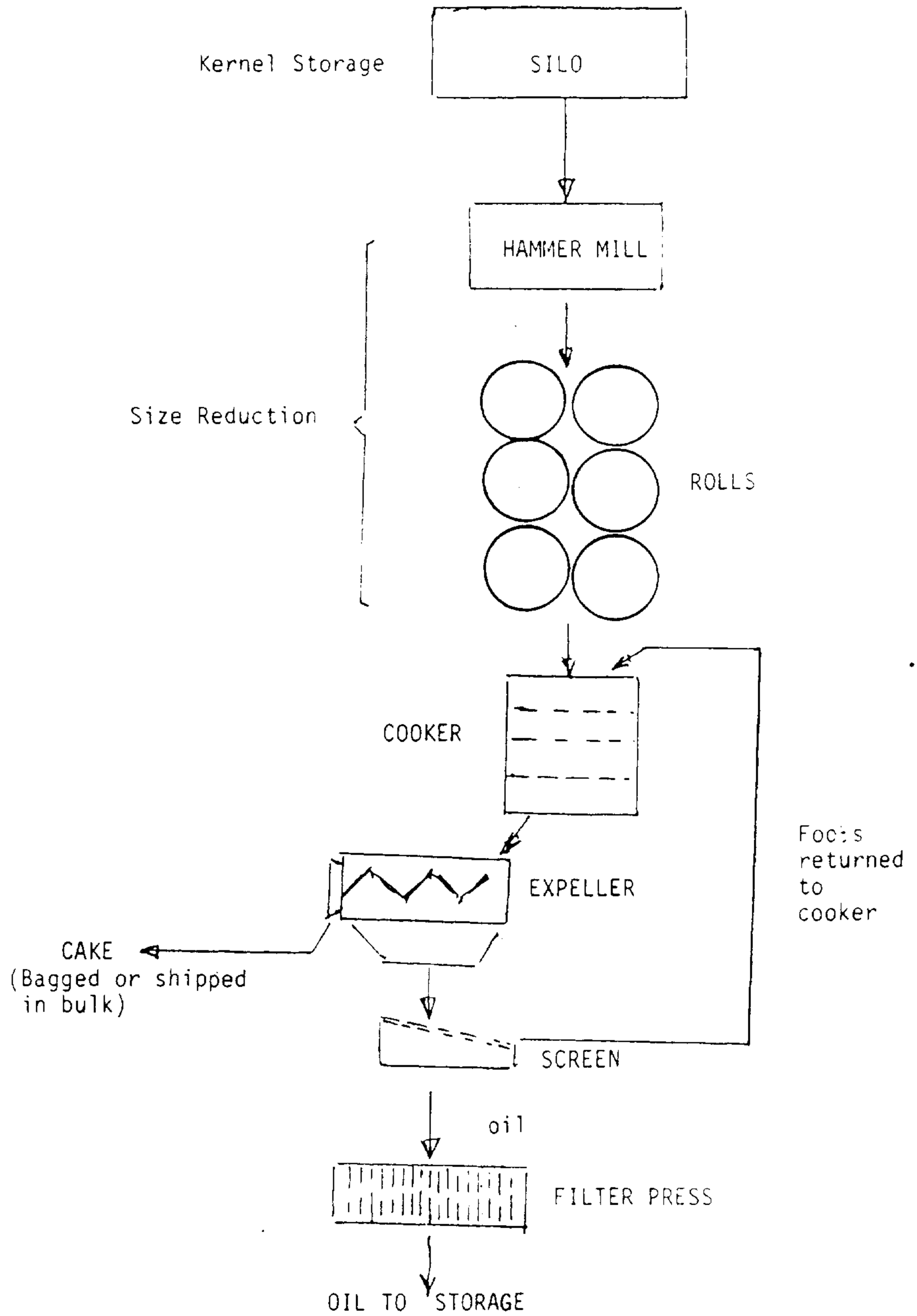
The first stage of the process is mechanical expression using low pressure expellers where the oil content of the expelled cake is approximately 20%. The expelled cake is then further broken up and then subjected to solvent extraction.

A comparison of the utility requirements between the various methods of production, based on the tonne of kernels processed, is given by the table below.

	Mechanical extraction	Solvent extraction	Pre-pressing solvent extraction
Utility			
Electricity, kwh	60 - 110	80 - 100	80 - 100
Hexane, lit.	nil	10 - 20	10 - 15
Steam (fuel) lit	0 - 9	23 - 25	20 - 25
Water, lit	0 - 140	400 - 600	400 - 600
Repair and maintenance, MR	$ 5 - 10	$ 4 - 8	$ 5 - 10
Products			
Palm kernel oil, %	40 - 43	44.5 - 46.5	44.5 - 46.5
Expeller cake/pellers, %	55 - 51	53.5 - 51.5	53.5 - 51.5
Losses, %	4 - 6	0 - 3	0 - 3

(J.H. Maycock)

FLOW CHART FOR SIMPLIFIED PALM KERNEL CRUSHING PLANT



SIMPLIFIED FLOW CHART FOR SOLVENT EXTRACTION PLANT