Future Milling Concepts or Idiosyncrasies? - Part 2**

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DIGESTION

Let us have a close look at the factors which are involved for good digestion of fruits. Many engineers and machine manufacturers do not appear to be in touch with the fundamentals when they design or manufacture fruit digesters. Even horizontal digesters have been manufactured and installed for fruit digestion. As all millers know too well that vertical digesters must be at least three-quarter full for proper digestion and it is preposterous for them to substitute vertical ones with horizontal units. Yet it is happening here. This is the second factor. The clearance between the digester blades and the body should as close as possible to ensure that all cells do rupture to release oil. Can horizontal units satisfy this condition? The third factor is the temperature which should be at least 90°C.

Consideration must be given to all the above factors when a digestion system is designed. If we are able to separate out nuts then we may come up with a different type of digester for the mash like a domestic kitchen blender that can rupture all the cells more effectively than the conventional digester. The sterilised fruit can be forced through a number of extruders of varying sizes but the nut orientation could pose a problem. Perhaps the mash could be forced through a pair of perforated rollers with curved blades like a potato peeler to capture the mesocarp but allow the nuts to pass through may work if sensibly assembled. Let us assume that the mesocarp peeler has been perfected, and all the mesocarp could be separated from the mash, the next step is to manufacture a dynamic digestion equipment to rupture all the cells in the mesocarp.

A machine similar to the kitchen blender with some modifications probably would do the job. As this machine can only work with some water it may be necessary to add water to it. After the blending operation if most of the oil has come out of the cells, the mash can be transferred to the press using a perforated screw conveyor. The residual oil in the mesocarp can be captured by the press.

The current digester design has ample opportunities for massive transformations. Like most other equipment in palm oil mills the digester design also could have evolved from the perception of a planter coupled with some non-professional input from a fabricator of sorts. Later of course Mongana researchers and Stork of Amsterdam among

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others undertook considerable research work to improve the design. But whether there was any lateral thinking for evolving an alternative system of digestion is unclear. The influential power of an existing system on an alternative system of thinking is something that is difficult to totally ignore. Therefore, let us look at some possibilities to improve oil extraction based on the fact that we try to extract most of the oil using the digester using the following hypothesis.

We are all aware that hot water can wash the oil out of mesocarp fibre and hot water is an environmentally safe solvent unlike hexane. Most of the digesters have steam heaters at two points at the lower half of the digester. If the top coil is used for steam heating and the bottom one for hot water flushing it may be possible to wash down most of the oil from the digester itself leaving very little work for the press screw. Most likely this flushing operation will remove most of the sand as well so that the press screw life can be extended. In addition, when most of the oil is removed in the digester the pressing pressure can be reduced resulting in less broken nuts. In theory it looks good but whether any one has tried out this modification is not known. But one thing commonly found in almost all mills is total absence of digester drainage. The drain pipes at the digester bottom are cold to the touch! That is not what anyone would expect.

DIGESTED FRUIT STORAGE

It was an error right at the beginning of mill mechanisation to place the press directly underneath the digester. Even the digester stirrer drive gear was located directly above the digester and when the greaser whose knowledge was limited to how much grease he can pump into the gearbox including the digester itself was his main focus with of course the disastrous consequence of hydrocarbon contamination of the palm oil. Why after so many years no one thought of placing all the digester away from the press is still a question mark. The advantages are: (a) it is easy to change the liners, (b) the liners can be pre-fabricated and pushed into the digester from the bottom using suitable jacks, (c) the digesters are not dedicated to individual presses and as such they can supply fruits to any press, and (d) possibility for all digesters to operate at full capacity.

All digesters can be clustered together in a neat array and deliver the digested fruits into a conveyor which can either convey them to a fruit silo or direct into presses as shown in *Figure 1*. Silos may present problems like clogging that could be difficult to clear if the silo size is large.

PRESSING

Presses can be made in large capacities - not necessary limit it to 15 t or 20 t capacity. The current screw press with double screws rotating in opposite directions might have actually evolved from single screw concept to satisfy high throughput.

It is possible to design and manufacture large presses. If I remember correctly some years ago I have seen a sketch of a press known under the brand *Strod press*. It was about four times the size of a P 15 press. It could probably give throughputs of even 60 t hr^{-1}. There is no legal limitation on the capacities of screw presses. The advantage would be fine adjustments like maintaining constant gap between the two screws so that oil loss in mesocarp fibre can be kept to a minimum. This can be accomplished by using self adjusting screw press. In addition, water dilution into the screw press also can be done using a hollow shaft instead of a solid one as is the case with the current ones. The screw scroll segments may be slotted into grooves machined on the shaft sleeve (like turbine blades) so that it will not be necessary to renew the whole screw during press overhaul. The oil gutter will be an integral part of the press and will be accessible from the press platform.

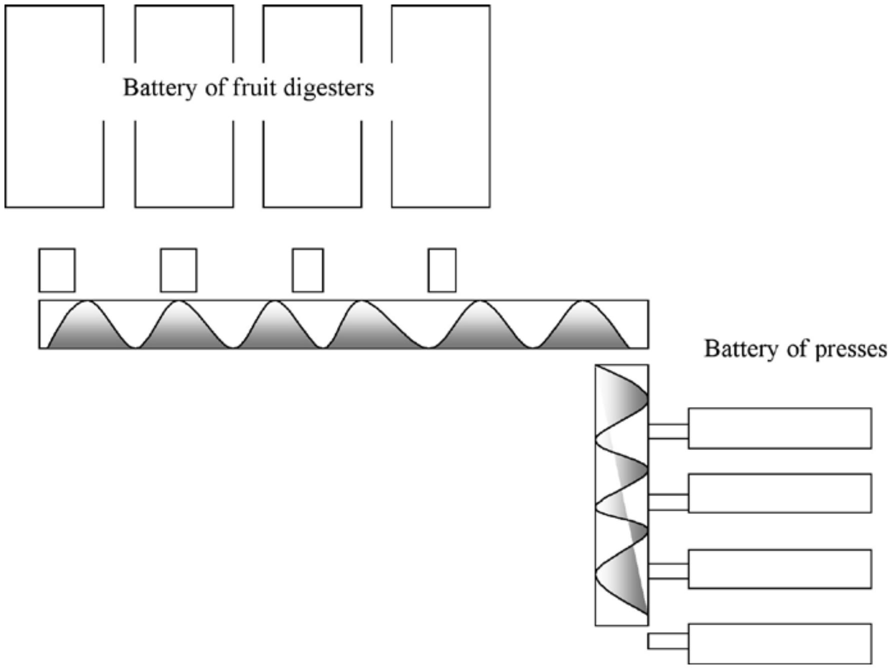

Figure 1. Clustering of digesters and presses separately.

Perhaps press manufacturers should consider a single press to cater the requirements of a mill in terms of throughputs. With this approach a number of additional features can be added on to the press like sensors to automatically vary pressing pressure on the mash to reduce nut breakage as well as to reduce oil loss in fibre.

All press components can be made accessible so that maintenance could be made simple. The presses can also be mono-screw type rotating within the stator fitted with adjustable restraining teeth. Probably this will be a better option than the former double screw press. From the design point of view a hollow shaft is better suited for taking shear stress than a solid shaft.

PRESS CAKE CONVEYOR

There is a lot to gain if we can heat up the press cake as it travels through this conveyor. During the seventies the press cake breaker conveyors were steam jacketed purportedly to heat up the cake. As it had no significant impact on the moisture content of the cake, the conveyor was forced to shed its jacket. The concept of removing the moisture level in the press cake was good and should have continued. Perhaps a small illustration would clarify the point.

Here is something to ponder. Press cake contains about 45% moisture by weight. In a 60 t FFB per hour mill the moisture transported by the press cake conveyor would be 60% x 13% x 45% = 3.5 t hr^{-1}. If 2.3 t of moisture can be evaporated using flue gas the moisture load on the conveyor can be reduced to 1.2 t. The heat required for the evaporation would amount to 2300 x 2258 kJ or 5193 MJ (enthalpy of evaporation at 1 bar, h_{fg}= 2258 kJ). If this is done, the de-pericarp fan and its drive motor sizes also could be reduced significantly. The flue gas temperature at about 290°C is still substantial when it leaves the stack. A counter flow of the gas through the conveyor could also trap some of the particles before the flues gas leave the conveyor.