Future Milling Concepts or Idiosyncrasies? - Part I

N Ravi Menon*

INTRODUCTION

The contents of this article are intended to offer to the industry discussions of some imaginary mill design concepts that should not be taken too seriously as they are far from perfect. It may even be qualified to be termed idiosyncrasy but even then it will still serve the purpose of tickling the intelligence of our mill engineers who are no doubt quite innovative. This is only a simple offshoot from the mind of a palm oil mill engineer based on his years of experience in the industry reinforced by his research exposure in the Malaysian Palm Oil Board, a combination very few people will have the opportunity to be blessed with. When writing this article, I tried my best to totally remove all the knowledge I have on existing methods of milling operation to prevent my current thinking from being skewed towards it. Perhaps this exercise itself may merit the credentials of a research work. In order to simplify this exercise, the system boundary and mill compound fencing shall be the same so that activities outside the mill like plantation operation and effluent treatment may be excluded.

* *Malaysian Palm Oil Board, P. O. Box 16020, 50720 Kuala Lumpur, Malaysia. E-mail: nravi@mpob.gov.my*

PROCESS STEPS

FFB Weighing Bridge

Can we do away with weighing? Probably not, as this weight is the basis for many computations including the very important oil extraction rate (OER). There is room for improvement like automatic data capture by the mill computer. The fresh fruit bunch (FFB) consignment lorry driver can carry an electronic card with information on the lorry, the field number, estate and bunch numbers, *etc.* that when swiped will transfer data to the mill computer. Simultaneously the data can be transmitted to the estate where the data can be processed. The crop quality data can also be transferred to the card by the crop quality checker using a small computer. During weighing out, the card can transfer crop quality data into the mill computer system to make the transaction complete. This way there is no manual input of data except the crop quality data and the information is instantly transferred to the estate. Similar systems can be organised for crude palm oil (CPO) and palm kernels.

Loose Fruit Segregator

It is pointless to torture the loose fruits in a thresher. It has no business to be in there. Many mills have devised systems to separate loose fruits from bunches but for some reason they failed to attract the industry despite consensus by some millers that loose fruit segregation to bypass the thresher has its merits. If the segregation is done in the estate like packing them in poly propylene bags which used to be the norm during the early days of the industry, the problem would have been solved amicably. As the fruits were hand picked they used to be free from trash. Now with shovel scooping of fruits they carry along with them substantial amount of sand as well; certainly not a satisfactory approach. As a lot of trash accompany the bunches there is a great advantage in cleaning them before the commencement of process operation. This applies for loose fruits as well. Therefore what is required is a system that can clean and segregate the loose fruits from bunches. Water washing is a popular way of doing this but will introduce a large quantity of effluent and hence is not practical. What if bunches together with loose fruits are allowed to roll on an inclined belt and land on a vibrating grill with sufficient gap for the loose fruit to slide through? The grill also can be fitted with a powerful air blast system with air velocity of about 25 m^{-1} (need to evaluate this by trial and error) so that some fruits also can be forcefully detached. It is shown in *Figure 1.*

Bunches can be transferred to thresher units, while the loose fruits also can be transported separately to the cages where it can be evenly distributed. This treatment should ensure the removal of the trash and at the same time separation of the loose fruits from bunches. The sketch may not give the exact process flow but suffice to demonstrate the principles involved.

Sterilization/ Cooking

Cooking is an important process parameter as insufficient cooking will affect oil extraction rate. When steam is admitted in a conventional horizontal sterilizer, it does not occupy the entire space in it due to the presence of large quantity of air within it. This air is indeed something which interferes with the cooking process. Every engineer knows only too well that air is a poor conductor of heat and despite that knowledge it is surprising that over a period of many decades now, the industry has not made any inroads solving this

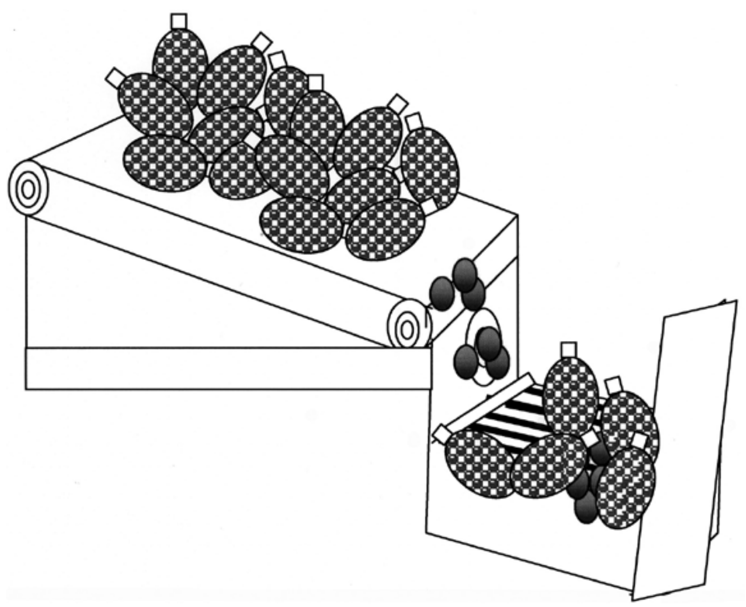

Figure 1. Loose fruit segregator.

see page 31

from page 26

seemingly simple and technically essential full de-aeration from the steriliser chamber so that our sterilisation is unaffected by the impact of Dalton's Law of Partial Pressures. There are many ways of doing this but probably the best is the air ejector system normally used for water de-aeration. It is shown in *Figure 2.* The present de-aeration system can be modified so that steam can be used to create a vacuum and de-aerate the steriliser. This requires higher pressure steam like 20 barg. But large quantities of low pressure steam like the steriliser exhaust steam may still be able to de-aerate the steriliser. No one seems to have tried it out. The proposed system is shown in *Figure 2.*

The above concept probably could help to tickle the imagination of young engineers who would like to be the architect of future processing systems. It would be ludicrous for us to conclude that the processing technology has reached its zenith with no room for any further advances and in 100 years from now it will remain unchanged.

Effective de-aeration of the steriliser will be of immense help in ensuring fruit detachment. Bunch crushing and double stripping is akin to fighting the consequences of an erratic cause which is improper sterilisation. This again can be traced to poor sterilisation resulting from a low effective steriliser pressure caused by the partial pressure of air and steam which drags down the saturation temperature of the steam to possibly below 130°C. For proper sterilisation the recommended temperature is 130°C for a minimum period of 30 min. If we install a thermometer on the steriliser perhaps we can get a better glimpse of the temperature profile in the steriliser. Some mill have done this.

The water filled vertical or spherical sterilisers may be able to create a partial vacuum when the water is discharged from the bottom without any external aid. The principle is sound but the possibility of the generation of additional effluent could negate the advantages. But it is worthwhile to have a serious look at this.

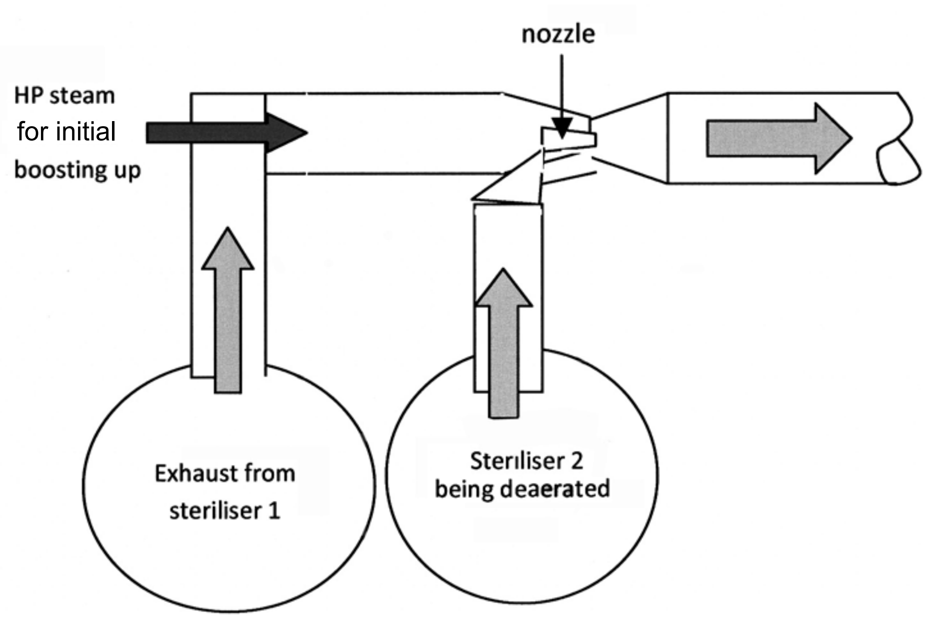

Figure 2. Untested conceptual systems - for mental exercise.

Threshing

Threshing has undergone two design changes: (a) beater arms and (b) rotating drums. Rotating drum lets bunches drop six times with each drop moving bunches forward by about 30 cm (1 ft). If the drum is overloaded they may absorb more oil than they should resulting in high oil losses in empty fruit bunch. So as the present set has a weakness that will cause oil losses we need to look at another way of stripping bunches. In the rotating drum stripping bunches are lifted about three-quarter way up and dropped. Look at some new concepts.

Horizontal mechanical flinger (HMF). If we feed bunches at one end of a rectangular metal chamber and they are thrown mechanically say at 45^{o}C to the opposite side and this bouncing action across the wall is repeated six times the stripping action could achieve the desired results with probably less oil absorbed by empty fruit bunches. The stages could be increased until all bunches are stripped. A scrapper bar chain conveyor at the bottom could evacuate bunches while free fruits could drop into a screw conveyor located underneath.

The flinger mechanism can be designed using two sets of cam shafts driven by geared motors mounted on the sides and their motion could be synchronised. A rough concept sketch is shown in *Figure 3*. If the velocity of the projectile is high perhaps even three flings should be able to give an efficient stripping.

Vertical gravity flinger (VGF). If bunches are allowed to forcefully drop through a vertical ducting having some side obstructions on its path bunches can be stripped. The drop may be given an initial

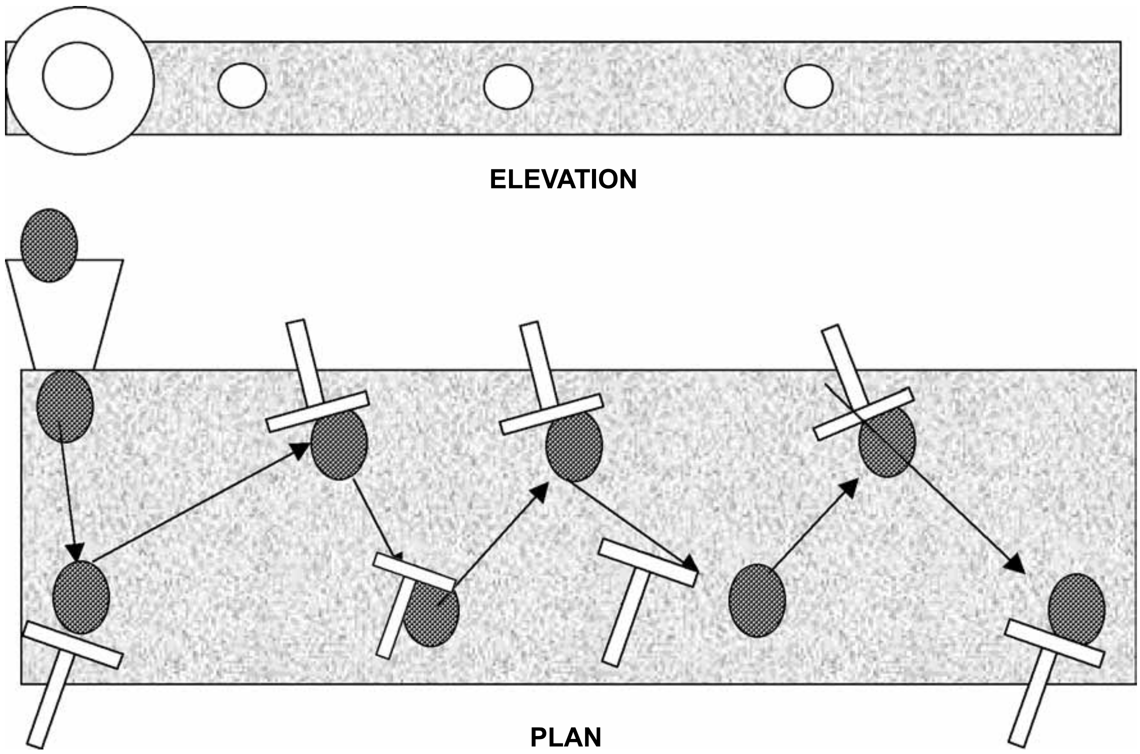

Figure 3. A mechanical bunch flinger showing the trajectory of bunches.

mechanical fling followed by gravity feed at an angular direction so that bunches will be hurled from one side to the other gradually dissipating the potential energy as bunches descend down. The expected height of the ducting is 6 cm to match the drop in a rotating drum system. It would be a good idea to impart a mechanical boost to bunches as they enter the flinger so that much of the stripping will take place at the first few stages. This is shown in *Figure 4*.

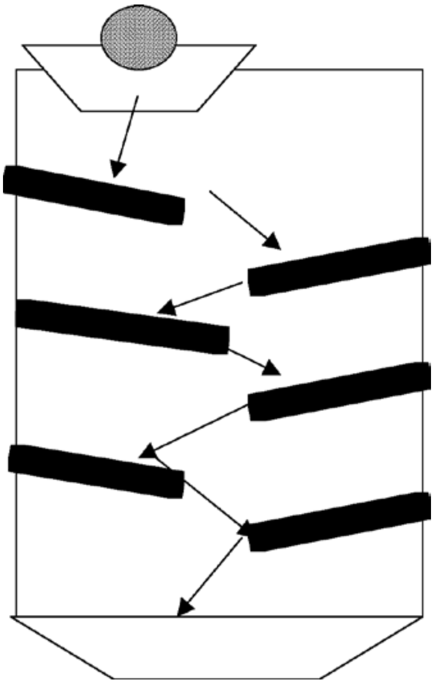

Figure 4. A vertical gravity flinger showing the trajectory of bunches.

Centrifugal mechanical flinger (CMF). This is quite similar to the chicken de-feathering device used by the poultry farm. It is shown in *Figure 5.*

In the CMF system driven by a motor, bunches are fed at the annular space surrounding the motor and they are hurled at the wall of the flinger at a high speed resulting in complete stripping of bunches with one throw. The speed has to be adjusted to give optimum performance. If there are still a high percentage of unstrapped bunches they may have to go through a second stripping action. The CMF is bound to occupy a large space. The overall diameter may be expected to even reach 3 m. There is certain level of flexibility in this with regard to performance improvement by simply altering the speed of the motor. Worth trying it out.

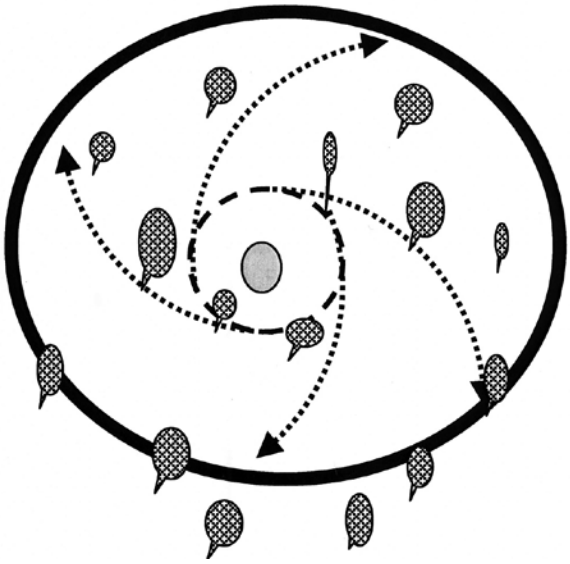

Figure 5. Centrifugal mechanical flinger.