Feature Article

Palm Oil Mill Innovation for Improved Efficiency, Based on Creativity and Profitability

Krishna Moorthy Palanisamy*

'THE DREAM MILL'

Can life for palm oil mill managers and engineers be (ever) made 'easy'? Actually, yes with a solution that is both easy and simple. Just picture this managers and engineers focusing on mill processes and production matters rather than tending to persistent mill utility issues. This will lead to enriching their daily working life and enhancing the core business of their company.

The current technological innovations and developments have no doubt given some boost to the palm oil mill operations. But new technologies have also emerged in recent times that can be profitably employed to re-engineer the design of existing palm oil extraction processes to achieve the desired results.

With The Dream Mill, mill managers and engineers can spend valuable time (a key scarce resource) focusing on mill processes and production:

- optimal process parameters
- extraction efficiencies
- product qualities
- product losses
- process energy efficiencies
- production scheduling

Instead of concentrating on regular daily chores involving non-productive processing issues such as:

- poor quality crop
- inadequate process steam
- high oil losses
- black boiler stack emissions related to Department of Environment (DOE) issues
- insufficient power
- insufficient labour
- machinery break down
- fuel shortage

The crude palm oil extraction process prevalent in the palm oil mills today was originally expounded in the Mongana Report (Congo Palm, 1955). As this process technology still appears to be remaining stagnant, it needs radical changes befitting

* *MECC Engineering Sdn Bhd*
1, Jalan Setia Nusantara U13/19A, Eco-Park, Setia Alam, 40170 Shah Alam, Selangor, Malaysia.
E-mail: krishna@rank.com.my

the current technological development that is taking place around the palm oil industry. Palm oil mills appear to be in a world of its own unaffected by the development of numerous technologies that can be adopted for its own improvements.

New innovative technologies involving process steam utilisation are incorporated to surpass the initial performance levels of certain processes. The source of long-standing mill performance issues can be traced to inefficient deaeration together with inadequate steam pressures in the sterilisation process. The proposed technologies provide the impetus for a new paradigm for the development of a modern palm oil mill design criteria.

Today, new drop-in-place technologies that have compelling ease of use, cost and carbon advantages are available to revamp existing mills. These innovative methods and systems are engineered to address the issues of inefficient deaeration and batch effects of sterilisation because these are the root of the causes and large fluctuations in steam demand and frequent blow off from the steriliser and steam receiver relief valves. Once these drawbacks are resolved, sterilisation in the horizontal steriliser can regain its superior performance.

The steam optimisation technologies offer several benefits for the boilers as well as sterilisers. Firstly, as the steam demand is successfully reduced, it can be met satisfactorily by existing over-stretched steam boilers and consumption of less amount of fuel. Secondly, the constancy of process steam demand allows for a stable boiler operation enabling compliance with regulatory boiler stack emission limits. Thirdly, the boiler plant maintenance issues and downtime are reduced.

The fourth significant advantage of the new technologies is that having boilers rendered a near steady-state operation; they become amenable for full automation of their operation. Automation can now facilitate control of the boiler plant including furnace draft and fuel feed systems.

The above mentioned advantages can relieve mill engineers of the major problems they encounter in their daily work at their mills — high count of unstripped and overripe bunches, inconsistent process temperatures due to fluctuating process steam pressure, inability of the turbo alternators to cope up with the process steam demand, black smoke emission from boiler stack, or lack of boiler fuel especially during low-crop seasons. Other pressing issues such as increasing environmental concerns and regulations, and skilled manpower shortages affecting boiler plant operation can now also be effectively addressed.

Relieved from being bogged down by mill utility issues, mill managers and engineers are now free to devote more time on process performance issues like quality of the finished products, product losses and extraction efficiencies

With the new technologies in place, the mill engineers have more time to attend to their core business activities as they are finally relieved of disruptive utility chores.

It is estimated that The Dream Mill could slice up to two fifths of its energy demand with the new design.

'AIR-VOID'

The 'Air-Void' system is a drop-in-place retrofit equipment designed for the deaeration of sterilisers air — a very innovative and scientific operational system incorporating sound thermodynamic principles to ensure maximum thermal efficiency. Heat transfer from the steam to the bunches had always been a persistent problem faced by the fresh fruit bunch (FFB) processing industry from the infancy of the industry itself. The air occupying the large vacant space within the steriliser is a very bad conductor of heat that initially forms an insulation layer between the FFB and the steam until through

diffusion heat transfer could be established but the air pockets within the bunch may still be present as it is continuously released by the bunches when they are subjected to heating. The deaeration of the steriliser is a very important operation as without which the steriliser temperature will remain far below the saturation temperature of the input steam due to the lower partial pressure of the steam in air/steam mixture. Until now this problem still remains unresolved despite the availability solutions overcome it. The important factor is to recognise that inefficient deaeration is the main weakness of the existing system.

The steam management and boiler operational issues at palm oil mills continue to remain problematic and have yet to be satisfactorily resolved. The root cause can be traced to the inefficient method of air removal at the steriliser station.

The Air-Void technology has been created specifically to solve the above-mentioned problem of inefficient air removal that is both serious and still prevalent in palm oil mills. The steam management system has hardly seen any significant improvement and the technology have remained stagnant for many decades. Research activities of the industry seem to have been mainly centred on downstream applications.

The effective evacuation of trapped air in the steriliser vessel at the onset of the sterilisation process is critical to ensure achieving the right heat treatment of palm fruits. However, many palm oil mills operating conventional horizontal sterilisers employ air release methods that are not efficient. At present, the trapped air is released through diffusion by using multiple steam pulses, during which the steriliser vessel experiences fluctuating steam pressures. This invariably leads to the excessive process steam consumption and a long process time to meet contemporary sterilisation requirements. A further consequence is the reduced throughput of the sterilisation station.

By addressing the issue of inefficient residual air removal that is the basis of inefficient steam usage at the steriliser station, the following attendant problems can be resolved:

Wasteful steam usage at the mill

Inefficient residual air removal method employed during the sterilisation cycle results in wasteful steam consumption and highly fluctuating steam demand at the steriliser station, a common problem plaguing palm oil mills today. This leads to frequent large draw-down of live steam from the boiler through the make-up valves bypassing the non-condensing steam turbine to meet the rising steam demand, and steam blow off during low steam demand periods. This gives rise to further steam loss at the mill increasing boiler load and consuming large amount of fuel to raise the steam.

Boiler operational woes

The widely fluctuating steam demands required by the sterilisation heating cycles tend to exert onerous load demand on the boilers. The resulting instability of the boiler operation can result in 'black smoke' emission from the boiler stack, a clear non-compliance operation not lightly taken by the regulatory bodies. Added to this are related boiler plant maintenance issues and prolonged boiler downtime hours.

Insufficient and inconsistent process steam pressures

The above two problems usually co-exist throughout all the mill operations affecting process efficiencies in each stations. The excessive and fluctuating steam demand of the sterilisation process causes varying pressure in the back pressure vessel, which in turn leads to inconsistent process steam pressure across the mill.

The Air-Void solves the above problems by allowing quick and efficient air

removal from the steriliser vessel through a novel steam flushing method right at the very start of the sterilisation cycle. The air-removal phase ensures that the steriliser atmosphere is almost void of air. The results are dramatic; adequate thermal treatment with:

- a shorter time for sterilisation,
- lower temperature process steam, and
- a lower steam consumption.

The above three outcomes translate into drastic improvements in process steam management and equipment capacities.

Fitting conventional horizontal sterilisers with the innovative fast-acting Air-Void offers several advantages and contributes to overall improved process efficiencies and performance as elaborated below:

Easy, seamless and relatively inexpensive integration

Seamless integration with existing conventional horizontal sterilisers, making expensive infrastructure investments is unnecessary. It is a viable solution for palm oil mills of all sizes.

Speedy solution

A swift drop-in-place retrofit solution that precisely fits the application without the need for any field engineering or fabrication. Existing steam connections can be used without modification so that commissioning is quickly and easily carried out.

Enables compliance with DOE regulations

Assists compliance with strict environmental legislation for steam boilers by avoiding boiler load swings and furnace combustion upsets which lead to 'black smoke' from the boiler stacks at the mill.

Environmental legislations demand ever-stricter efficiency and control of emissions from industrial boilers and other power plant processes. For example, the DOE in Malaysia has recently introduced stricter stack particulate emission limits requiring operators to carry out online continuous monitoring of their emission parameters, whilst other countries' legislations are equally onerous.

Maintains operation of existing boilers at design parameters

Maintains the operation of existing boilers at design load factors that brings about improved fuel feeding and boiler draft control. These are the pre-requisites for clean combustion and reduced stack emissions, which lead to dramatic cost savings.

Enables boiler automation

Boiler controls become amenable for full automation once boilers are rendered near-steady-state operation. Automation can now facilitate control of the boiler plant including furnace draft and fuel feed systems.

CONCLUSION

The Air-Void is a drop-in-place retrofit solution that addresses critical steam management issues present in today's palm oil mills that is affordable, quick and easy to implement. It tweaks the performance of existing horizontal sterilisers to unprecedented levels of efficiency and productivity. It makes the horizontal steriliser far superior in terms of steam usage when compared with other types of sterilisers, for example, the vertical steriliser and the continuous steriliser.