Feature Article

Milling Laws

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INTRODUCTION

During process operation there are many basic principles which should be adhered to in order to operate the mill efficiently. Do you know that a large volume of oil is lost in the sludge water simply because the oil filled cells were not ruptured to release oil?

The oil extraction rate (OER) of the mill can be raised quite easily if only certain simple procedures are followed. They are now documented under the code of practice (CoP). They are given in *Figure 1* in a consecutive order so that it is easy to comprehend the correct flow from upstream to downstream. There are seven of them. Millers have to depend only on one upstream activity, *i.e.* good estate practice.

Law No. 1: No Loose Fruits Shall be Left in the Field after the Day's Delivery of Crop

Loose fruits. The fresh fruit bunches (FFB) delivered to the mills shall have all the missing loose fruits in order to increase the mill OER. Every one knows it but no one seems to recover the lost fruits as there is not enough emphasis given to it. Full loose fruit recovery is capable of increasing OER by a minimum of 2%. Probably every one in the industry is aware of this.

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Law No. 2: Fruits Shall Not be Unloaded on Hopper Apron under Any Circumstances

Hopper apron. During FFB reception the fruit shall not be dumped on hopper apron. If dumping is done year after year for decades something must be fundamentally wrong with the mill management or the owners. The fruits get crushed by the tractors and ground into a paste that can only damage the cement rendering of the hopper apron. Palm fruits with the highest oil content are the ones being abused in the mills. If the hoppers are not sufficient in number why the mills are not adding on the hopper say, 5 units per year so that exorbitant capital layout is not necessary? Whichever way a palm oil consumer look at it he will find it is totally unacceptable. Fruits have to be treated more gently as it is an edible product like apples and oranges.

Law No. 3: The Best Sterilizer Design Shall Have the Least Empty Space

Poor heat transfer. At low temperatures cell rupture is unlikely to be effective as compared to high temperature operation. A good temperature is 130°C for at least 30 min. This can be obtained from steam at 4 barg (saturation temperature 143.6), if there is no air in the sterilizer. As more than half of it is filled up with air, the effective temperature will correspond to 3 barg or even lower than this, based on Dalton's Law

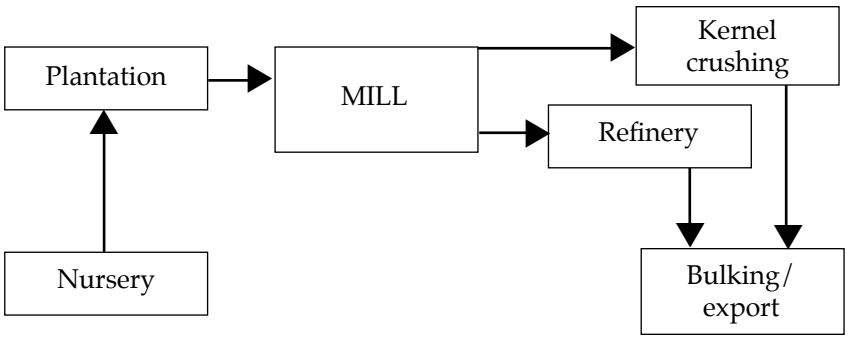

Figure 1. Flow diagram of the palm oil industry.

of Partial Pressures. Let us look at the much talked about Dalton' Law, the pressure of a mixture of gases is equal to the sum of the partial pressure of the constituents. The air pressure at atmospheric pressure is 1.013 bar and the pressure of steam is 4 barg. If each of them occupy half the space in a sterilizer, the partial pressure of the steam would be:

$$1/(1+1) \times 4 = 2 \text{ barg}$$

The steam temperature within the sterilizer would be corresponding to the saturation temperature at this pressure, *i.e.* = 120.2°C. This is clearly not sufficient for efficient sterilization of bunches. This also brings to our mind the following important law.

Law No. 4: Air Released by Bunches Must be Evacuated Continuously to Maintain Good Heat Transfer to Bunches

Continuous air release. In order to address the problem of having the least air occupation within the sterilizer chamber, the air should be discharged, as much as possible, during the first two peaks of the sterilizer cycles (de-aeration cycles) followed by a constant discharge through the condensate valve by-pass line. Air is continuously discharged from the bunches as they are heated by steam and this air must be evacuated for improved heat transfer. This generates another law.

Law No. 5: The Requirement of Different Sterilization Regimes for Crop of Different Ripeness Shall be Strictly Adhered to

Sterilization. Sterilization time also is critical. If the crop contains too much over-ripe crop make sure the sterilization time is adjusted down so that oil is not lost in the condensate. Three sterilization regimes are generally provided in the sterilization auto control setting to cater for under-ripe crop, normal crop and over-ripe crop.

Law No. 6: Stripper Bunch Feeding Shall be Even and Well Regulated

Stripping. During the stripping operation, millers do not seem to be paying much attention in enforcing a constant feed of bunches into the stripping machine. One of the highest oil losses occurs in empty fruit bunches and most mills do not even measure this loss either because of the unreliability of the results or the difficulty encountered in performing this gruesome task. Stripper feeder should not be overfed with bunches resulting in build up of bunches as this will encourage bunches to absorb oil. The feed must be even and regulated even if this calls for a long feed conveyor.

Law No. 7: The Digester Stirrer Blade Tip Clearance Shall Not Exceed 6 mm

Digester blade tip clearance. This happens in all mills due to poor knowledge of the engineers about the principle of digestion.

It is imperative that the digester remains circular at all times. But during the renewal of liners at the bottom section of the digester, body looses its concentricity due to distortion caused by welding. When this happens the blade tip clearance with respect to the digester body may run to several centimeters and this is detrimental to proper fruit digestion as the fruit will take a short cut impairing digestion. Most mills do not seem to think that this is a very important criterion for proper processing. The solution lies in fitting in completely built up concentric sections into the sterilizer body. This can be easily done if all sterilizers are located in a separate area away from the presses so that the liners can be inserted from the bottom. After fitting the stirrer blade assembly, the blade tip clearance should be as low as possible, *e.g.* 6 mm so that the fruits can not slip past the blades.

Law No. 8: Too Much Oil in the Digested Mash will Not Allow a Good Pressing as the Fruits will Become Slippery during Pressing

Digester drainage. Maximum oil drainage form the digester would ensure that the press cake is (1) not slippery while being pressed, (2) reduces high nut breakage as low press cone pressure is sufficient for pressing. In most mills, the digester drain pipe remain cold as they are often choked with fibre. A large box type drainage system will promote digester drainage. The mill work shop can easily fabricate this.

Law No. 9: Over Dilution Raises Absolute Losses and Also Effluent Production

Water dilution. Many engineers do not seem to appreciate that the absolute oil loss in sludge water will increase with increased dilution. Therefore caution must be exercised when performing dilution on crude oil. Indiscriminate dilution will cause additional losses in sludge water. This is because the oil loss in the sludge water, ex-separator remains constant irrespective of the oil content in the sludge input to the separator.

Law No. 10: A Modified Crude Oil Tank Capable of Creating a Laminar Flow Regime is Desirable for Improved Separation of Sand from the Crude Oil

De-sanding crude oil. Most of the sand must be removed from the crude oil before the crude oil is subjected to clarification as it may interfere with proper separation of oil from the sludge. If space permits a long tank with many compartments will be a good investment as it can trap much of the sand when there is laminar oil flow. The present tank has too short a retention time to present a laminar flow regime.

Law No. 11: Use only Positive Displacement Pump for Crude Oil Pumping. Centrifugal Pump Causes Emulsification of Crude Oil

Crude oil pump. The most appropriate pump for this is the positive displacement pump that does not promote the creation of emulsion as is experienced in a centrifugal pump. It is difficult to separate emulsified oil from the sludge.

Law No. 12: Before Clarifying Crude Oil Remove as Much Solids as Possible from it Using a Decanter

Decanter. Before clarification of crude oil remove the solids from the crude oil using a decanter. This will improve oil separation.

Law No. 13: Reduce as Much Oil in the Clarifier Underflow as Possible to Reduce the Overall Oil Loss Sin the Clarifier

Clarification tank. Install a small stage 1 clarifier where most of the oil can be recovered followed by a coil heating chamber before crude oil is fed into the clarifier proper. This way, the oil in the underflow of clarifier proper is considerably reduced. The preheating chamber ensures that the crude oil temperature is maintained at above 90°C.