Design and Revamp Guidelines for Palm Oil Stripper Columns

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16 July 2023

Introduction

The palm oil industry has emerged as one of the vital manufacturing sectors in the world. Further, it has gradually become the most abundant traded vegetable oil in the world, owing to the growing demand.

Palm oil processing refers to the extraction and refining of palm oil from the fruit of the oil palm tree (Elaeis guineensis). Palm oil is widely used in various industries, including food, cosmetics, and biofuel production.

The crude palm oil is gathered from the mesocarp (seed) of the palm oil. However, the crude palm oil that has been extracted contains unwanted impurities and requires a purification process to partially or eliminate them to produce edible oils, mainly cooking oil.

In the current scenario, palm oil is widely used in tropical countries in Southeast Asia, Africa, and parts of Brazil for cooking purposes. Further, due to its low costs and oxidative stability, palm oil has grown popular in these regions.

As mentioned before, crude palm oil that is extracted contains impurities that require a purification process to improve the quality, physical appearance, oxidative stability, and other properties. The impurities are removed at a processing plant, and thus, it is essential to ensure that the plant is modern and equipped with advanced technologies to make the process efficient.

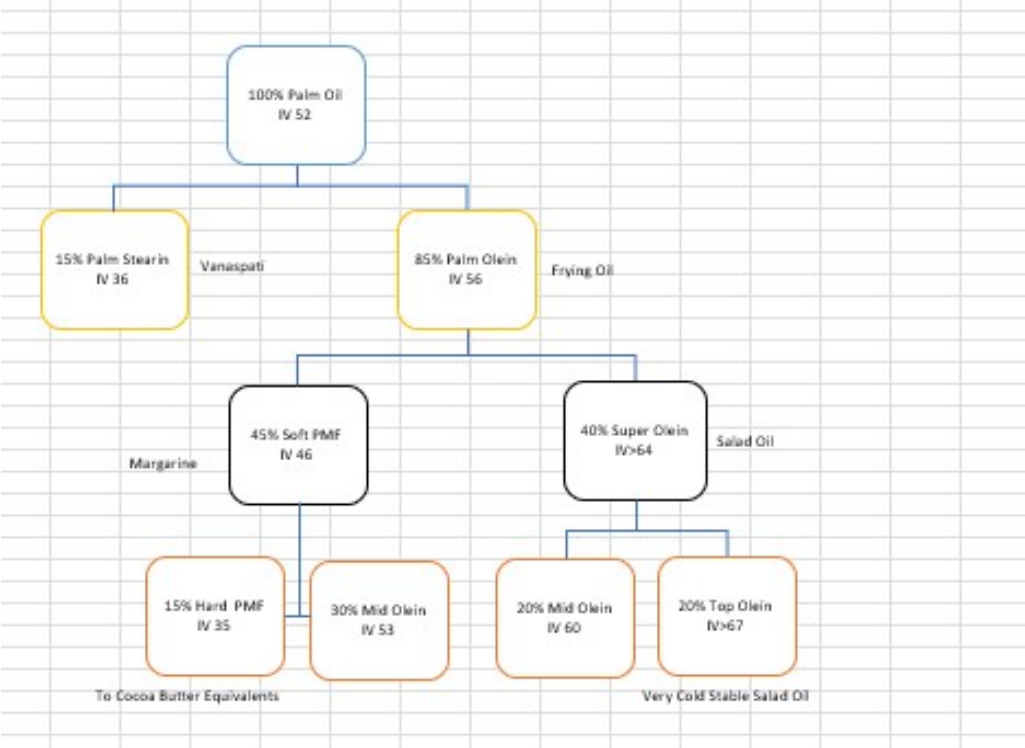
The palm oil processing process typically involves the following steps:

Harvesting
Sterilization
Threshing
Digestion
Extraction of oil
Clarification
Refining – Physical and Chemical
Fractionation

Fractionation

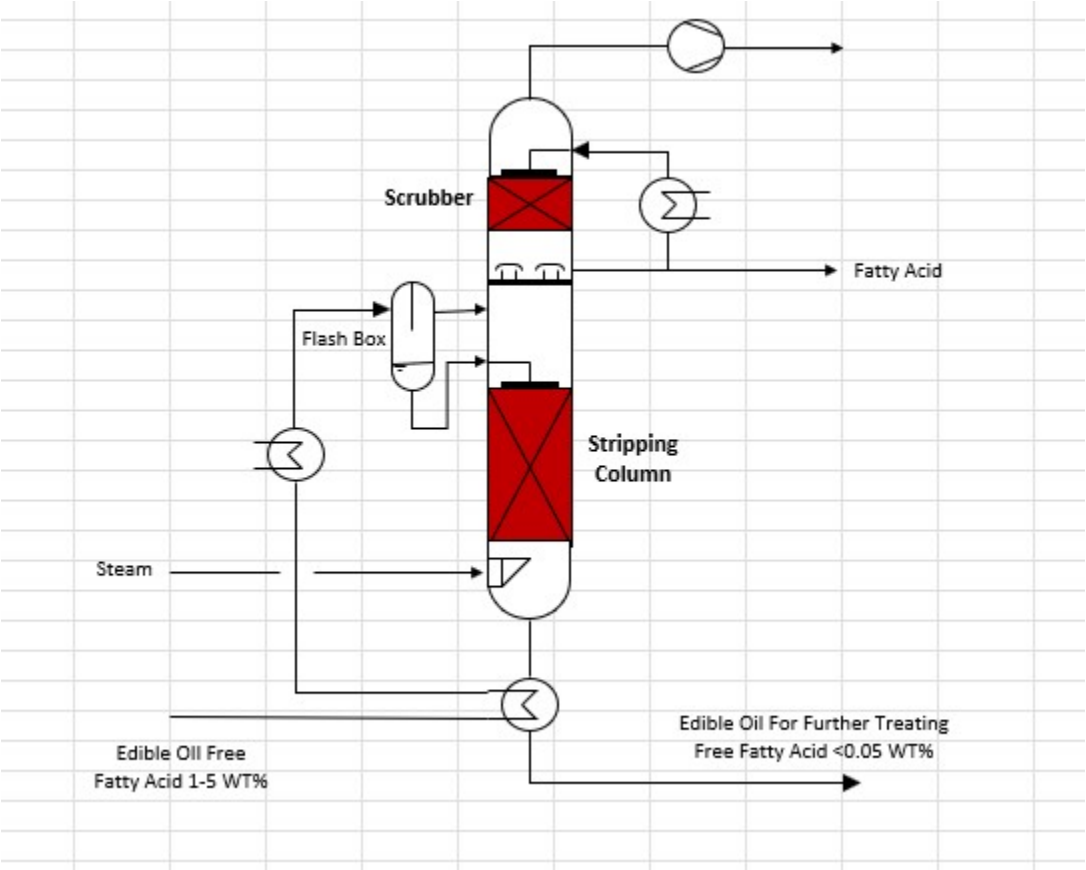
Fractionation is a process that can be employed to separate the palm oil into different fractions, such as palm olein (liquid fraction) and palm stearin (solid fraction). This process is used to obtain oils with specific melting points and different applications.

After processing, the palm oil is usually stored and transported in bulk for various uses in the food industry, such as cooking oil, margarine, and processed foods. It is also used in the production of personal care products, soaps, and biodiesel.



Palm Oil Stripper

The Palm Oil Stripper is one of the first fractionation columns in the palm oil process. The Palm Oil Stripper is typically one or two columns. For a single column, the bottoms section is called the stripper and the top section is called the scrubbing section. Preheated, hot crude palm oil is entering the stripper column, which is equipped with structured packing and operated at very low pressure, where the FFA are stripped off by introducing stripping steam in the bottom. Some processes have the palm oil stripper as part of the deodorization system.



For a single column the top section is called the scrubbing section. The scrubbing section can be one to three beds. The scrubbing section is typically structured packing of KLM 250X EC style. The EC (Enhanced Capacity) is 2nd Generation Structured Packing.

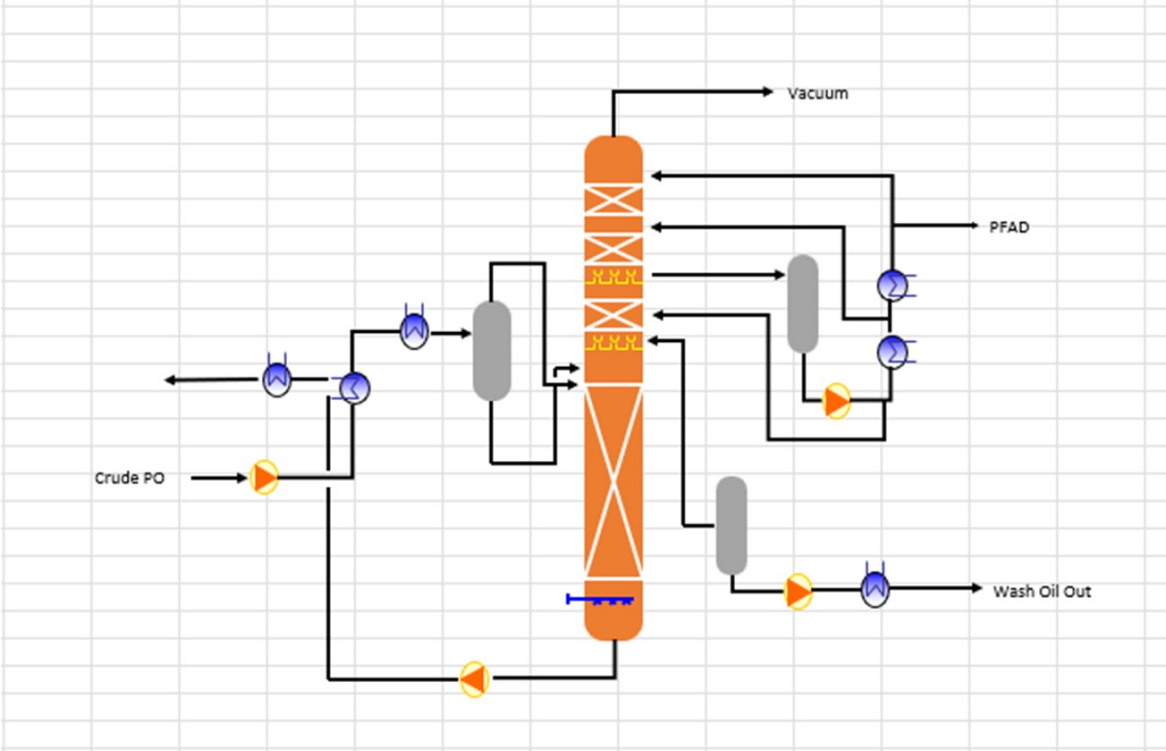
If the column has two stripping section beds, the top bed height of 1.3 meters with 1.3 mbar pressure drop. The higher-pressure drop is due to the pump around bed which has higher flow parameters. The middle bed height is approximately 1.6 meters with 0.6 mbar pressure drop. Total tower pressure drop may be in the range of 4 to 6 mbar. A typical column diameter is one to two meters.

The stripping section is structured packing of KLM 250Y EC style with a bed height of four to 6 meters. The 6-meter bed might have approximately 3.92 mbar pressure drop.

Typical metallurgy is SS 304, SS 316 and SS 316L. Typical stripping steam ratio is 0.20 kg/hr for each MTPD. Free Fatty Acid (FFA) in the feed is about 5% wt and FFA out is about 0.05% wt. Typically, about one stage per meter and

packing pressure drop about 1 mbar per meter except for the pump around sections. Typically, design with about 20% safety factors.

Some Palm Oil Strippers may be more complex with an extra draw from the column.



Steps of a Column Revamp

1. Determine Current Capacity and Limitations

The first step of a revamp is to understand your current capacity and limitations. One way to determine your current capacity and limitations is a high load test. You develop a test and measure all of the relevant data. Determine what is the current capacity and limitations. Limitations might include packing, heat exchangers, or pumps.

2. Develop a simulation matching current data

From the high load test data, a simulation is developed for the complete system including heat exchangers and pumps. The simulation should match the field data. KLM is happy to assist in your simulation.

3. Review the equipment.

   Heat Exchangers

   Heat exchangers are rarely optimized or designed well because they are awarded to the low bidder. Then the operating unit pays for the low unit performance in heat exchanged and run length. Equipment should be bid on a cost and performance matrix.

   When a performance matrix is utilized, the lowest bidder rarely wins the heat exchanger bidding. For many units heat exchangers set the run time between maintenance outages. With today's high energy cost heat exchanger is a larger focus. KLM can assist with a better design and supply of heat exchangers.

   Pumps

   Pumps again are awarded to the lowest bidder. Typical low-cost pump efficiency might be 80% where newer pumps are above 90% - this is a large energy saving. If you need to replace a pump do not replace it with a low efficiency pump. KLM can assist with a high efficiency pump.

   Packing

   Structured Packing has performed well in Palm Oil Strippers. Distillation of Oleochemicals requires attention to the following key features:

   - High Vacuum
   - Low pressure drop
   - Low bottom temperature
   - Minimum holdup
   - Short residence time

   There is a trade off in structured packing between capacity and fractionation ability. Early columns were designed with KLM 450Y which has higher fractionation capacity, but lower capacity ability. Most newer columns are designed with KLM 250Y EC (Enhanced Capacity - 2nd Generation Structured Packing) which has less fractionation ability but higher capacity.

   From the High load test, we can develop vapor and liquid flows. We can then calculate tower hydraulic loads. KLM is happy to assist in developing hydraulic profiles and hydraulic capacity.

To increase fractional ability

If your tower diameter is not the limiting case from the hydraulic profile, we can increase your style of packing to increase your fractioning ability. If you had KLM 250Y before, we could consider KLM 300Y, or KLM 350Y for better fractionation. If you had KLM 350Y before, we could consider KLM 400Y or KLM 450Y for better fractionation.

To increase capacity

If your tower diameter is the limiting case from the hydraulic profile and your fractionation ability is good, we could slightly decrease your style of packing to increase your capacity. If you had KLM 250X before we could consider KLM 200X. If you had KLM 350Y before we could consider KLM 300Y or KLM 250Y.

If you had KLM 250Y before we could consider KLM 250Y EC for increased capacity. The KLM 250Y and KLM 250Y EC has roughly the same efficiency but the KLM 250Y EC has about 25% to 40% more capacity.

Here are some average Number of Theoretical Stage Per Meter (NTSM) and Height of Equivalent Theoretical Plate (HETP). These numbers are based on low pressure of about 1 bar, low relative volatility, and good vapor / liquid distribution – see next section on distributors.

Style	NTSM	HETP
KLM 200 Y	2	20 Inches (508 mm)
KLM 250 Y	2.5	16 inches (406 mm)
KLM 350 Y	3.33	11 inches (279 mm)
KLM 500 Y	4	9.75 Inches (248 mm)

Distributors

For Packing systems, every designer will mention that the packing only works as well as the distributor, and then they normally provide a not optimized distributor. Normal industry standard distributors average about 90 to 92% distribution quality. Below 90% is considered poor and 94% is achievable.

For structured packing, the top two layers distribute the liquid. If each layer is 300mm and you have a 3-meter bed, you have lost efficiency in the top two layers (600mm) which is 20% of the bed height. Remember, higher efficiency will save energy and reduce energy costs.

For random packing, the packing will mix the liquid some, but not like the structured packing. It is more important to have an optimized distributor for random packing to increase efficiency and reduce energy.

KLM optimizes distributor design to gain as much distribution as possible, to improve the packing efficiency, reduce energy costs and save money. With energy in USA at USD $4.00 MMBtu and in Asia at 15.00 MMBtu, it does not take much energy saving to be real money.

Palm Oil has a viscosity challenge – make sure you have an optimized distributor for your Palm Oil Application.

Cost of Quality

There are hundreds of Random Packing Suppliers, some at very low cost. KLM only buys from Quality Suppliers that we have vetted.

Suppose you are buying random packing and thickness is 0.30 mm. Low-cost vendor provides you thickness of 0.28, which is difficult to measure. His raw material cost is 6.66% percent lower. If you have a large bed height, the crush strength of the thinner packing is lower and the bottom of the bed may be crushed, leading to a higher pressure drop.

Suppose you are buying random packing and the size is 25 mm. Low-cost vendor provides you packing of 27mm, which is difficult to measure. Packing is sold in 1-meter bags. The bags should be full and weighted, make sure the bags are weighted. Again, His raw material cost is 3 to 5% percent lower by using less metal.

We know that larger packing size gives more capacity, but less efficiency. If your energy cost is low this should not have a large effect, but most companies do not have low energy cost.

With energy in US at USD $4.00 MMBtu and in Asia at 15.00 MMBtu, it does not take much energy saving to be real money. There may be a good reason someone's packing is lower cost – and it may not actually save you money.

Conclusions

Palm Oil Stripper Columns are typically the first fractionation column in palm oil processing. There are many types and styles of Palm Oil Strippers. There are opportunities to revamp these towers. Revamps, when possible, should increase capacity and reduce energy. This can be accomplished with the proper design of heat exchangers, pumps, and distillation equipment. KLM would be happy to work with your team.

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