

KLM

**Technology
Group**

KLM Technology Group
Engineering Solutions



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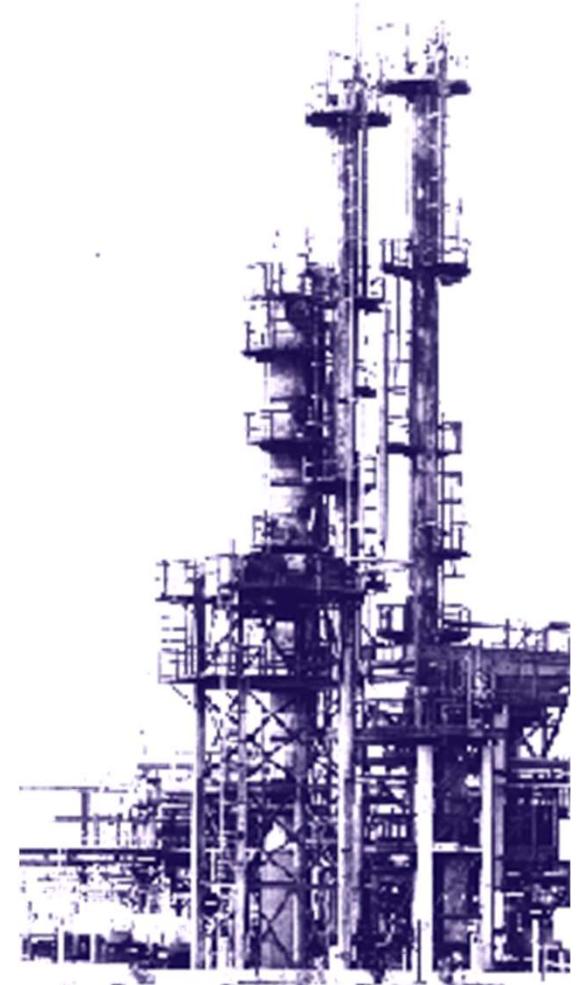
Consulting, Guidelines, and Training



Engineering Solutions

Based in USA since 1995,

KLM is a technical consultancy group, providing specialized services and equipment to improve process plant operational efficiency, profitability and safety.



KLM Core Business

Training (75+ Training Classes)

Engineering Design Guidelines

Process Optimization Studies

Process Energy Studies

Process Safety Management

HAZOP Facilitation

Facility Siting Studies

Engineering Support

Basic Design Packages

Detailed Design Packages

Process Equipment

Random Packing

Structured Packing

Marketing

Engineering Practice Magazine

Unit Commissioning

**Distillation Equipment Inspecting
and Correct Installation**

Unit Benchmarking

Evaluation of Process Units

KLM Provides

- 1. Process Simulation**
- 2. Distillation Hydraulics – KLM and third party**
- 3. Unit Troubleshooting**
- 4. Unit Commissioning**
- 5. Training for your team**
- 6. Thirty Plus Years Process Engineering Experience**

KLM Core Business

Process Equipment

KLM as an EPC Company can purchase from many of the major equipment suppliers.

Distillation Equipment

Towers Shells

Random Packing

Structured Packing

Trays

Heat Exchange Equipment

Pumps and Compressors

KLM Core Business

Process Equipment

Distillation Equipment

Can be ordered with normal lead times or can be sources for immediate replacement

Random Packing

KLM has a stock of random packing in key Countries for Immediate replacement

Structured Packing

KLM has a stock of Structured Packing in key countries for immediate replacement

KLM Core Business

Process Equipment

KLM buys a large volume of process equipment each year, because we buy heat exchangers, pumps and distillation equipment for many end users.

Many times, our cost to the end user is lower than they can negotiate themselves because the end user may only be buying a few items per year and the vendor adds a large profit margin.

Be sure and let KLM bid on your projects.

There are rules for which Distillation Device should be utilized based on Pressure, Flow and Fouling Tendencies

Pressure

For high pressure applications trays should be utilized, above 150 PSIG (10 Bar). Tray efficiency increases with pressure where packing efficiency decreases.

There is a back mixing effect for packing at high pressures, so it is difficult to guarantee the efficiency at high pressures. Tray efficiency can be guaranteed at high pressures.

For lower pressure application, 1 bar and Vacuum systems, packing has much higher efficiency which can be guaranteed.

There are rules for which Distillation Device should be utilized based on Pressure, Flow and Fouling Tendencies

Flow

For high flow parameters trays are preferred.

For low flow parameters packing may be utilized.

There are rules for which Distillation Device should be utilized based on Pressure, Flow and Fouling Tendencies

Fouling Tendencies

For high fouling system a well-designed anti fouling tray is the best option

With the proper distributors structured packing has worked well in Refinery Vacuum Tower which is a highly fouling service.

For fouling systems random packing may be the last choice. Random packing has horizontal components which enhance fouling.

Distributor Quality

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 92% distribution quality. Below 90% is considered poor and 94% is achievable.

Distributor Quality

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 cost.

Distributor Quality

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 cost and saves 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.

Advantages of Structured Packing

Structured packing is unique in that the top two layers act as a continuation of the distributor to distribute the liquid more evenly.

This results in excellent liquid distribution, leading to higher overall efficiency than random packing.

In offshore application where there is motion and tilt this is an important consideration

Advantages of Structured Packing

Structured packing has very high efficiency in low pressure applications.

This equates to a higher number of stages for the same tower height

This equate to lower reflux requirements – energy savings

Advantages of Structured Packing

Structured packing has higher capacity than trays in low pressure applications.

This equates to reduced tower diameters

This equate to higher operating rate in same tower diameter

Advantages of Structured Packing

Structured packing has low pressure drop as compared to trayed applications.

This equates to lower bottoms temperature for heat sensitive products

Higher separation of difficult separations

Lower energy consumption

Less foaming

Advantages of Structured Packing

Structured packing has lower fouling rate than random packing

There are no horizontal areas where fouling can begin and multiply

Longer Run Length

Less Residence time than trays

Less polymerization inhibitor required

Styles of Structured Packing

Structured Packing has multiple styles. There is some made of sheet metal and some with wire gauze. There are multiple textures of the sheet metal. Some have holes and some have no holes.

The most common utilized is sheet metal, with textured dimples to increase wetting ability and small holes to increase distribution.

1st Generation Structured Packing - 1970



Sizing of Structured Packing

Structured Packing is sized based on the area M^2/M^3 - There is a trade off between capacity and efficiency for the different sizes of structured packing. Number of theoretical stage per meter (NTSM) is an indication of efficiency. The larger the area the smaller the capacity, but the higher the efficiency.

Type	Area	NTSM
KLM 200 Y	200	2
KLM 250 Y	250	2.5
KLM 350 Y	350	3.3
KLM 500 Y	500	4

NTSM at atmospheric or vacuum pressures and good liquid distribution.

Sizing of Structured Packing

There are two different angles of rows for the sheet metal – X and Y.

X has an angle of 60 degrees. X has lower pressure drop and higher capacity than Y. It may be used in high flow areas like pump around sections.

Y has an angle of 45 degrees. It has a higher efficiency but slightly less capacity. Y is utilized the most in applications.

2nd Generation Structured Packing – 1990s

A 2nd Generation Structured Packing was introduced in the 1990s. It has a straightened area at the interface between the layers of packing. Instead of the interface being at 45 or 60 degrees the interface is matching.

This simple change to the packing results in a 25% to 40% increased capacity at the same efficiency. Today most new columns are utilizing 2nd Generation Structured packing.

2nd Generation Structured Packing – 1990s – Enhanced Capacity (EC)

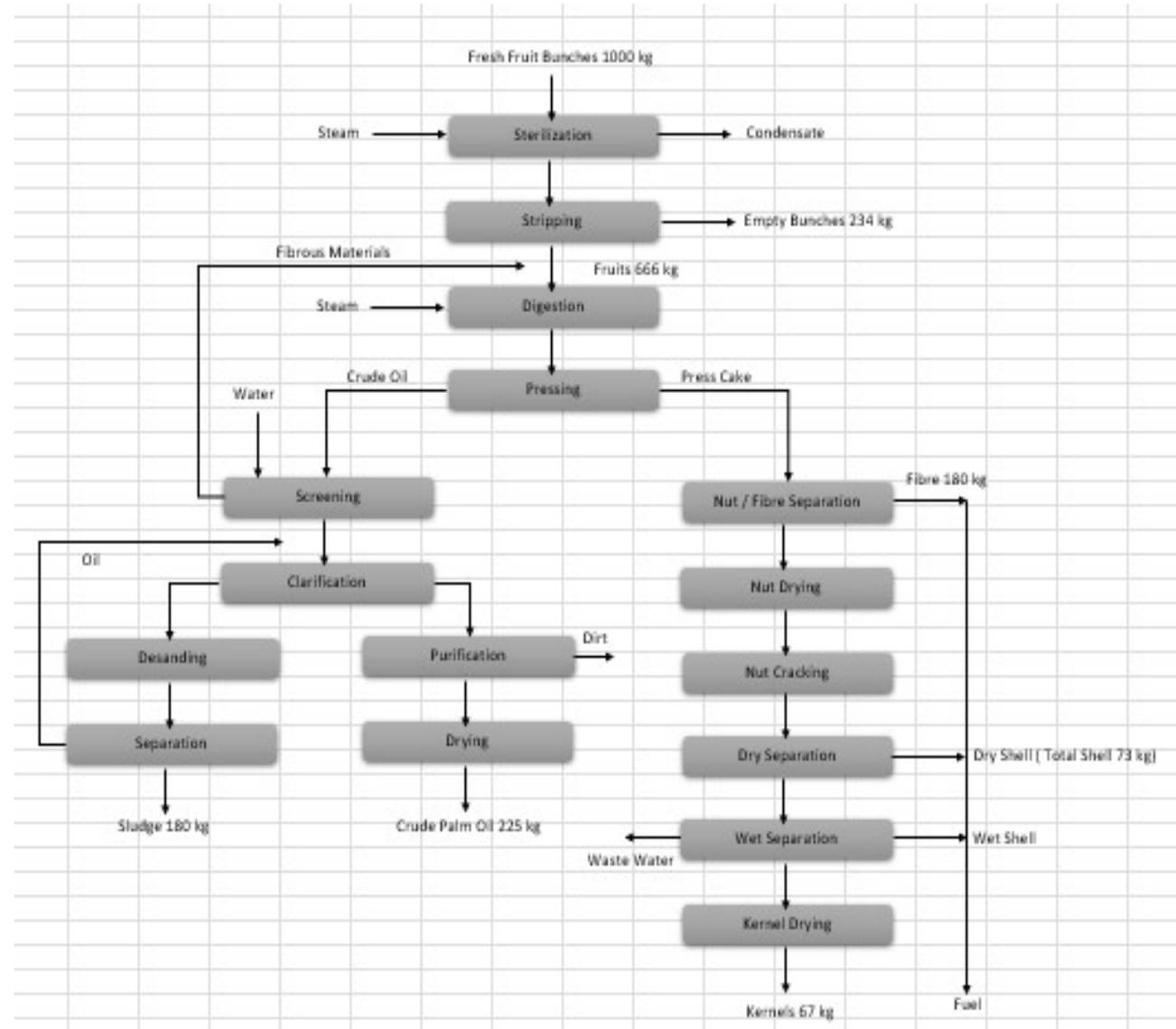
Type	Area	NTSM	Capacity
KLM 250 Y EC	250	2.5	+125% to 140%
KLM 450Y EC	350	3.3	+125% to 140%
KLM 750 Y EC	500	4	+125% to 140%

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. South East Asia is the largest exporter and producer of crude palm oil in the world.



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 in Palm Oil is an important unit operation. Typical applications for fractionating in Palm Oil Technology include;

Palm Oil Stripper
Fatty Acid Distillation
Glycerin Distillation

Fractionation

Important elements of fractionation design for palm oil include;

- 1. Low Temperatures to insure color and odor properties**
- 2. Low residence time at higher temperatures – reduce tower bottoms boots**
- 3. Falling Film Reboilers**
- 4. Proper section of distributors – understating of viscosity properties**
- 5. Proper selection of packing metallurgy and style for best capacity and efficiency**

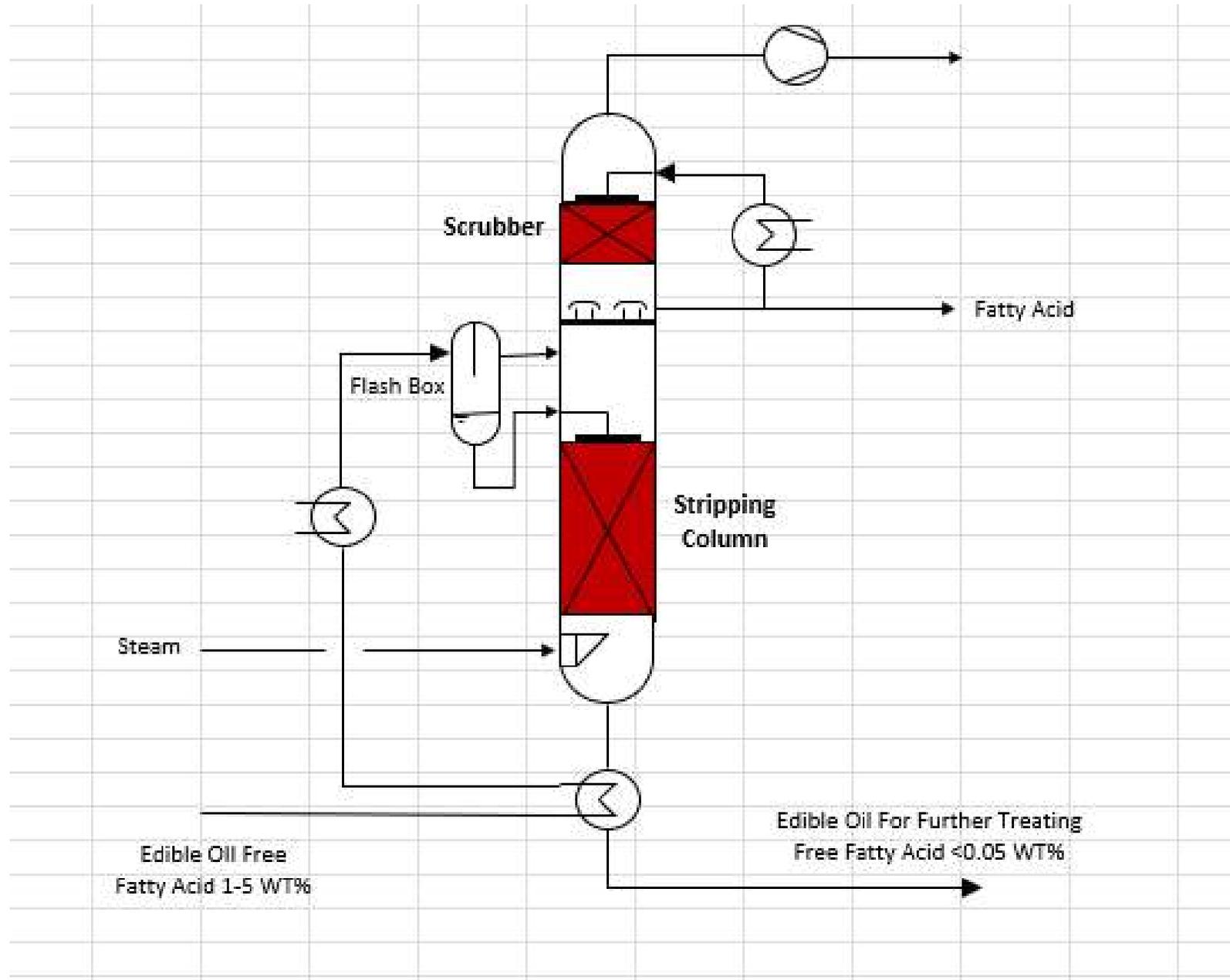
Palm Oil Stripper

Palm Oil Stripper is typically one or two columns. 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 Free Fatty Acids are stripped off by introducing stripping steam in the bottom.

Some processes have the palm oil stripper as part of the deodorization system.

Palm Oil Stripper



The stripping section is typically structured packing of KLM 250 Y EC (Enhanced Capacity) style (based on column diameter) with a bed height of four to 6 meters. The 6-meter bed might have approximately 3.92 mbar pressure drop.

Typical metallurgy is 304, 316 and 316L. Typical stripping steam ratio is 0.20 kg/hr for each MTPD. FFA in 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. Typically, about 20% safety factors.

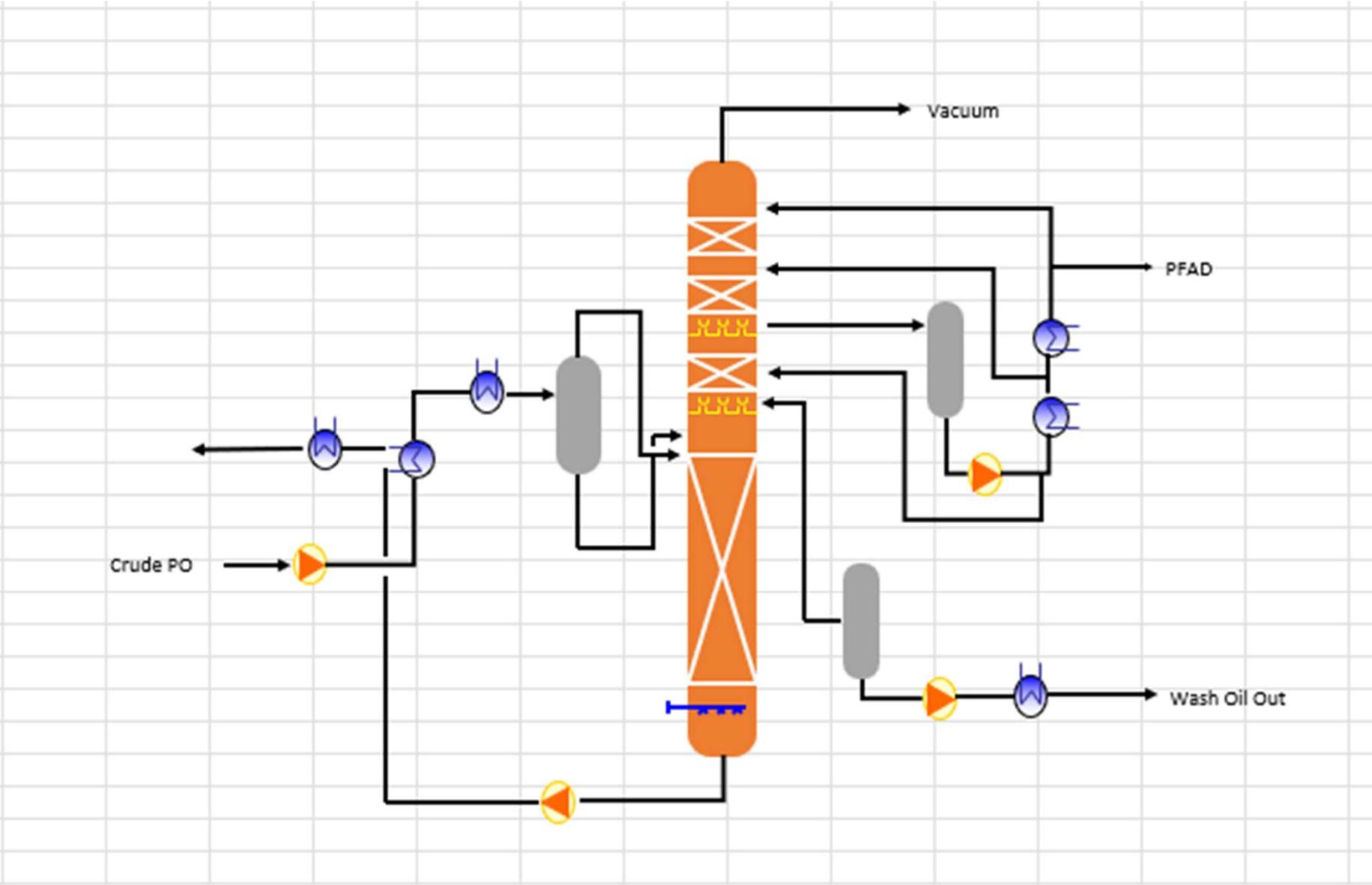
Total tower pressure drop may be in the range of 4 to 6 mbar. A typical column diameter is one to two meters.

The scrubbing section may be multiple beds based on the design. For a two-bed design;

The scrubbing section is structured packing of KLM 250X EC (Enhanced Capacity 2nd Generation Structured Packing) style with a top bed height of 1.3 meters with 1.3 mbar pressure drop. The higher-pressure drop is due to the pump around bed.

The middle bed height is approximately 1.6 meters with 0.6 mbar pressure drop.

Palm Oil Stripper



Fatty Acid Distillation may be a system of two to four columns. For a four-column system;

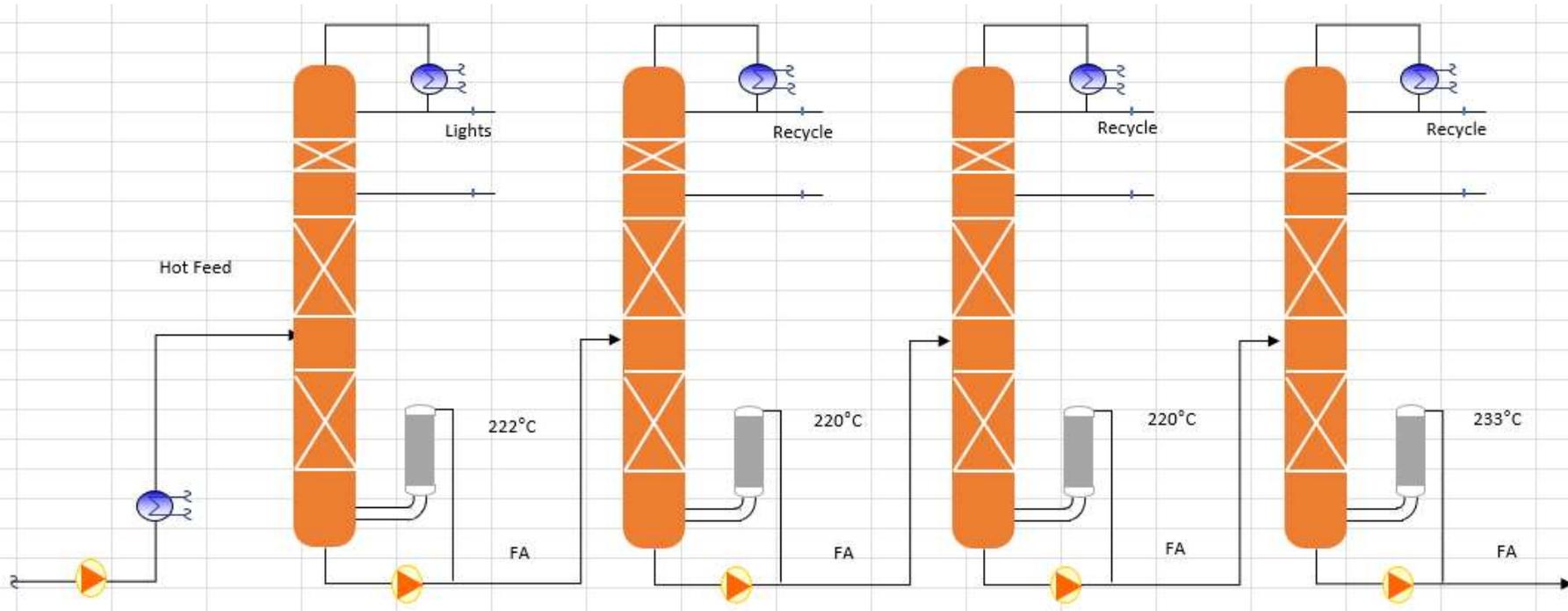
The first column removes the light materials and making a C8 side draw. This column is about operated about 60 mbar pressure.

The second column overhead is recycled and making a C10 side draw. This column is operated about 50 mbar pressure.

The third column overhead is recycled and making a C12 side draw. This column is operated about 9 mbar pressure.

The fourth column overhead is recycled and making a C14 side draw and a C16 bottoms product. This column is operated about 3 mbar pressure.

Fatty Acid Distillation



One of the key points to Fatty Acid distillation is low pressure drop in the column leading to lower reboiler temperatures. Fatty acids are heat sensitive; therefore, odor and color will deteriorate if exposed to high temperature or long residence times.

Specialty falling film reboilers also reduce the odor and color deterioration. They are typically SS 317 L metallurgy.

The material selection is of high importance. Short chain FA can be very corrosive. Even traces will lead to increase in corrosion rate.

Falling Film Reboilers Characteristics



- **Short residence time (5-10 seconds)**
- **High Heat transfer coefficient**
(Water 2.0-2.5kW/m² °C)
(Organic 0.5-1.0 kW/m² °C)
- **Low pressure drop (2-5 mbar)**
- **Low-temperature evaporation**
- **Suitable for vacuum operation**
- **High evaporation rate (70-95%)**
- **Operation flexibility can reach 4:1**
- **Low liquid retention in equipment**
- **Not prone to scaling**
- **Operational economy**

Pressure drop is limited as to achieve bottom temperature below 240 °C, allowable column pressure drop should not exceed about 10 mbar. Higher bottom temperatures lead to inferior product qualities. Typical top bed pump around temperature is in the range of 145 C.

Some columns have overhead condensers installed on the tower to reduce the total tower pressure drop. Sometimes these are called hammer style heat exchangers as they resemble a hammer

Typically, the top pump around bed is 1 to 1.3 meters in height and is designed with KLM 125 X, KLM 200X or KLM 250 X.

The middle and bottom beds are designed with KLM 250 Y HC, KLM 350Y HC and KLM 450Y HC.

The KLM 250Y HC might have 2 equivalent stages and the KLM 450Y HC might have 3 equivalent stages. The packing is typically SS 316 L metallurgy.

Quality Suppliers-Buyer Beware

There are hundreds of Random and Structured 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 higher pressure drop.

Quality Suppliers-Buyer Beware

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. Again, His raw material cost is 3 to 5% percent lower.

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

Quality Suppliers-Buyer Beware

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.

Equipment Installation

KLM can design and supply the very best distillation internals, but if they are not installed correctly the capacity and efficiency will be reduced.

Many organizations do not have the experienced tower inspectors because they only enter the towers on 3-to-5-year basis

KLM is happy to provide senior tower inspectors to assist in your turnaround and tower reviews.

Equipment Installation

KLM Service Technicians provide a valuable service to our customers by assuring that the distillation column equipment is installed properly, meeting KLM's installation specifications.

KLM Service Technicians are available as our customers need them, any time, anywhere, providing the following services;

- Inventory of mass transfer equipment at customer's site**
- Supervision of installation to meet equipment specifications**

Equipment Installation

KLM Service Technicians are available as our customers need them, any time, anywhere, providing the following services;

- **Observation and assessment of new and replacement column equipment**
- **Review and evaluation of existing mass transfer equipment**
- **Installation expediting and troubleshooting**
- **Turnaround and installation consulting**

Column Hardware

Column Hardware Can be ordered with normal lead times or can be sourced for immediate replacement

KLM has a stock of column hardware packing in key Countries for immediate replacement

We can also provide column hardware on a consignment basis for your turnaround



1. Over 20 Distillation Projects with multiple columns
2. Over 40 Heat Exchangers
3. Over 25 Pumps
4. Over 20 Pressure Vessels



BST Thailand

- 1. Petronas, Malaysia – Tower Design - 2006**
- 2. BST, Thailand – Tower Design - 2007**
- 3. Titan, Malaysia – Ethylene Revamp Review, Multiple Towers Reviewed - 2007**
- 4. ROC Ethylene Plant, Thailand – Tower Design Review and HAZOP – 2007**
- 5. Commissioned five BTXs with multiple tower internal inspections – 2008**
- 6. Ethylene Plant 3D Model Review – Korea - 2012**
- 7. Al Sanea, Kuwait – Tower Design – 2019**
- 8. Biofuels Project Review with Facility Siting, USA 2022**
- 9. Palm Oil Consulting, Malaysia - 2022**
- 10. Formosa, USA – HAZOP – 2023**
- 11. Numerous Training Classes – 2005 to Present**

KLM Provides

- 1. Process Simulation**
- 2. Distillation Hydraulics – KLM and third party**
- 3. Unit Troubleshooting**
- 4. Unit Commissioning**
- 5. Training for your team**
- 6. Thirty Plus Years Process Engineering Experience**

- 1. Solid Track Record of Projects in Southeast Asia since 2005.**
- 2. Strength in Process Engineering**
- 3. Distillation Equipment Supply**
- 4. Heat Exchanger and Pump Supply**
- 5. Strong Partners in Mechanical Engineering and Fabrication, especially Modular Fabrication.**
- 6. Wide Range of Industries Serviced.**
- 7. Ready to assist in your next project.**



Thank You

