

KLM

**Technology
Group**

KLM Technology Group
Engineering Solutions



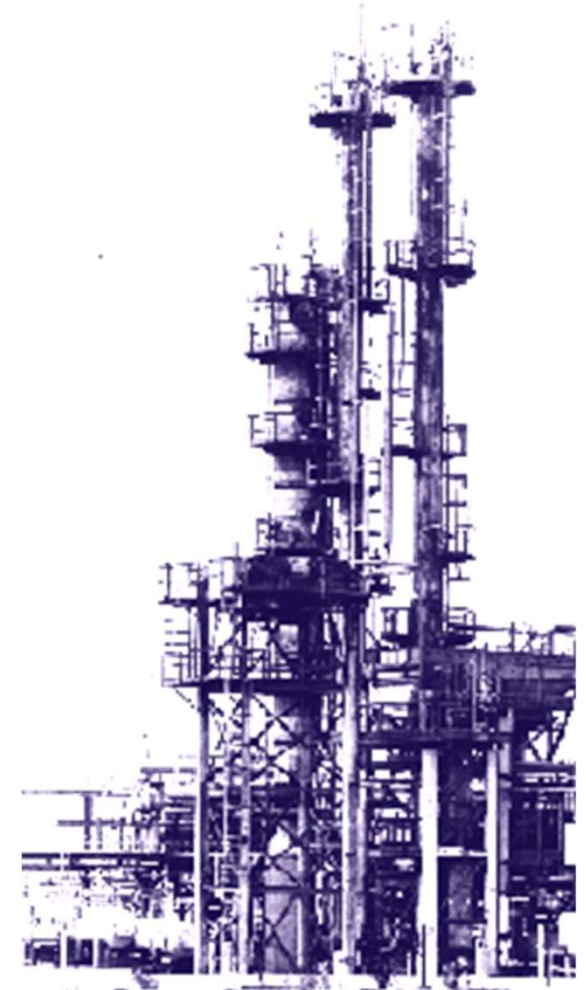
KLM Technology Group

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 consider 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
200Y	200	2
250 Y	250	2.5
350 Y	350	3.3
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
250 Y EC	250	2.5	+125% to 140%
450Y EC	350	3.3	+125% to 140%
750 Y EC	500	4	+125% to 140%

Advantages of Random Packing

Random 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 Random Packing

Random packing has 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 Random Packing

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

This equates to reduced tower diameters

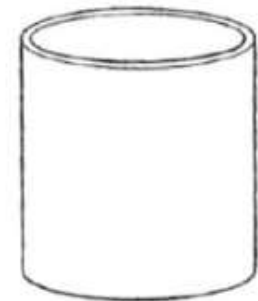
This equate to higher operating rate in same tower diameter

Styles of Random Packing

There are many style of random packing, and they are classed in the date of invention.

1st Generation were developed in the early 1900s

Raschig Rings – 1914



Pall Rings – 1940s



Styles of Random Packing

2nd Generation were developed in the early 1970s

I Type Rings – 1970



Improved Pall Rings – 1980



Styles of Random Packing

Performance is based on style and size of packing.

Newer generation will high higher capacity and efficiency than older generations.

We again have the trade off between capacity and efficiency. A 25 mm (1 inch) size will have higher efficiency, but lower capacity compared to a 50mm (2 inch) size.

Styles of Random Packing

I Style may be the best from a cost and performance matrix.

Size	Density kg/m ³	NTSM
25mm (1 inch)	236	2.6
50mm (2 inch)	146	1.7
70mm (3 inch)	110	1

Styles of Random Packing

F Style – Improved Pall Ring

Size	Density kg/m ³	NTSM
25mm (1 inch)	316	2.5
50mm (2 inch)	191	1.6
70mm (3 inch)	159	1

Styles of Random Packing

H Style – Improved Pall Ring

Size	Density kg/m ³	NTSM
25mm (1 inch)	242	2.5
50mm (2 inch)	172 ?	1.6
70mm (3 inch)	190	1

Quality Suppliers-Buyer Beware

There are hundreds of Random Packing Suppliers, some at very low cost. KLM only buys from Quality Suppliers what 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 will not save you money actually.

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



KLM Technology Group – Equipment References

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

KLM Technology Group

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



Thank You

