

# MASS TRANSFER TECHNOLOGY



**FINEPAC<sup>®</sup> STRUCTURES PVT. LTD.**

ООО «ТИ-СИСТЕМС» ИНЖИНИРИНГ И ПОСТАВКА ТЕХНОЛОГИЧЕСКОГО ОБОРУДОВАНИЯ  
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# INTRODUCTION TO DISTILLATION

Distillation may be described as a process in which a liquid or a vapour mixture of two or more substances is separated into its component fractions of desired purity by application or removal of heat.

It is based on a fact that the vapour of a boiling mixture will be richer in components that have a lower boiling point. The vapour phase is created by boiling of the liquid phase using steam or an electrical heating element. The more volatile component will distribute more in the vapour phase and the less volatile component will distribute more in the liquid phase. Based on this fact distillation columns can be designed according to the fractionation process.

Distillation is used for many commercial processes, such as production of gasoline, distilled water, xylene, alcohol, paraffin, kerosene, and a variety of different liquids.

## TYPES OF DISTILLATION COLUMNS

There are different types of distillation columns each designed to perform specific type of separation. Here we classify distillation columns on their method of operation.

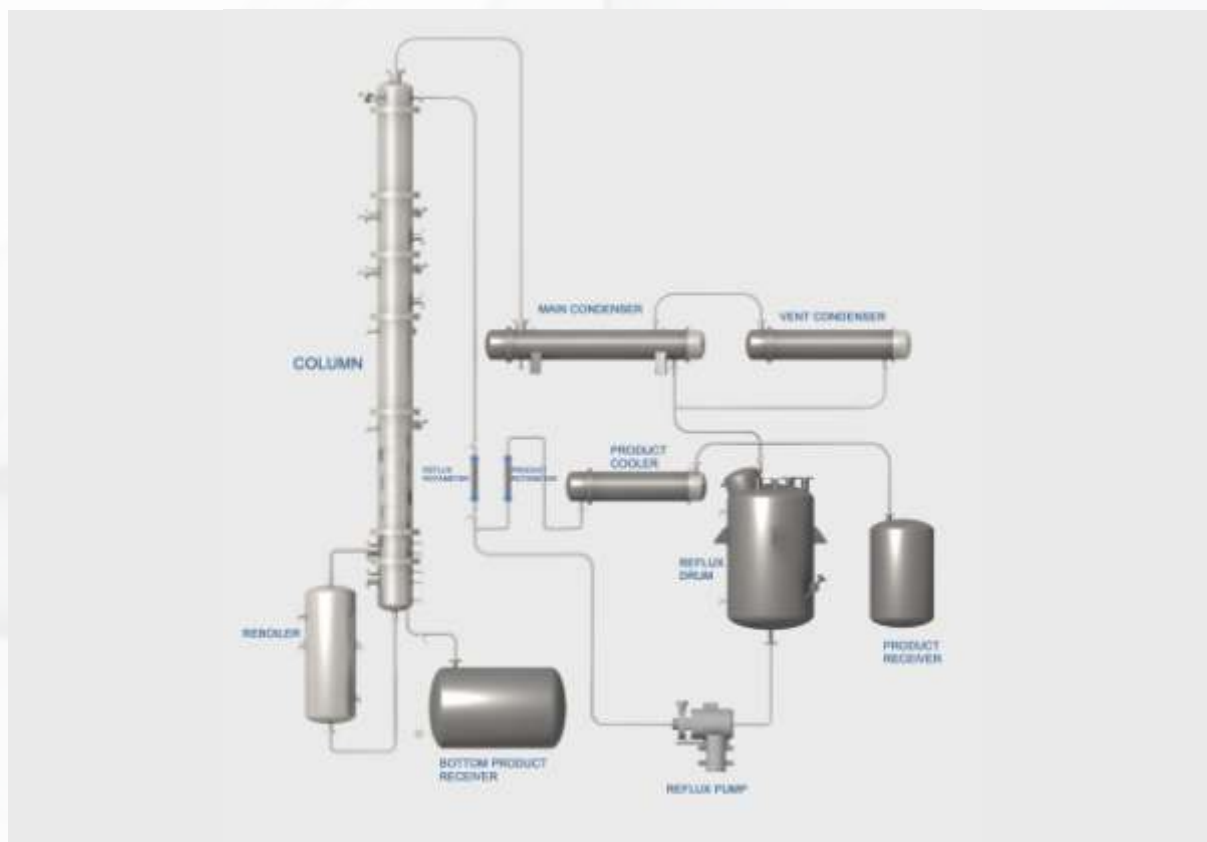
### **Batch Columns**

In batch columns the feed is introduced in batches. Simply put the column is charged with a batch and the distillation process is carried out. On achieving the desired task the next batch of feed is introduced.

### **Continuous Columns**

Continuous Columns process the feed continuously. No interruption occurs unless there is a problem with the column or the surrounding process units. They are capable of handling high throughputs.

## DISTILLATION COLUMN SETUP

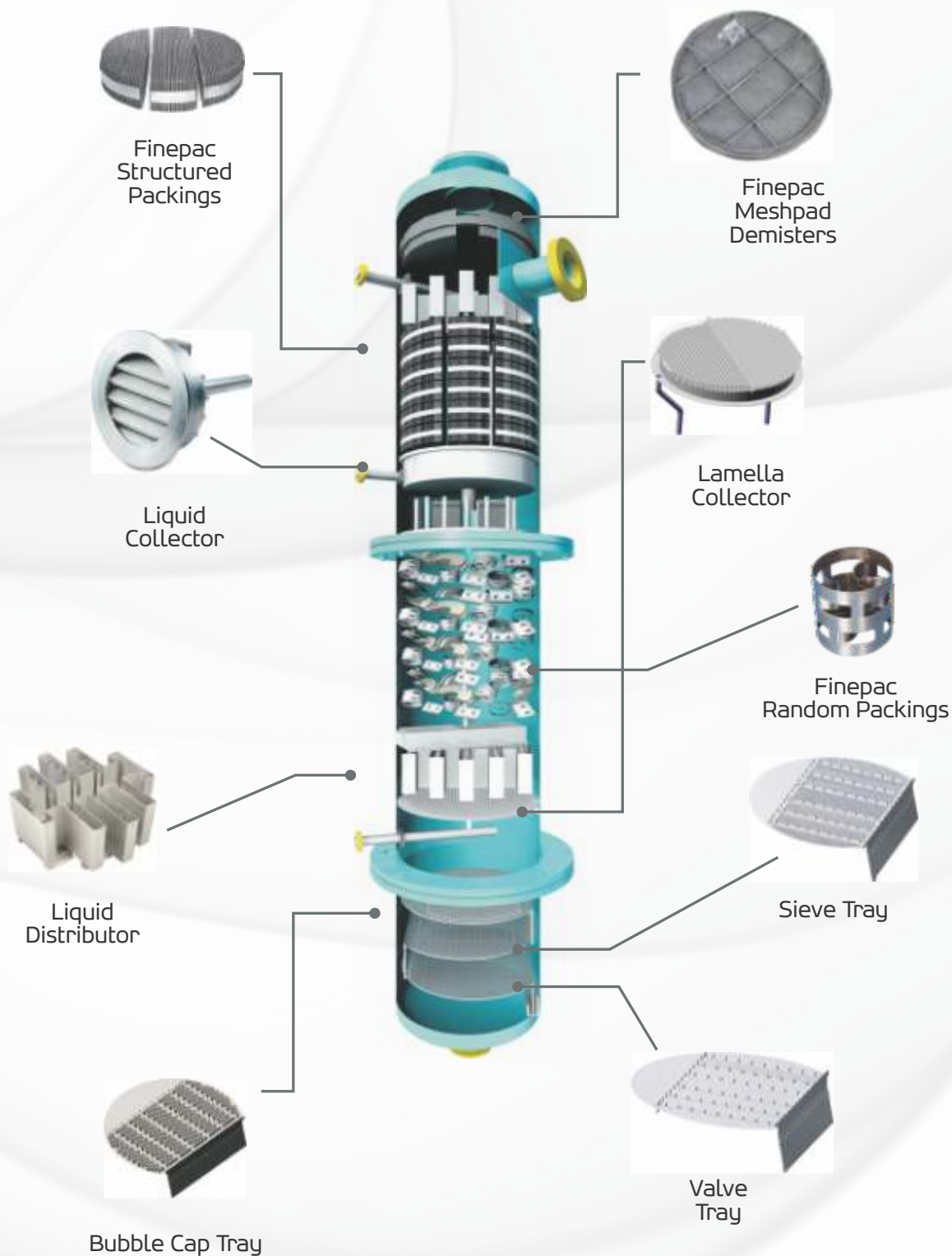


### Basic Operation & Terminology

The liquid mixture to be processed is called as the feed and this is generally fed near the middle section of the column. The feed flows through the column under gravity and is collected at the bottom in the reboiler. Heat is supplied to the reboiler to generate vapour. The vapour raised in the reboiler is introduced into the unit at the bottom of the column.

The vapour moves up the column and on exiting the top of the column passes into a condenser where it is cooled. The condensed liquid is stored in a holding vessel called as the reflux drum. A portion of the liquid is recycled back to the top of the column called as the reflux. The condensed liquid from the system is known as the distillate which is the final product.

# COLUMN ARRANGEMENT





## PACKED COLUMN INTERNALS

### Wide range of high performing products

For more than 20 years Finepac has been serving the chemical process and related industries with innovative yet reliable solutions. Today the company is regarded as one of the leading specialists in the field of thermal fractionation technology offering a wide array of products and services.



#### Structured Packings

More than 20 years of experience in the field of development of structured packings makes us the ideal partner to provide you the best solution for your application.



#### Random Packings

We offer a wide range of random packings ranging from traditional to high performance random packings to suit your requirements.



#### Internals for Packed Columns

Packings will perform to their optimum level only when complimented by appropriately designed column internals.



#### Mass Transfer Trays

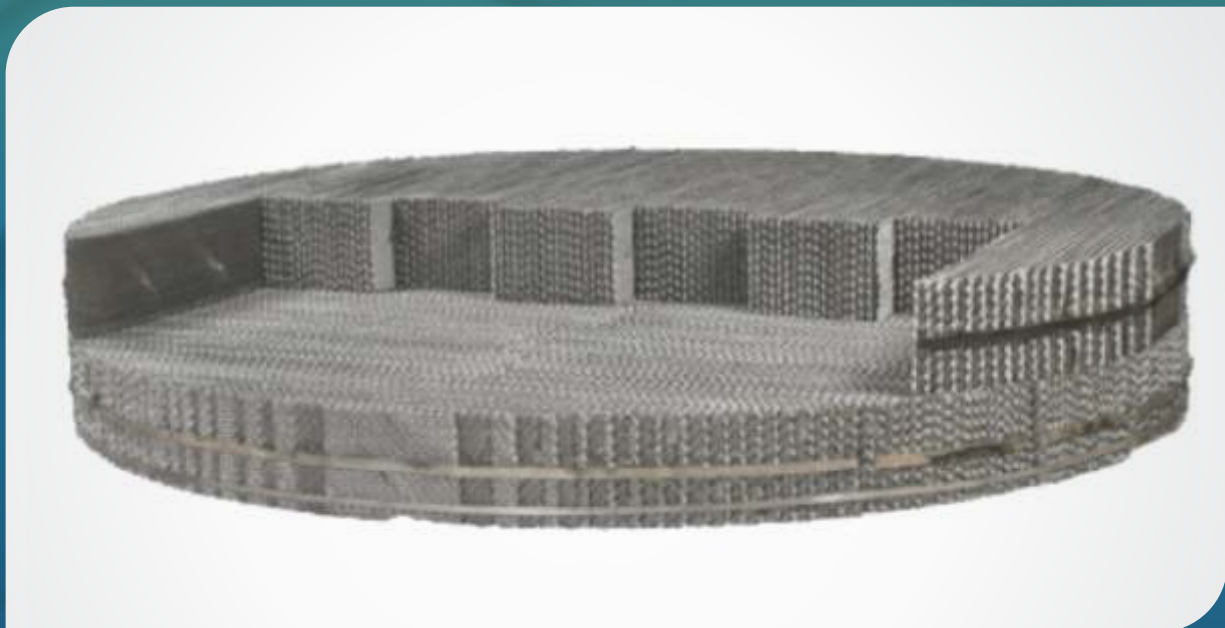
We offer a wide variety of traditional as well as high performance mass transfer tray configurations.

# FINEPAC STRUCTURED PACKINGS

## A benchmark for quality in distillation

Finepac structured packings provide a very good solvent purification by distillation or solvent recovery by absorption. These packings provide a high fractionation efficiency, high throughput and a low pressure drop.

Different fractionation tasks require different performance from packings. Finepac packings have a widely variable geometrical shapes and different surface structures. This concept allows highest flexibility to fulfill the differing requirements of different fractionation tasks. Each type packing has specific performance characteristics and under certain conditions provides a particular benefit that makes one style more desirable than the other for that particular application.



## Performance characteristics of Structured Packings

- Excellent liquid spreading characteristics
- Low pressure drop
- Reduced liquid hold up
- High capacity
- Higher efficiency as compared to trays and random packings for the same tower height.

## FINEPAC SHEET METAL PACKINGS

### The industry standard for thermal fractionation

Finepac sheet metal packing is a result of many years of experience and development in the field of distillation technology using structured packings. These packings provide a lower pressure drop per theoretical stage and increased capacity as compared to trays and conventional random packings. Columns packed with these packings can provide improved product yields, purities, reduced reflux ratios, increased throughput, lower pressure drop and increase heat transfer rates. These packings are available in two configurations namely X and Y depending on the angle of inclination.



**Segmented Structured Packing**



**Single unit Structured Packing**  
(Small diameter columns)

### Structured Packing Performance

Packing Types	Surface Area (m <sup>2</sup> /m <sup>3</sup> )	F-Factor	Number Of Theoretical Stages Per Meter (NTSM)
FP 1.25	125	3.5	1
FP 1.70	170	3.0	1.5
FP 2.00	200	2.7	2
FP 2.50	250	2.2	2.3
FP 3.50	350	1.8	2.8
FP 5.00	500	1.5	3.8
FP 7.50	750	1.2	4.5

Other Finepac structured packing configurations available on request

### Material of Construction

Stainless steel, High alloy steels, Titanium, Tantalum, Hastelloy, Copper, Monel, etc.

Other special materials available on request.

[For Standard Organic System]

# FINEPAC WIREMESH PACKINGS

Special mesh packings for unsurpassed efficiency.



Finepac wiremesh packings fulfill the special requirements demanded by fractionation under vacuum conditions. The characteristics of lowest pressure drop per theoretical stage makes the wiremesh the preferred packing for processing specialty chemicals, pharmaceuticals & temperature sensitive materials. These packings are used to achieve the maximum number of theoretical stages in minimum column height. On account of the capillary effect, these packings provide an extremely wettable surface which provides excellent mass transfer efficiency.

## Wiremesh Packing Performance

Packing Types	Surface Area (m <sup>2</sup> /m <sup>3</sup> )	F-Factor	Number Of Theoretical Stages Per Meter (NTSM)
WM 5.0 M	500	2.2	6
WM 7.5 L	750	1.5	9

Other Finepac Wiremesh packing configurations available on request

[For Standard Organic System]

## Material of Construction:

Stainless steel, High alloy steels, Titanium, Tantalum, Hastelloy, Copper, Monel etc.

Other special materials available on request.

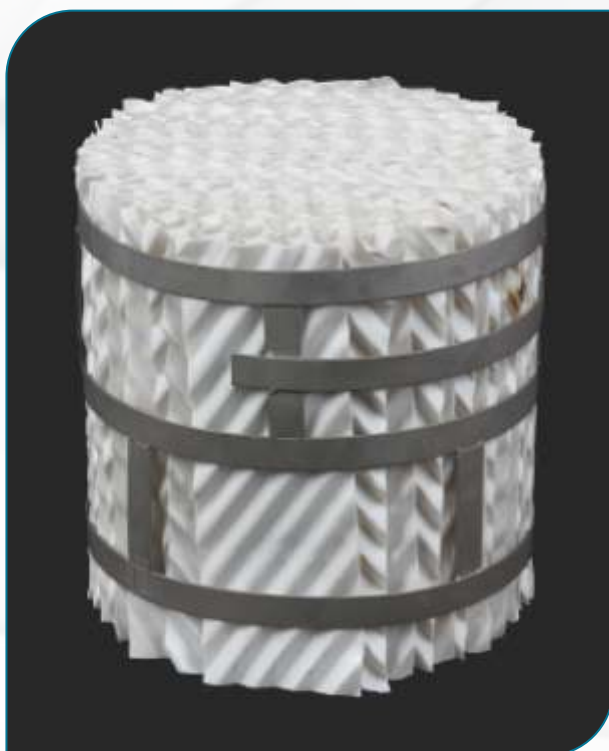


## FINEPAC CORROSION RESISTANT PACKINGS

### Excellent performance in corrosive environments

Finepac CR series packings provide similar performance characteristics of high efficiency, high capacity and low pressure drop as the sheet metal packings with the added advantage that these packings can also be used in chemically corrosive atmospheres.

These types of packings find applications in deaerators, flue gas coolers, HCl absorbers, SO<sub>2</sub> absorbers, CL<sub>2</sub>/SiO<sub>2</sub> scrubbers.



**Teflon Packings**



**Ceramic Packings**

### Material of Construction:

Polypropylene, Teflon, Ceramics

In case of plastic packings the support system are made from Hastelloy, Titanium and Tantalum.

# FINEPAC GRID PACKINGS

## High performance for severe service

Grid structured packings combines the efficiency of structured packing with the robustness and fouling resistance of grid packing. These are specifically developed for severe services that are susceptible to fouling, erosion, coking and high solid content. These are installed in rigid modules stacked in successive layers with a fixed orientation. This provides for overall pressure drop while increasing the tower efficiency simultaneously. There are a number of benefits provided by these packings like they provide good de-entrainment and efficiency on account of the corrugated grid structure, easy installation and removal, superior durability etc.



## Grid Packing Specification

Grid Packing				
Packing type	40L	64L	64M	90M
Specific Surface Area (m <sup>2</sup> /m <sup>3</sup> )	40	64	64	90
Surface Structure	Smooth, without dimples and holes			
Material thickness(mm)	0.5 to 1.6 mm			
Material	Stainless steel, high alloy steel, nickel based alloys Other materials available on request			

Other Finepac grid packing configurations available on request

## FINEPAC LABORATORY PACKINGS

### For precise scale up applications

Lab setups and pilot plants are an important step in the development phase. Finepac supplies packings for small scale columns and miniplant systems. These guarantee a safe scale up from pilot to industrial plants.

### Characteristics of Finepac Laboratory packings

- Designed for column diameter from 20 to 100 mm.
- Provides highest number of theoretical stages per unit height
- Available in 2 configurations – DM packing & EM packing
- Low pressure drop & high capacity.
- NTSM remains constant over a wide range of liquid loading



**DM Packing**



**EM packing**

### Material of Construction:

Stainless steel, High alloy steels

Other special materials available on request.

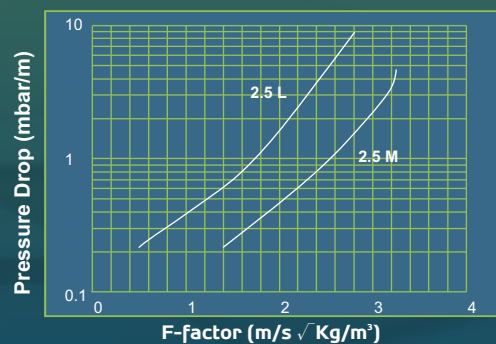
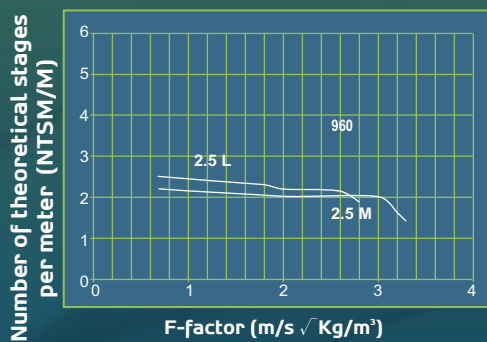
# PERFORMANCE CHARTS

## An overview of packing separation efficiency & pressure drop

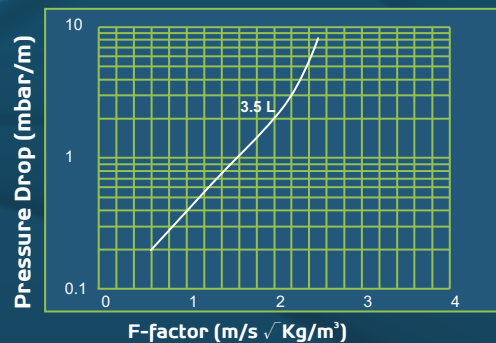
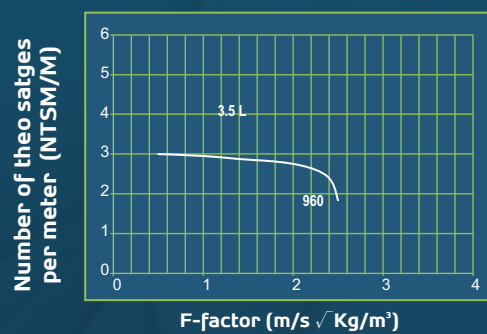
The following charts give you a clear overview of the performance characteristics of our main type of packings.

Information about performance characteristics of other types of packings is available on request.

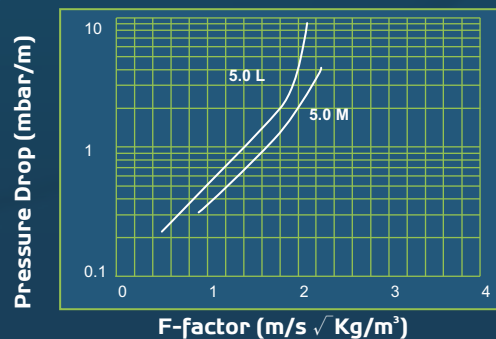
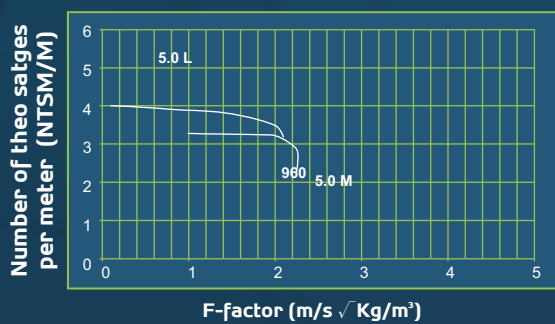
### Finepac 2.5 Packing



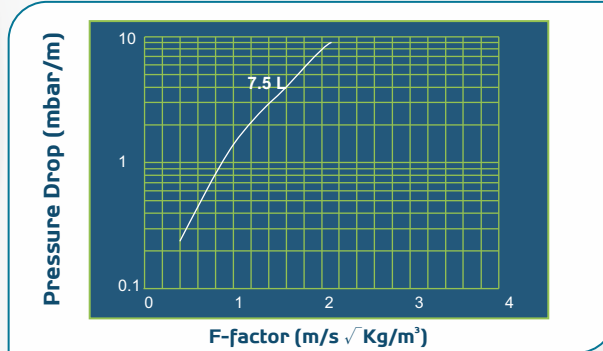
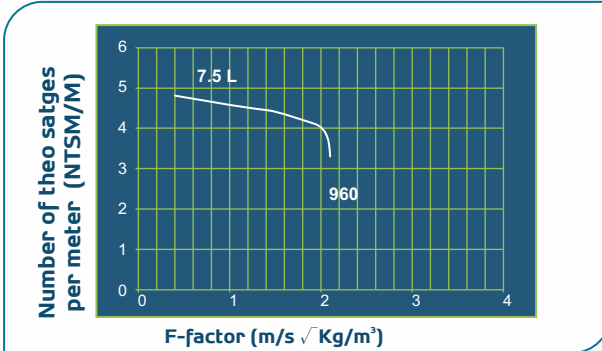
### Finepac 3.5 Packing



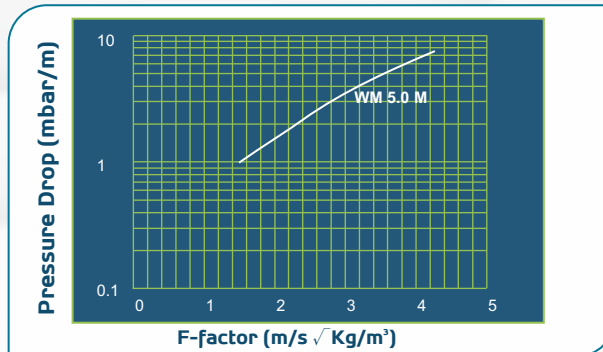
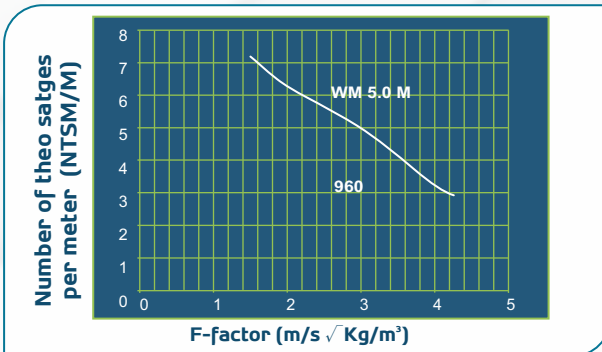
### Finepac 5.0 Packing



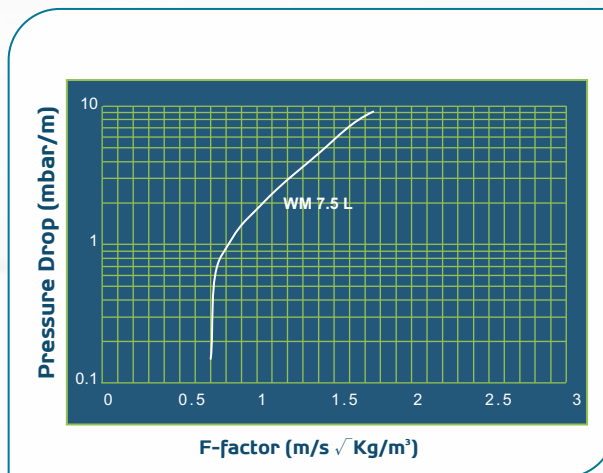
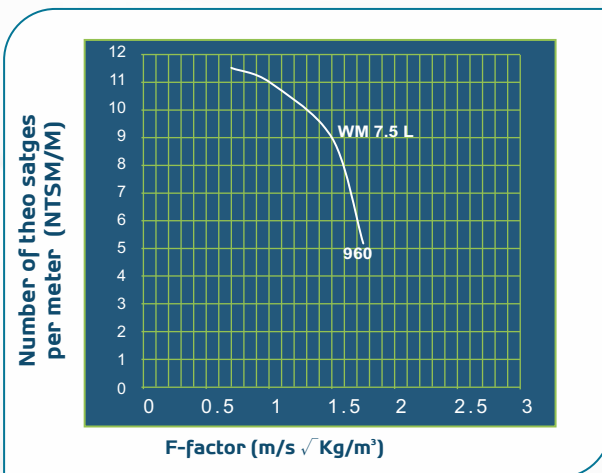
### Finepac 7.5 Packing



### Finepac WM 5.0 Packing



### Finepac WM 7.5 Packing



Performance of other Finepac packing configuration available on request

# FINEPAC RANDOM PACKING

## Delivering optimized separation performance for any application

For a long period of time Random packings have been used for distillation, absorption & stripping operations in the process industry. Random packings have stood the test of time as they provide a number of benefits in high liquid load and high pressure applications with high absorption efficiency and reduced pressure drop. More over the ease of replacements and storage makes random packings the ideal choice for systems involving heavy fouling or corrosion.

Owing to our experience and technical expertise in this field, Finepac provides a broad portfolio of random packings which deliver reduced capital and operating costs even in the most commanding applications. Whatever be the process requirements, Finepac random packings are available in the required materials and sizes to deliver an optimized performance.

## Process Advantages of Random Packings

As discussed before a number of process advantages can be realized using random packings. The main reasons to use tower packings are

- Reduced pressure drop through the column.
- Reduced liquid hold up through the column
- Variety of packing types for different types of processes
- Higher capacity compared to trays at same efficiency.
- Good performance in fouling conditions.

## Material of Construction

Stainless steels, Carbon steel, Nickel based alloys, Aluminium, Titanium etc.

Other special materials available on request.

# FINEPAC METAL RANDOM PACKINGS

## FP – Pall ring Random Packing



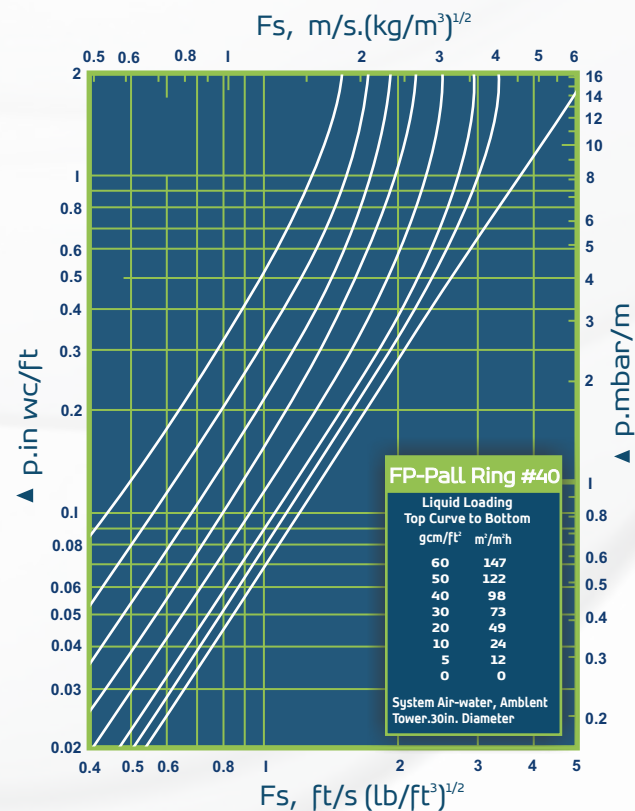
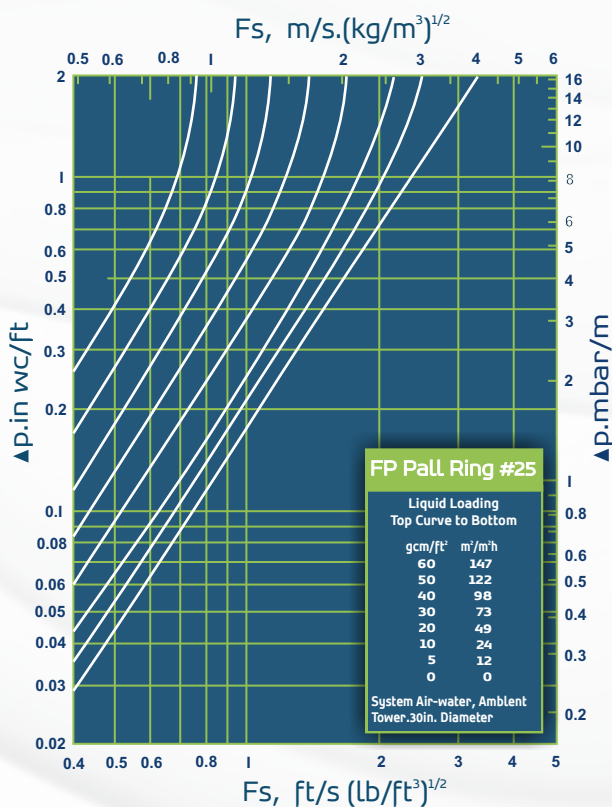
Pall ring random packing is still used widely today. The FP-Pall ring random packing is the industry recognized Pall ring packing equivalent. These packings provide enhanced capacity under a wide range of operating conditions and provide good mechanical strength owing to its geometric shape.

### FP-Pall Ring

### FP-Pall Ring packing sizes

Normal Size (mm)	13	16	19	25	38	50	75
Number Per Cubic Meter	4,00,000	2,10,000	1,00,000	51,000	13,500	6,500	1,820
Specific Surface Area(m <sup>2</sup> /m <sup>3</sup> )	430	345	250	208	131	98	71
Void Fraction %	90	93.1	94	94.5	95	96	96
Packing Factor F	73	71	63	48	28	20	18

Other FP-Pall Ring configurations available on request

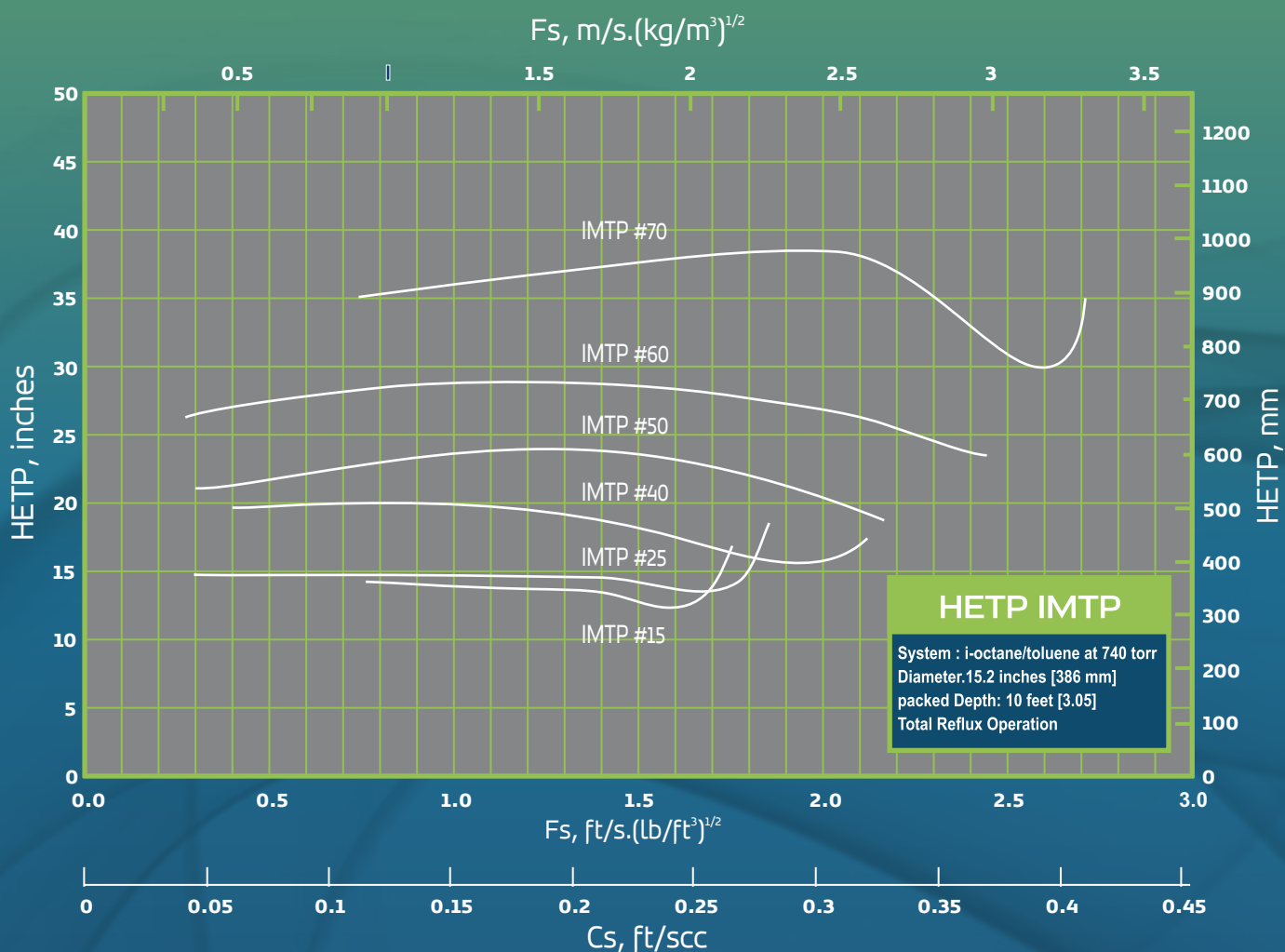


### FP- Pall Ring performance

## FP-IMTP Random Packing



These packings are the industry recognized equivalent of the IMTP random packing. These were the first high performance packings used commercially on a large scale. They combine the advantages of the saddle shape packing with the modern high performance of the ring type packing. The particular shape of these packings provides a lower pressure drop at the same vapour and liquid loads compared to the packings of the previous generation. These packings have been popularly used in distillation and absorption columns for many years.



### FP-IMTP ring performance

FP-IMTP Ring	FP-IMTP Ring packings sizes					
Normal Size (mm)	15	25	40	50	60	70
Specific Surface Area (m <sup>2</sup> /m <sup>3</sup> )	305	226	151	100	80	60
Void Fraction %	97	97	98	98	98	98

Other FP-IMTP ring configurations available on request

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## FINEPAC PLASTIC RANDOM PACKINGS

For more than 50 years, random packings have been used successfully as an inexpensive but efficient means to increase tower capacity and efficiency. Plastic random packings are especially useful for corrosive applications with low to moderate operating temperatures and can offer economic advantage over metal packings.

**Finepac offers a wide range of traditional and high performance plastic random packings in a variety of configurations.**



**FP-Pall Ring**



**FP-Super Saddle**



**FP-Tellerette**

Other Plastic Random packings available on request.

Packings available in a wide variety of sizes.

### **Material of Construction**

- Polypropylene (PPE)
- Polyvinylidene fluoride (PVDF)
- Polyvinyl chloride (PVC)
- Fluorinated ethylene propylene (FEP)
- High density polyethylene (HDPE)

## FINEPAC CERAMIC RANDOM PACKINGS

Ceramic random packings typically find their application in processes involving high temperature and chemically corrosive media. These packings are made from chemically resistant porcelains and are most suitable for use in highly corrosive acidic media and high temperature applications.

These packings generate an extremely thin film which promotes the mixing of liquid and vapour.

**Finepac is a proven manufacturer, exporter and supplier of ceramic random packings in a variety of configurations.**



**FP-Pall Ring**



**FP-Super Saddle**



**FP-Saddles**

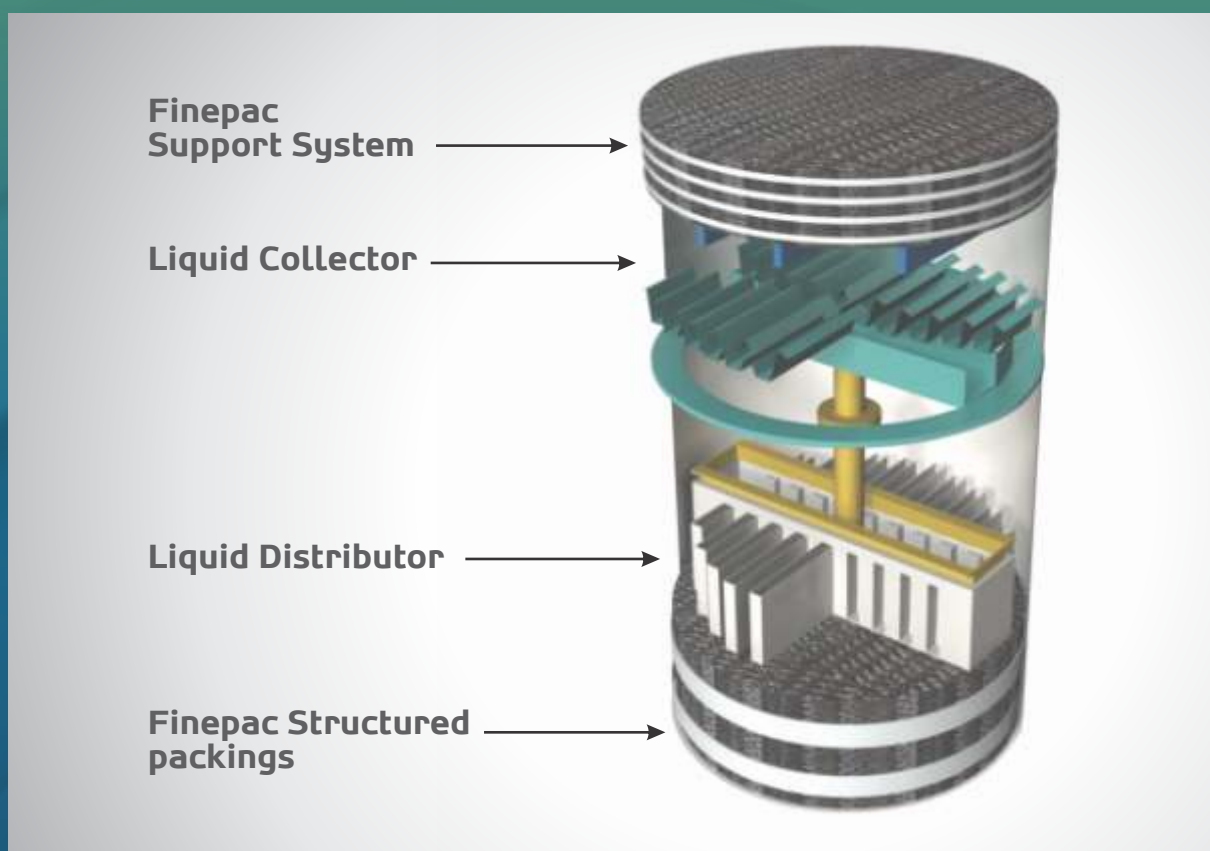
Other Ceramic Random packings available on request.

Packings available in a wide variety of sizes.

# FINEPAC COLUMN INTERNALS

## System accessories for Finepac Packings

Structured packings can give their best performance only when complemented with appropriately designed column internals for optimum liquid-vapour distillation to the packed beds. A flawless column performance can thus be achieved using the fully integrated system.



## Column Arrangement

Finepac offers a proven range of internals for a wide range of flow rates, physical properties and turndown requirements. We provide the following range of internals.

- Finepac distributors
- Finepac collectors
- Finepac auxiliary Internals

## FINEPAC LIQUID DISTRIBUTORS

### Distributors for optimum separation performance

Liquid distribution is one of the most important functions in distillation columns with structured packings. The high separation efficiency of structured packings can only be achieved with precision engineered liquid distributors. Owing to our vast experience and technical know-how in the area we design and manufacture, liquid distributors capable of delivering performance of the highest order.

### Finepac Liquid Distributors Characteristics

**Number of drip points :** 150-200/m<sup>2</sup> depending upon application and liquid load.

**Liquid loads:** Less than 0.1 to greater than 250 m<sup>3</sup>/m<sup>2</sup>h depending upon distributor design.

**Flexibility:** Standard turndown ratio (1:25). Higher ratios to the order of (1:10) possible using multi-stage distributors.

### Material of Construction

Stainless steel, High alloy steel, Nickel based alloys, Carbon steel, Titanium.  
Other special materials available on request.

### Liquid Distributor Configurations

#### Channel Type Distributor



- Normally used in column diameter upto 1.5m and flow rates in the range of 1-35 m<sup>3</sup>/m<sup>2</sup>h
- Liquid is fed into a large central channel and then distributed through the holes in the individual channel onto the packing.

#### VEP Distributors

- Normally used in large diameter columns with flow rates in the range of 1-35 m<sup>3</sup> / m<sup>2</sup>h
- Feed liquid is pre-distributed at a controlled rate from main channel to individual arm channel.
- Larger hole diameters than conventional discharge systems.

### Trough Type Distributor



- Normally used when column diameter is less than 1m
- Similar to channel type distributor
- Liquid first flows into the main channel and then to the individual arm channel.
- Surface area coverage is high for the distributors.

### Pipe Type Distributor



- These distributors are generally used when the requirement is for a distributor which is non sensitive on moving conditions like offshore columns of vessels.
- The liquid discharge takes place from the underside of distributor tubes
- Not suitable for liquids with solid contaminants.

### Pan Type Distributor



- Normally used in columns with diameters upto 1.2m and flow rates in the range of 2.5 – 75m<sup>3</sup>/m<sup>2</sup>h
- Orifices for liquid flow are provided in the bottom of the pan
- Vapour passage is provided by circular or rectangular gas risers

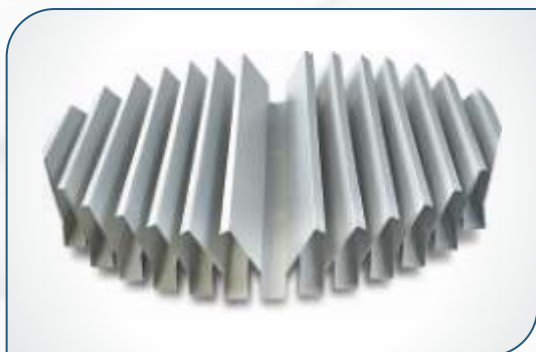
**Other distributor configurations available on request**

# FINEPAC LIQUID COLLECTORS

## For flawless liquid collection and transfer

Liquid collectors are placed between 2 packing sections. The liquid trickling down from the upper section is collected in the collector and from there it is passed to the liquid distributor placed below. They facilitate cross mixing of streams with the internal column liquid.

## Finepac offers Liquid Collectors in the following configurations



### Lamella Type Collector

- The collector is used as a separate unit to accumulate liquids from the packing sections from the above column
- It requires a ring channel which is then welded to the column wall.
- The pressure drop of this collector is negligible.



### Flange Type Collector

- These collectors are normally used in small diameter columns
- These are designed to be installed between column flanges.



### Customised Liquid Collectors

- Different separation tasks require different set of collector requirements.
- Occasionally we need to provide collector configurations to suit the client requirements.  
In these scenarios we custom design and manufacture
- collectors exactly as per the client specifications.

# FINEPAC AUXILIARY INTERNALS

## Internals to complement collector – distributor systems

The range of column Internals provided by Finepac is completed by its range of specialized column Internals. Integrating these internals with collector-distributor systems and high performance packings ensures a flawless column performance.

## Finepac offers the following auxiliary internals



### Flash Box:

Captures impurities, prevents foaming



### Support Grid:

Supports packed layers within a column



### Chimney Tray:

When side draw of a product is required



### Multi Beam Support:

Supports random packings, gas injection



### Bed Limiter:

To limit the packed height of random packings

## EQUIPMENT TESTING FACILITIES

### Delivering Quality Assurance

We at Finepac consider it very important to deliver an assured quality on all our products. For this purpose we run two state of the art equipment testing facilities to rigorously test our products against a stringent set of internal inspection procedures. This ensure our delivered products are exactly as per the customer specification

- **Pilot plant for structured and random packings**
- **Liquid distributor test plant**

#### Pilot Testing Facility



- The Finepac pilot plant is specifically built for testing out packing performance. Following are the key features of the plant.

#### **150mm column diameter, 10m column height fully equipped pilot plant**

- Preparation of vapour liquid equilibrium (VLE) data for unknown mixtures
- Testing packing performance at different operating conditions
- Testing minimum and maximum load limit for structured and random packings
- Research and development of new packing types

#### Distributor Testing Setup



Each Finepac distributor is tested at our distributor testing setup to a quality test with water. Following are the key features of the setup.

- Range of flow rates from 0.05m<sup>3</sup>/hr to 200m<sup>3</sup>/hr
- Distributors upto 8m in diameter can be tested.
- Parameters like distribution accuracy, leak test, throughput and operating range can be effectively tested.



# FINEPAC MASS TRANSFER TRAYS

## High performance trays for severe service.

Mass transfer trays have traditionally played an important role in thermal fractionation for a very long time. To meet the increasing demand for reliability and high performance rating in processing equipments, Finepac offers an extensive portfolio of mass transfer trays tailor made to meet exact performance requirements of your specific application.

## Finepac offers the following tray configurations.

- **Sieve Trays** – For simple mass transfer solutions
- **Bubble cap trays** - For applications involving high turndown.
- **Fixed Valve trays** - For low pressure drop
- **Float valve trays** -For greater operation flexibility
- **Cartridge trays** – For small column diameters.

## Tray configuration guideline

Following parameters impact tray operation and have to be considered during the tray design

- Active area
- Downcomer area
- Open area (hole area)
- Tray spacing
- Down comer clearance
- Outlet weir height
- Flow path length
- Number of flow paths

## FINEPAC TRAY CONFIGURATIONS

### Sieve Trays

These trays are generally considered as low cost mass transfer solutions. These are generally used in applications where a high turndown is not necessary. Finepac offers a number of options in sieve tray design as per the process requirements.



### Bubble Cap Trays

These trays are provided with inverted bubble caps having vertical slots fixed over cylindrical risers. Vapour travels upwards through the risers and diffuses through the bubble caps. These are generally used for low liquid loads & wide range of turndown ratio without weeping.



## Floating Valve Trays

These trays are provided with either round or rectangular floating valves. Valves are floating due to vapour flow from the underneath. This maintains a near constant pressure drop with respect to variation in vapour flow rate. Due to this characteristic valve trays sustain higher tray efficiency. They are generally used in applications involving high turndown ratio.



## Fixed Valve Trays

The fixed valve trays has valves in a bridge like construction extruded from the tray deck. This construction allows for increased stiffness to the tray deck. These valves provide large vapor passages and operate at low pressure drops with high capacities. These trays exhibit excellent fouling resistance characteristics.



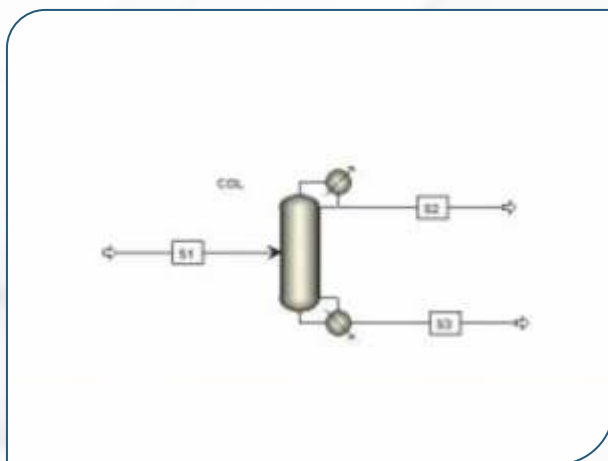
## Cartridge Trays

These trays are generally used in small diameter columns where physically installing the tray is not a feasible option. They are assembled in bundles for easy and fast installation. They are used in column diameters ranging from 300mm to 1m.



## FINEPAC PROCESS DESIGN AND ENGINEERING

In addition to delivering state of the art process technologies and product solutions, the Finepac portfolio of services also includes a complete range of technical services in the field of mass transfer and separation technology. Our comprehensive technical expertise and vast experience in this field enables us to provide you an optimized process design and engineering for any separation task.



**Our process engineers and experts can offer you a full spectrum of process and engineering related services for a wide variety of process tasks including**

- Process description
- Feasibility study
- Process flow diagram (PFD)
- Piping and instrumentation diagram (P & ID)
- Equipment specifications
- Column internals and tray selection
- Detailed equipment engineering
- Process guarantee
- Selection and sizing of revamps and retro fits

# VESSEL FABRICATION

## Benchmark for quality in vessel fabrication

To compliment its range of column internals and oil & gas internals Finepac also provides precision engineered ASME Pressure vessel design & fabrication. Services for over 20 years we have partnered our expertise in vessel fabrication with customer requirements to produce quality products.

We fabricate process equipments from all grades of stainless steel, carbon steel, high alloy steel, copper, aluminium etc. We guarantee international quality fabrication inspected by reputed third party inspection agencies.

### We provide for

- World class manufacturing facility
- Customised design and fabrication services
- Vessels certified with U stamp, S stamp and ASME certification
- Vessels fabricated in accordance to nationally recognised standards including TEMA standard

## Core Competencies

### Design

Finepac's services provide the experience of industry leading design and engineering to help ensure that our solutions exceed customer expectation. We also provide for full technical support for your project from concept through to installation.

### Fabrication

Craftsmanship and quality are our hallmarks. Our ASME certified welders & inspectors use the latest technology to ensure that every product meets our rigid quality standard. Our fully equipped facilities allow us to fabricate all our products inhouse which helps us to control the delivery time as well as the possibility to fabricate any vessel large or small.

**Finepac offers fabrication solutions for the following process equipments.**



**Columns**



**Heat Exchangers**



**Pressure vessels**



**Reactors**

**Other fabrication solutions available on request.**

## **Quality Assurance**

Quality of our products is of paramount importance to us at Finepac. We design our products to utmost precision, manufacture them to ensure optimum degree of quality & test against a rigid set of internal inspection procedures. In addition we also provide for third party inspections by reputed inspection agencies like Ceil, Beareu Veritas, TUV etc.



 **FINEPAC<sup>®</sup> STRUCTURES PVT. LTD.**

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