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SEPARATOR AND REACTOR
INTERNALS
PANTAN is a well-established leading designer and manufacturer of a complete range of Process Vessel internals for the Oil, Gas and Petrochemical Industries.

For well over a decade now, our company has developed a comprehensive range of products and services including:

- Fractionation Trays
- Packed Tower Internals
- Separator Internals
- Reactor Internals
- Site Services

PANTAN certified according to ISO 9001:2015 for Designing and Manufacturing of Process Vessel Internals. Our principal focus is on improving products quality and customer satisfaction.
Proper consideration of the feed inlet design is also critical. Typically this may be either an open nozzle, elbowed pipe with target wear plate, half open pipe or in some cases, especially where high liquid loads and slug flow are anticipated, it is advisable to install a Panta Inlet™ vane device.

Separator Configuration

There are three principal categories of separation process for which PANTAN offer comprehensive package of Vessel Internal Hardware and Engineering Support.

There are three principal categories of separation process for which PANTAN offer comprehensive package of Vessel Internal Hardware and Engineering Support.

### Table of Typical Application

<table>
<thead>
<tr>
<th>Type</th>
<th>Device</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Panta Mesh™ &amp; Panta Vane™</td>
<td>Packed, Trayed Columns, Particulate Scrubbers, KO Drums</td>
</tr>
<tr>
<td>2</td>
<td>Panta Mesh™ &amp; Panta Vane™</td>
<td>Packed, Trayed Columns, Fouling Service</td>
</tr>
<tr>
<td>3</td>
<td>Panta Vane™</td>
<td>KO Drums, Suction Scrubbers</td>
</tr>
<tr>
<td>4</td>
<td>Panta Mesh™</td>
<td>Particulate Scrubbers</td>
</tr>
<tr>
<td>5</td>
<td>Panta Vane™</td>
<td>Production Separators, Slug Catchers</td>
</tr>
<tr>
<td>6</td>
<td>Panta Settle™ &amp; Panta Vane™</td>
<td>Production separator &amp; 3 Phase Separator</td>
</tr>
</tbody>
</table>

The vessel configurations shown on these pages are simplified to show typical arrangements only. In almost all cases, vessel dimensions, including inlet and outlet nozzle size and locations, are critical to the proper functioning of the separator internals.
### Demister Pad

Panta Mesh™ Mist Eliminator comprises a pad of knitted wire mesh sandwiched between two rigid grids to provide support. Liquid mists collect on the wires as the bulk vapor travels through the pad. The collected liquid droplets coalesce into a continuous film on the wires and drain from the mesh under gravity.

Droplet removal is by inertial impaction. As the gas flows through the Panta Mesh™ pad, it must flow around the dense matrix form by the knitted wire and as a result the entrained liquid droplets will tend to collide and coalesce on the wire surfaces. The coalesced liquids will tend to retain on the wire surface by capillary action and will drain from the Panta Mesh™ pad under gravity unless the gas velocity or liquid loading exceeds the capacity limit. Removal of any droplet size can be calculated based on centrifugal forces and Stokes Law.

In general droplet removal efficiency increases with:
- Increasing Gas Velocity
- Increasing Gas and Liquid density difference
- Decreasing Gas Viscosity
- Increasing Mesh Density
- Increasing Mesh Pad Thickness

Specifications of some popular types of mesh pads which are used in most processes are listed in the below table:

<table>
<thead>
<tr>
<th>Panta Mesh™ Type</th>
<th>Material</th>
<th>Efficiency</th>
<th>Wire Diameter (mm)</th>
<th>Mesh Density (kg/m³)</th>
<th>Surface Area (m²/m³)</th>
<th>Void Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM-145</td>
<td>Metal</td>
<td>Moderate</td>
<td>0.28</td>
<td>144</td>
<td>255</td>
<td>0.28</td>
</tr>
<tr>
<td>PM-195</td>
<td>Metal</td>
<td>High</td>
<td>0.28</td>
<td>192</td>
<td>360</td>
<td>0.28</td>
</tr>
<tr>
<td>PMH-125</td>
<td>Metal</td>
<td>High</td>
<td>0.15</td>
<td>128</td>
<td>460</td>
<td>0.15</td>
</tr>
</tbody>
</table>

### Vane Pack

Panta Vane™ Mist Eliminator consists of a series of specially profiled baffles that removes liquid droplets from vapor stream by the inertial impaction of the droplets on the baffles. The liquid droplets carry over with vapor which has been crossing vane zigzag do not intend to change direction, so collide to latter and forming larger droplets which trickle downward to the liquid in the bottom of separator drum.

Specifications of types of Panta Vane™ are as below:
- Simple vertical flow vane (VC0 Series)
- Single pocket horizontal flow vane (HZ1 Series)
- Double pocket horizontal flow vane (HZ2 Series)

Specifications of some popular types of mesh pads which are used in most processes are listed in the below table:

<table>
<thead>
<tr>
<th>Panta Vane™ Type</th>
<th>Drainage Channel</th>
<th>Vane Pitch</th>
<th>Fouling Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC0-225</td>
<td>None</td>
<td>25</td>
<td>Good</td>
</tr>
<tr>
<td>VC0-325</td>
<td>None</td>
<td>25</td>
<td>Good</td>
</tr>
<tr>
<td>VC0-425</td>
<td>None</td>
<td>25</td>
<td>Good</td>
</tr>
<tr>
<td>HZ1-225</td>
<td>Open</td>
<td>25</td>
<td>Reasonable</td>
</tr>
<tr>
<td>HZ1-325</td>
<td>Open</td>
<td>25</td>
<td>Reasonable</td>
</tr>
<tr>
<td>HZ1-425</td>
<td>Open</td>
<td>25</td>
<td>Reasonable</td>
</tr>
<tr>
<td>HZ2-220</td>
<td>Open</td>
<td>20</td>
<td>Reasonable</td>
</tr>
<tr>
<td>HZ2-320</td>
<td>Open</td>
<td>20</td>
<td>Reasonable</td>
</tr>
<tr>
<td>HZ2-420</td>
<td>Enclosed</td>
<td>20</td>
<td>Avoid</td>
</tr>
</tbody>
</table>

For most application, K=0.107 m/s, may however be used for estimation purposes. To account for the effect of induced maldistribution Panta Mesh™ should be sized with:

\[
Cs = K \times \left( \frac{(d_l - d_g)}{d_g} \right)^{0.5}
\]

Where: 
- \( d_l \) = Liquid density (kg/m³)
- \( d_g \) = Gas density (kg/m³)
- \( K \) = Mesh capacity factor (m/s)
- \( \Delta P \) = Pressure drop (Pa)
- \( V \) = Superficial Gas Rate (m/s)
- \( Q \) = Gas rate (m³/s)
- \( A_F \) = Net face area of Panta Mesh™ pad (m³)

**Panta Mesh™ Pressure Drop Curve**

The liquids collected by the Penta-Mesh™ Pad will re-entain if the gas load on the Pad face exceeds:

\[
Cs = K \times \left( \frac{(d_l - d_g)}{d_g} \right)^{0.5}
\]

Where: 
- \( d_l \) = Liquid density (kg/m³)
- \( d_g \) = Gas density (kg/m³)
- \( K \) = Mesh capacity factor (m/s)
- \( \Delta P \) = Pressure drop (Pa)
- \( V \) = Superficial Gas Rate (m/s)
- \( Q \) = Gas rate (m³/s)
- \( A_F \) = Net face area of Panta Mesh™ pad (m³)

The degree of removal of any droplet size can be calculated based on centrifugal forces and Stokes Law. In general droplet removal efficiency increases with:
- Increasing Gas Velocity
- Increasing Gas and Liquid density difference
- Decreasing Gas Viscosity
- Increasing Vane Angle
- Increasing Vane Pitch
**Multi-Cyclon**

Panta Spin™ Centrifugal Mist Eliminators consist of multiple cyclone pipes. An intense spinning motion is induced into the gas entering the cyclone pipes which throws the liquid droplets onto the pipe wall due to the resulting centrifugal forces.

**Features:**
- Higher gas and liquid handling capacity
- More compaction with the same duty
- Higher removal efficiency for large droplets

Multi-cyclone is usually combined with another Mist Eliminator device such as “Demister Pad” placed upstream for better operation. These devices having either coalescing or demisting roles and improve total droplet removal efficiency.

**Plate Pack Coalescer**

Panta Settle™ Coalescers are used to enhance the separation of two immiscible liquids. They perform very effectively in two phase liquid-liquid separation or in 3 phase separation provided the feed to the separator does not contain a stable liquid emulsion. The gravity settler works solely on the principle of stokes law, which predicts the rate of rise or fall of droplets of dispersed fluid inside continues phase. The Panta Settle™ as Parallel Plate Pack includes metal plates by narrow space between them to form channel to drain away coalesced liquid. To facilitate capture of the dispersed droplets, the plates are inclined to the horizontal, which promotes droplet coalescence into films, and to guide them for entrapment into channels, thereby preventing remixing with the Continues phase.

<table>
<thead>
<tr>
<th>Penta Settle™ Style</th>
<th>Plate Pitch (mm)</th>
<th>Plate Angle</th>
<th>Fouling Resistance</th>
<th>Droplet Cut-off Size Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPP-15F</td>
<td>15</td>
<td>45°</td>
<td>Low</td>
<td>20-50 Microns</td>
</tr>
<tr>
<td>PPP-20F</td>
<td>20</td>
<td>45°</td>
<td>Moderate</td>
<td>30-100 Microns</td>
</tr>
<tr>
<td>PPP-25F</td>
<td>25</td>
<td>45°</td>
<td>Moderate</td>
<td>50-200 Microns</td>
</tr>
<tr>
<td>PPP-25S</td>
<td>25</td>
<td>60°</td>
<td>Good</td>
<td>50-300 Microns</td>
</tr>
</tbody>
</table>
\section*{Vane Inlet Device}

Panta Inlet™ reduce inlet momentum, and promote initial bulk separation of Vapor-liquid feeds to a vessel. A uniform distribution plays essential roles in separation efficiency. Panta Vane Inlet™ consist of a series of curved vane arranged in heavy duty housing.

\textbf{Features}

- Reduced inlet nozzle size
- Lower formation of fine mists and emulsions
- Improved Vapor distribution
- Lower Vapor velocities
- Lower liquid re-entrainment
- Reduced slug momentum
- Reduced liquid load on mist eliminator

\section*{Computational Fluid Dynamic (CFD) Analysis}

The CFD uses to analyze products, key further and new products development whilst CFD reduces the volume of necessary experiments for design studies where would hardly be available.

PANTAN use CFD to investigate the flow regime in wide range of products like Distributors, Vane Pack, Multi-cyclones and etc. This tool allows us to increase the separation efficiency and to optimize the design rules.

\textbf{Velocity magnitude and Pressure distribution simulation results in (a) Panta Spin™ and (b) Panta Vane™}
PANTAN design and manufacture a wide range of reactor internals for media retention for both axial flow and for radial flow Reactors.

### AXIAL Flow Reactor Internals

The down flow or up flow systems are widely used in Desulfurizers, Hydrotreaters, Hydrocrackers, Molecular Sieves, Gas Sweeteners and other Absorption Process. PANTAN design and manufacture wide range of internals for these systems to retain the media and to provide a proper collection area for the process flow across the entire vessel diameter or length. These are:

- Distributor Tray
- Quench Mixer
- Catalyst Support Grid
- Scale Trap
- Inlet Diffuser
- Outlet Collector

#### Distributor Tray

In the hydroprocessing reactor, the hydrocarbon feed is reacted with hydrogen over a fixed bed of catalyst at an elevated temperature and pressure. For petroleum fractions heavier than naphtha, the mixture of hydrocarbon feed and hydrogen typically consists of two phases: a liquid phase and a vapor phase. In order to use the catalyst efficiently, the liquid and the vapor must be distributed uniformly across the reactor cross-section. Our standard Distributor Trays is multi chimneys type which are generally composed of lateral openings (holes notches spaced vertically up the axis of the chimney) for liquid and superior apertures for gas.

#### Quench Mixer

In two phase hydproprocessing reactors with quench in inter-bed, a mixing device is required in order to contact the quench fluid with vapor and liquid media from above catalyst bed for efficient transfer phenomena with uniform composition and temperature profiles in the bed below.

#### Catalyst Support Grid

Support Grids are designed to provide sufficient strength to support catalytic beds under normal operating conditions while at the same time without creating any capacity restriction in the column, a suitable support grid selection depends on the type of catalyst as well as maximum design load. The Support Grids surface are furnished by wire meshes or wedge wire screens which are the filtering elements for retaining catalyst media.

#### Scale Trap

A series of cylindrical screens arrayed at the top of the upper catalyst bed either to collect metallic contaminates or scales from plugins the top surface of the upper catalyst bed or to increase the total surface area of the upper catalyst bed to extend the bed’s useful life.
The radial flow systems are widely used in Catalytic Reforming, Styrene Dehydrogenation, NOX Removal Systems, Solvent Recovery, Ammonia Converters, and Isomerization Processes. These reactor are employed for their high-volume flow capacity with minimal pressure drop. Radial flow systems increase contact efficiency between the process stream and catalyst bed which causes vessel size reduction. These type of reactors not only produce a higher yield, but also they are more energy efficient.

The main internals of a radial flow reactor are:
- Center Pipes
- Scallop
- Cover Plates

In its simplest form a radial flow system consist of two concentric screens and an annulus filled with catalyst slots on both the center screen and outer basket are oriented vertically to allow media to slide against the screen surface during processing without becoming abraded by the slot edges.

Inlet Diffuser
It is designed to prevent flow maldistribution in the bed and to avoid movement of the catalyst bed by high-velocity impingement. Inlet Diffuser reduces kinetic energy of feed to ensure that the distribution of feed inside reactor or in the Distributor Tray below is not turbulence directly from the inlet tube.

Outlet Collector
It is designed to give an even flow distribution at the bed outlet in order to ensure optimal utilization of the catalyst in the bottom of bed, another task of Outlet Collector is to prevent the catalyst, inert Ball and fines from entering the outlet pipe.