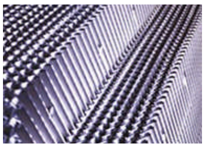
Coalescers

OVERVIEW

There are numerous industrial applications requiring effective physical separation of two process liquids. HAT has developed a number of **AlphaSEP™** Coalescers to handle a wide range of duties from severe fouling or viscous service through to fine polishing of clean, light liquids.

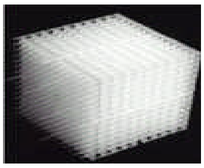
Standard Types:

FP Flat Plate Coalescers
50 – 150 m^2/m^3 Interface Area



MP Matrix Pack Coalescers
150 – 350 m^2/m^3 Interface Area

High Performance Types:



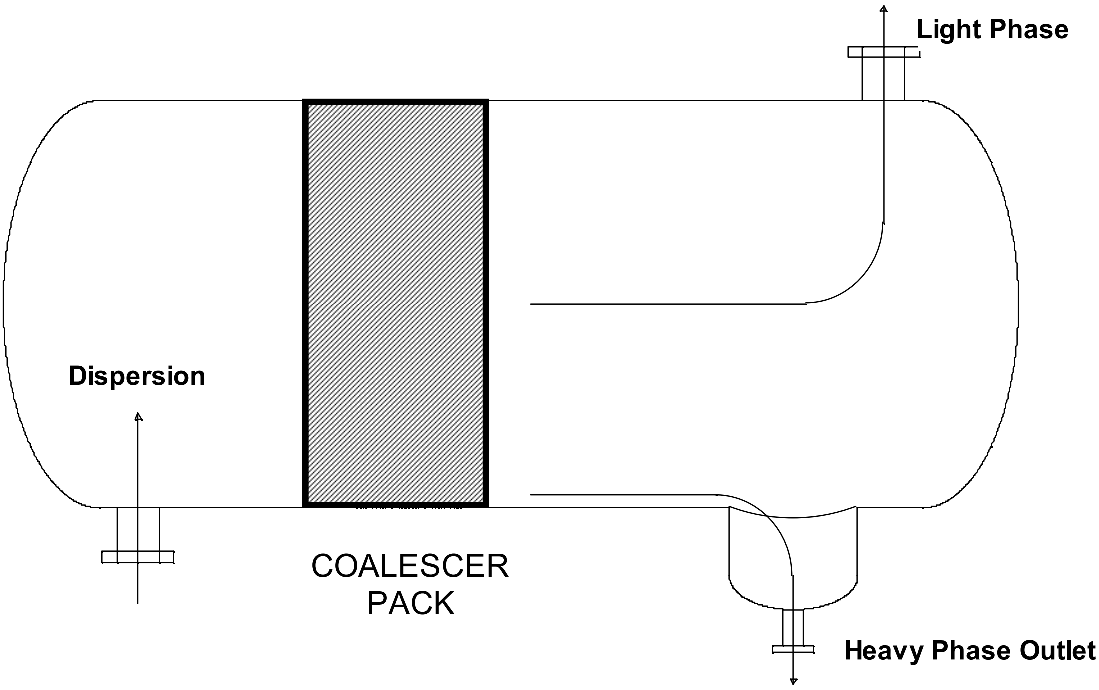
LP Pack Coalescers
433 m^2/m^3 Interface Area

DM Dual Media Mesh Coalescers
750 m^2/m^3 Interface Area

Plate Coalescers

Mixtures of immiscible liquids can generally be separated by a process of settling as a result of the density difference between the two phases. However gravitational settling becomes increasingly difficult as the droplet size of the dispersed phase decreases. The settling process can be enhanced considerably by passing the dispersion through a suitable coalescer pack.

HAT's **AlphaSEP™ FP** Flat Plate Coalescer Packs are specifically designed to be used as effective coalescers in dirty liquid-liquid service where a level of phase separation is required that cannot be obtained in an empty, gravity separator. Coalescer style, face velocity and configuration will depend on the specific application.



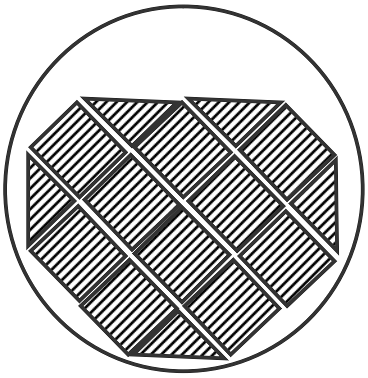
TYPICAL ARRANGEMENT OF SEPARATOR VESSEL

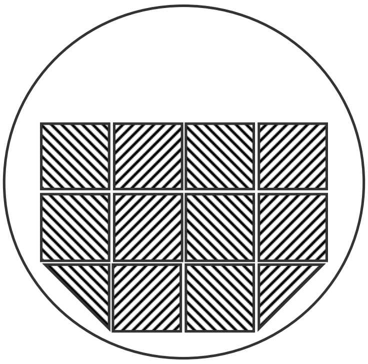
Liquid-liquid separator vessels are usually arranged horizontally as shown above. The coalescer pack is used to enhance the separation of liquid dispersions and consists of angled, flat metal plates with a spacing and style to suit service conditions. Generally a 45° slope is used, but this can be increased to 60° for particularly severe fouling service to ensure any solids fall from the plates to avoid plugging.

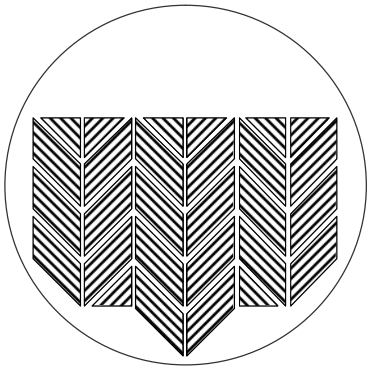
Plate Coalescers

Plate spacing is typically 15 – 25mm (giving a bulk surface area between 75 and 125 m^2/m^3), standard pack length is 1000mm and the complete pack is assembled using a modular system from sub-assemblies. These sub-assemblies are designed to pass through vessel manways and be easily bolted together within the vessel. Unlike other manufacturers, HAT does not normally supply loose panel systems unless specifically requested, due to the added complexity and lower mechanical integrity.

Several styles of **AlphaSEP** FP packs are available as illustrated below.







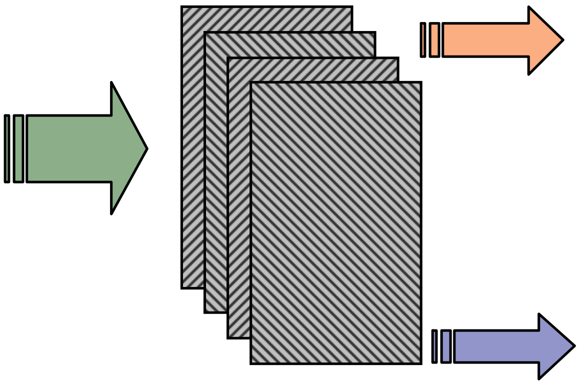
Type FP-A	Type FP-B	Type FP-C
This has the simplest construction, being blocks measuring 300 x 300mm face area stacked in a diamond pattern. However, the exit paths for the phases and solids are longer so this style is generally used for clean, coarse separation.	A more advanced design of pack, again using 300 x 300mm modules, but stacked in a square pattern. This allows each row of packs to be reversed giving the characteristic 'fishbone' pattern, which provides drainage channels for the different phases and solids.	Our most sophisticated pack constructed from trapezoidal modules in which the plates are also provided with self-cleaning gutters ensuring that solids are deposited behind the pack rather than below it as with the other common designs. The mechanical integrity is also very high.

Dispersions of droplets sized over 1000 microns tend to be very unstable and separate rapidly under gravity. Dispersions of droplets sized below 10 microns tend to be very stable and do not easily separate. Flat plate coalescers as shown above are very effective in coalescing all droplets as small as 100 microns into droplets greater than 1000 microns.

Matrix Coalescers

Mixtures of immiscible liquids can generally be separated by a process of settling as a result of the density difference between the two phases. However gravitational settling becomes increasingly difficult as the droplet size of the dispersed phase decreases. The settling process can be enhanced considerably by passing the dispersion through a suitable coalescer pack.

HAT's **AlphaSEP™ MP** Matrix Coalescer Packs are specifically designed to be used as effective coalescers in light fouling liquid-liquid service where a level of phase separation is required that cannot be obtained in an empty, gravity separator. Coalescer style, face velocity and configuration will depend on the specific application. The packs can also be used in gas-liquid service for foam breaking applications.



Liquid-liquid matrix coalescer packs are usually arranged vertically as shown above. The pack consists of corrugated metal plates with a spacing and style to suit service conditions.

Pack surface areas are typically 125 and 250 m^2/m^3, standard pack depth is 600mm and the complete pack is assembled using a modular system from sub-assemblies. These sub-assemblies are designed to pass through vessel manways and be easily stacked together within the vessel.

Most packs are supplied in stainless steel, but they are also available in exotic alloys as well as stable plastics such as PVDF.

Matrix Coalescers

Sizing

Dispersions of droplets sized over 1000 microns tend to be very unstable and separate rapidly under gravity. Dispersions of droplets sized below 10 microns tend to be very stable and do not easily separate. Matrix coalescers as shown above are very effective in coalescing all droplets as small as 50 microns into droplets greater than 1000 microns.

The matrix pack used for liquid-liquid coalescing is similar to that used for other applications such as structured packing in absorber and distillation towers, and to static mixing elements. It is the velocity through the pack that is critical in determining the effectiveness for each application. In liquid-liquid separation for instance, at low Reynolds numbers the dispersed liquid droplets will, due to the frequent direction changes and high surface area, bump into each other and the metal surfaces and coalesce into larger drops which easily separate. As the velocity rises however and the flow becomes more turbulent, these larger droplets will be torn apart and any dispersed liquid layer on the metal surface will be dragged from it and also broken up into a dispersion. In effect the pack becomes an effective static mixer.

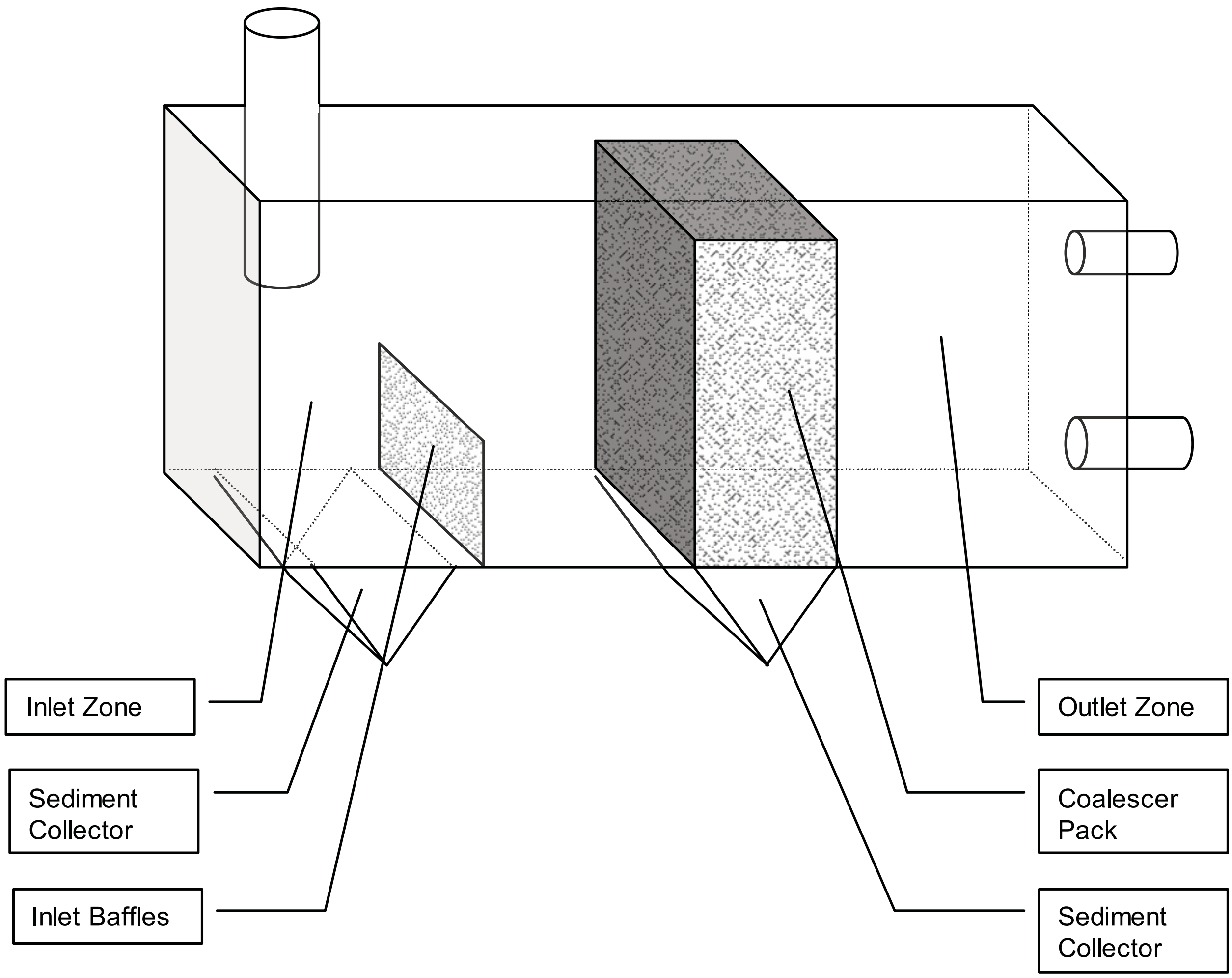
Depending on the degree of separation required and the characteristics of the dispersion, the liquid flux rate should typically be kept below 2 m^3/m^2.minute for sizing these coalescer packs.

Pack Model	Description	Applications
MP-250-S	250 m^2/m^3 surface area with 45° plate angle	Best performance in clean service
MP-250-H	250 m^2/m^3 surface area with 60° plate angle	As above, will tolerate some light fouling
MP-125-S	125 m^2/m^3 surface area with 45° plate angle	Lower pressure dop suits clean, viscous liquids or foam breaking
MP-125-H	125 m^2/m^3 surface area with 60° plate angle	As above, with light fouling

Polypropylene Packs

Mixtures of immiscible liquids can generally be separated by a process of settling as a result of the density difference between the two phases. However gravitational settling becomes increasingly difficult as the droplet size of the dispersed phase decreases. The settling process can be enhanced considerably by passing the dispersion through a suitable coalescer pack.

HAT's **AlphaSEP™ LP** Polypropylene Coalescer Packs are specifically designed to be used as effective coalescers in dirty oily water service where a level of phase separation is required that cannot be obtained in a gravity or plate separator. Coalescer arrangement, face velocity and configuration will depend on the specific application.



TYPICAL ARRANGEMENT OF LP COALESCER

Polypropylene Packs

Selecting the right coalescing media for the duty depends on many factors with initial consideration given to the droplet size range in the dispersion and the target separation performance.

Droplet Diameter Range	Media Type	Performance
> 1000 micron	None	80 – 90% Removal
100 – 1000 micron	Flat Plate Pack	90-95% Removal
50 – 500 micron	Matrix Pack	> 95% removal
20 – 300 micron	LP High Surface Pack	>99% Removal
10 – 100 micron	Dual Media Mesh Pack	> 99% Removal
5 – 20 micron	Cartridge Coalescer	> 99.9% Removal
< 3 – 5 micron	Specialist Filter	N/A

Performance indications for ideally designed vessel and system in a single stage

The high surface area media used in HAT's LP Coalescers easily passes the **EPA Method 413.2** test for removal of oil droplets 20 microns and larger. Testing at the Danish Institute of Technology confirmed that the media beats the efficiency requirements of the European Standard **CEN EN 858-1** for >99.9% oil removal regardless of droplet dize.

While removing oil efficiently, the LP media also shows superior resistance to plugging by sludge and iron deposits commonly found in oily water. The rounded rod design of the pack allows self cleaning. As deposits form on the polypropylene surfaces they quickly reach a critical mass that forces them to slough off the slick, vertical rods and fall into the sludge compartment below the media.

The AlphaSEP LP media has a specific surface area of 433 m^2/m^3. This can be compared with typical flat plate packs at 100 m^2/m^3 and matrix packs of 250 m^2/m^3.

Installation Options

For gravity flow systems commonly a rectangular (non-pressurised) separator design is used, whereas for pressurised systems a horizontal, cylindrical separator would be installed. In both cases the vessel is divided in to several zones:

Inlet Zone

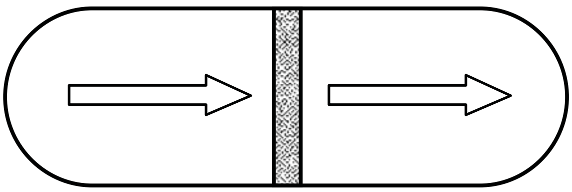
Where the fluid first enters the vessel a section is allowed for fluid calming, solids settling, and flow distribution to the next zone. Inlet devices would typically include pipe or trough deflectors or cyclones to encourage maximum initial solids separation. A system of baffles would then distribute the fluid for the next separation zone.

Polypropylene Packs

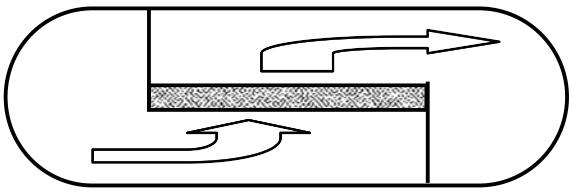
Separation Zone

This is where the bulk liquids flow through the coalescer pack and the separation is achieved. The primary factor here is to achieve the correct bulk velocity – too high and the residence time will be insufficient for all the droplets to be captured, also there could be a danger of turbulent flow through the media which would undo any separation achieved. A Reynolds number around 500 achieves maximum performance, although on some systems it may be higher where the performance is less critical e.g. the discharge is not into public water.

The packs may be placed across the axis of the vessel to achieve axial flow of the liquid through the media or, where a greater area is required, it may be placed along the central axis and the liquid sent in a cross flow arrangement.



Axial Flow



Cross Flow

A sediment collection system should be placed under the coalescer pack to remove the solids occasionally. For pressurised systems where access to the pack is more complex, consideration should be given to a liquid or gas spray/sparge system to occasionally aid pack cleaning should it be necessary.

Outlet Zone

The outlet zone is a quiescent, settling zone where the 2 phases are physically separated by means of a skimmer device such as a weir or an overflow bucket or trough. The size and depth of the skimmer depends on the relative quantity of the light phase liquid.

Polypropylene Packs

Sizing and Performance

The following curves are typical performance predictions for a pressurised oily water treatment system where the inlet oil droplet distribution is based on smaller particles than would be found in a gravity based system.

Where a droplet distribution is available we can calculate more accurate performance projections.