Pan America Environmental, Inc.

Model TPi

TPi

Tilted Plate Interceptor Steel Oil Water Separators

The TPi Series oil water separators are designed per the American Petroleum Institute (API) separator design guidelines

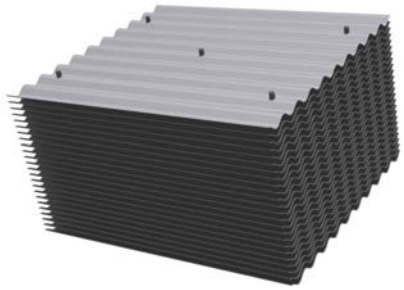
The TPi Series Tilted Plate Interceptors are designed per API-421 1st Edition, February 1990, Section 4 Parallel Plate Separators.

This design is based on a 60 micron oil droplet size with an expected performance of 50 mg/L or less non-emulsified free oil droplet.

TPi tank and plate packs can be used in high solids applications designed for a 45º - 60º angle range and a plate spacing of 0.50 -1.5".

Pan America provides its Wave Plate™ TPi pack which allows more surface area per plate pack footprint than our flat plate pack. TPi media packs are offered with and without 304 SS media frame.

***Wave Plate*™ Plate Pack**



Standard Features:

- A36 or 304 or 316 SS construction
- Water weir
- Oil skimmer
- Slotted inlet diffuser baffle
- Effluent chamber
- Gasketed vapor cover
- NPT/flanged fittings
- Vent fittings
- V-hopper Bottom
- TPi Wave Plate™ coalescing media
- Legs & lifting lugs

Typical applications:

- Refinery process water
- Oil Fields: Frac & Produced waters
- DAF/Clarifier pretreatment
- Power plant water treatment
- Aircraft wash racks
- Machining coolant oil removal
- Tank farm tank bottoms
- Vehicle washwater treatment
- R.O. Filter pre-treatment
- Oil spill recovery
- Trench water treatment
- Bilge water treatment
- Hydraulic fluid tank de-watering

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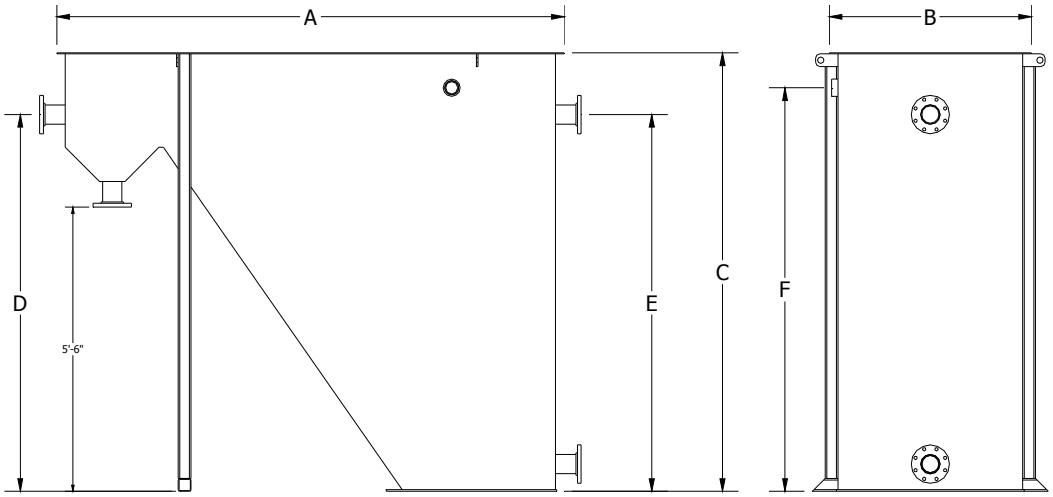

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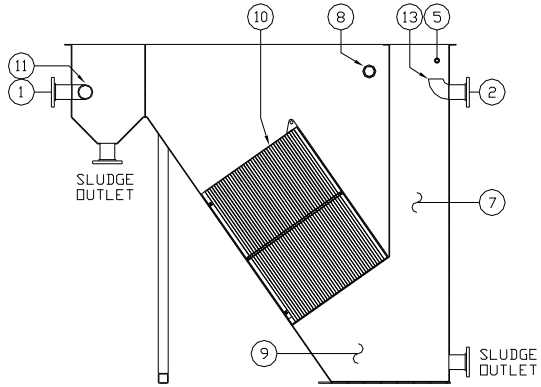
Plate packs with frame

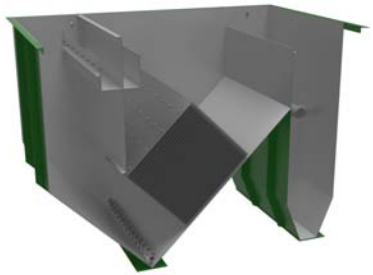
Model	Length A	Width B	Height C	Inlet D	Outlet E	Oil Outlet F	Sludge Vol. Gal.	Inlet Size	Outlet Size	Sludge Outlet Size	Oil Outlet Size	Empty Weight	Operat. Weight	Flow Rate GPM .90 SG
TPi-Half	10'-9"	2'-8"	8'-9"	7'-4"	7'-4"	8'-1"	125	4"	4"	4"	3"	2500	8100	57
TPi-Full	10'-9"	4'-5"	8'-9"	7'-4"	7'-4"	8'-1"	250	6"	6"	4"	3"	3000	14500	115
TPi-Dual	10'-9"	8'-0"	11'-3"	7'-4"	7'-4"	8'-1"	500	6"	6"	4"	3"	4500	27000	230
TPi-Triple	10'-9"	11'-5"	11'-3"	7'-4"	7'-4"	8'-1"	750	8"	8"	4"	4"	6500	40500	345
TPi-Quad	10'-9"	15'-0"	11'-7"	7'-4"	7'-4"	8'-1"	1000	8"	8"	4"	4"	11000	56000	459

Item	Qty	Desc		Qty	Desc		Qty	Desc		Qty	Desc		Qty	Desc
1	1	Inlet	4	2	Sludge outlet	7	1	Effluent chamber	10	-	TPi Pack	13	1	Weir
2	1	Outlet	5	2	Vent	8	1	Oil outlet	11	1	Inlet Diffuser	14	4	Lift Lug
3	1		6	1	Drain	9	1	v-hopper	12			15		



Dimensions, design and capacities are not for construction and are subject to change without notice. Flow rates shown above are based on an oil specific gravity of 0.90. Higher SGs can be removed at lower flows.

Alternate Designs
Can be provided



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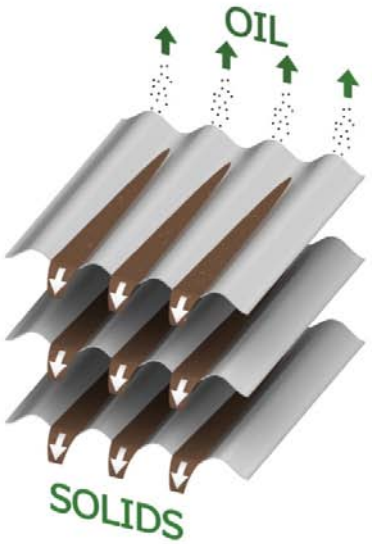
Separation Process Description

The TPi plate pack system provides a large surface area for oils to attach to and coalesce on in order to accelerate the oil separation process. Solids will encounter the media surface and be settled out faster than a tank without this plate system.

As the solids settle on the plates they slide down gathering together into a larger solids matrix and eventually fall off the plate end into the sludge hopper.



This plate system makes the TPi the best choice when an application has high solids and oil/fuels mixed together in the same wastestream.

System Sizing and Design

Once we have the application data necessary to determine the system design we decide on the pack size and surface area by calculating the required area via the API-421 calculations.
Upon evaluating the application we can provide standard plate pack designs or we can change the plate dimensions to increase or decrease overall pack size(s) to fit the project needs.

Where large flow rates are involved we typically will customize the plate packs to reduce the number of plate packs and the tank size/design whether in steel or concrete.

The plate pack angle can also be optimized for solids and oils to allow the solids to remove from the pack as effectively as the oils. Typical pack angles are 45°, 55° and 60°. The more steep the angle the more plates are required as we need to use the projected effective surface area when solids removal is a primary goal. With this in mind 55° is the standard angle we use in our Slant Plate Clarifier settler designs, which is optimum in settling processes to increase the speed of solids removal from the pack versus a lower angle.

Emulsified Oils

As with all coalescing style separation technologies dissolved and emulsified oils cannot be removed via coalescence or gravity separation.

To remove an emulsion prior to a TPi system a chemical eraction would need to be provided via acid for an acid cracking process (which needs to be jar tested to verify function) or other chemical process consisting of demulsifying chemical(s) that will break the emulsion to a free liquid layer.

Once the emulsion is broken to a liquid it can be separated by the TPi system. Jar testing of this process is recommended to verify your emulsion can be cracked in this fashion as each emulsion is different.

Custom Engineering

The TPi system can be custom engineered to fit a particular project, condition or specification in steel or concrete.

Pan America can also combine the TPi with many of our other water treatment technologies to provide a complete solution.

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Oil Water Separator Options Descriptions

Influent Feed System Air operated, diaphragm pump with air controls or progressive cavity pump, sump level switches & Nema 4 control panel, base mounted, 115/230/460V power offered. Electric diaphragm pumps available.

Effluent Pumpout Centrifugal pump with level switches & Nema 4 control panel, base mounted, 115/230/460V power offered. OS Effluent chamber must be expanded to accommodate pumpout or provision of an external pumpout tank.

Sludge Pumpout System Air operated, diaphragm pump with air controls & Nema 4 control panel, auto on/off timer, base mounted, 115V/1ph/60Hz power req'd. Progressive cavity pump system also available. 1 - 100 GPM.

Oil Pumpout System Air operated, diaphragm pump with air controls, level switches & Nema 4 control panel, base mounted, 115V/1ph/60Hz power req'd. Electric gear or progressive pump systems available. 1 - 100 GPM (larger if required)

Sludge Auger OS separator V-hopper(s) can be provided with a sludge auger. System consists of stainless steel shafts with coated steel screw auger(s) driven by a slow speed gear motor drive assembly. The auger extends the full length of the solids hopper(s) and conveys solids to the sludge outlet. A Nema 4 on/off control box is provided, power required: 230 or 460V/3ph/60Hz.

Freeze Protection Immersion heaters mounted through tank wall. Each heater has an independent thermocouple well, 0-100 deg. F thermostat and Nema 1 (or optional Nema 4) housing. 230/460V/3ph/60Hz power req'd.

Retpak Secondary Coalescer High surface area, reticulated, secondary coalescing media for polishing flow after standard Flopak media.

Oil Sight Glass Two automatic, brass valves with tempered sight glass and protection rods mounted in oil reservoir. If glass is broken check ball stops outflow from reservoir.

External Sight / Level Glass An externally mounted clear PVC sight tube is provided with multi-point level switch for indication or pump control of oil or water. Switch is removable for cleaning and inspection.

Elevation Stand Epoxy coated steel stand or legs to elevate tank to desired level. Standard deck height is 30". Full platforms & walkways with ladders or stairways can be designed where required or desired.

High Temperature Design Flopak coalescing media and any piping is constructed of a combination of CPVC &/or polypropylene (or other materials) for temperature resistance up to 200° F.

Alternate Media Construction Standard Flopak media is PVC. HPVC, polypropylene, glass-coupled polypropylene and 304/316 stainless media is available. Contact PAE to determine proper media type for your application. Media plate spacing is available in 1/2", 3/4" & 1.2".

External Storage/Feed Tanks A wide variety of tank volumes can be supplied for your water, product and sludge holding needs. Flat bottom and cone bottom designs constructed in polyethylene, fiberglass, steel & stainless steel can be provided.

Effluent Filter Systems Solids filter systems can be provided to remove filterable solids from the separator effluent. Contact Pan America to determine proper filtration needs for your application.

AQAM Filter Systems AQAM (Alkyl Quaternary Ammonium Montmorillonite) filter systems can be provided to remove trace hydrocarbons, sheens, DNAPLs, slightly soluble chlorinated hydrocarbons and high molecular weight organics from the separator effluent. Contact Pan America to determine proper filtration needs for your application.
Can be used to protect and increase GAC lifespan.

Carbon Filtration Systems (GAC) GAC carbon filters can be provided to remove contaminants after the separator. Contact Pan America to determine proper system needs for your application.

Emulsion Cracking Systems Emulsion cracking systems can be provided to remove oil-in-water emulsions prior to the separator. Contact Pan America to determine proper system needs for your application.

pH Adjustment Systems pH adjustment systems can be provided to maintain pH levels prior to or after the separator. Contact Pan America to determine proper system needs for your application.

System Containerization OS separators with any options can be installed in a 20 or 40' shipping container(s) to simplify system provision and field implementation. System would include the complete mounting, piping and wiring of the system in one or more container as required by the project.

Trailer Mounting OS separators can be mounted on a trailer for system mobilization. Trailer design generally includes corner leveling jacks, bubble levels, walkway, toolbox, electric or hydraulic brakes, piping and wiring of options.

Field Skid Mounting OS separator system can be mounted to a mobile skid with leveling for quick field mobilization.

Skid Mounted System OS separators can be combined with our other treatment equipment and options into a fully integrated, custom designed system completely mounted, plumbed and wired to a system skid. To simplify your need to do the wiring and plumbing on site, reducing

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your time frames and on site costs, we design around your requirements.

Vent Scrubber Separator vapors can be extracted and scrubbed prior to discharge to atmosphere to remove VOC content.

Level Sensors Level sensors can be provided to detect water and oil/fuels. One or more sensor points can be provided to perform various functions such as high level, low level, pump on/off based on liquid levels and level detection for DCS controls or other functions based on your needs.

Class 1 Div 1 & 2 Systems can be designed for use in a class 1 div 1 or 2 environment. Controls, components and wiring are changed to meet the needs of these environments. Intrinsically safe relays are also used for level sensors.

Oil Monitor An oil detection system can be provided to monitor effluent oil content and provide various actions based on the oil alarm setpoint. Actions might include: audible/visual alarm, redirection of influent or effluent via actuated valve, shutdown of influent pump or your custom action.

Oil Water Separation Theory

Coalescing Oil Water Separators: Coalescing Oil Water Separators are passive, physical separation systems designed for removal of oils, fuels, hydraulic fluids, LNAPL and DNAPL products from water. Pan America Environmental's designed performance can be described by a combination of Stoke's Law and current coalescing plate theory, wherein, the oil droplet rise rate and other parameters dictate the surface area required for gravity & coalescent separation.

Separation Process: The water/oil mixture enters the separator and is spreadout horizontally, distributed through an energy and turbulence-diffusing device. The mixture enters the Flopak media where laminar and sinusoidal flow is established and the oils impinge on the media surface. As oils accumulate they coalesce into larger droplets, rising upward through the pack corrugations until they reach the top of the pack, where they detach and rise to the water's surface. At the same time solids encounter the media and slide down the corrugations, falling into the v-hopper under the Flopak media.

Stokes Law: This equation relates the terminal settling or rise velocity of a smooth, rigid sphere in a viscous fluid of known density and viscosity to the diameter of the sphere when subjected to a known force field (gravity). The equation is:

$V = (2gr^2)(d1-d2)/9\mu$
where
V = velocity of rise (cm sec^{-1}),
g = acceleration of gravity (cm sec^{-2}),
r = "equivalent" radius of particle (cm),
dl = density of particle (g cm^{-3}),
d2 = density of medium (g cm^{-3}), and
μ = viscosity of medium (dyne sec cm^{-2}).

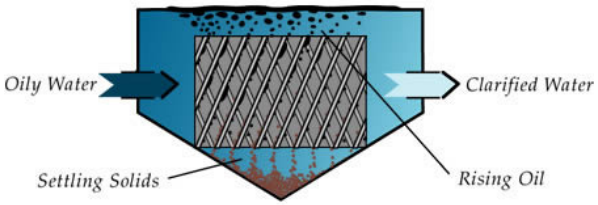
Coalescence: Gravity separation utilizes the difference in specific gravity between the oil and water. Oil separates from a fluid at a rate explained by Stoke's Law. The formula predicts how fast an oil droplet will rise or settle through water based on the density and size of the oil droplet size and the distance the object must travel. Our separators are built to exploit both variables of Stokes Law.

With the use of our Flopak media oil only need rise a short distance before encountering the oleophilic, coalescing media plates inside the separation chamber as opposed to rising a great distance in gravity separation. Upon impinging on the plates the oils coalesce (gather) into larger droplets until the droplet buoyancy is sufficient to pull away from the media and rise to the water's surface. The design will meet particular design criteria as indicated below:

- ☐ The hydraulic distribution of the influent flow must assure full usage of the cross-sectional area of the media to fully utilize the plate pack's surface area.
- ☐ Flow control and direction must be determined to prevent hydraulic short circuiting around, under or over the media pack.
- ☐ A laminar flow condition must be maintained (Reynolds "Re" number less than 500) in order to assist droplets to rise. Per the American Petroleum Institute's (API) Publication 421 of February 1990.
- ☐ Horizontal flow through velocities in the separator must not exceed 3 feet per minute or 15 times the rate of rise of the droplets which ever is smaller.
- ☐ The media containment chamber design, plate design/angle and spacing sufficient to facilitate removal of accumulating solids. Plates are to be smooth surfaced and angled at 60 deg.

Flopak Coalescing Media Design

Pan America's Flopak coalescing media provides a laminar flow path that creates a quiescent zone to facilitate the impact with and attachment of oils to the media surface by reducing wastestream turbulence and velocity. This control of the wastestream creates a more ideal environment for oil removal. By virtue of our Flopak media design, solids will also collide with the media and settle to the separator



bottom to some degree.Due to oil typically being lighter than water, they (oil) will rise up the coalescing plate. As the oil droplets rise up the plate they will coalesce or come together with other droplets, creating progressively larger droplets. Once the droplet size is sufficient or the droplet reaches the top of the media plate the droplet pulls away from the plate and rises to the water surface. To some degree, the solids replicate this process in reverse (settling).

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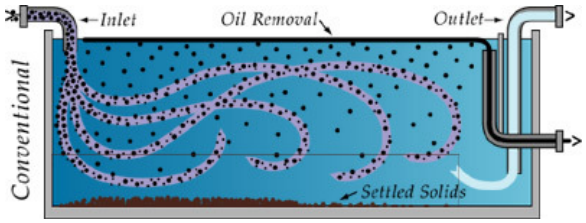
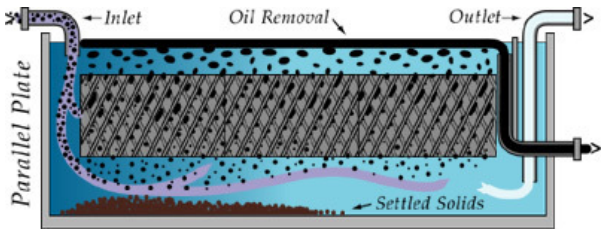
Gravity Separation vs Coalescing Plates

Two types of oil water separator exist today in varying types of design, but all are dependent on these two types of design.
The first and oldest type is gravity or conventional separation, simple separation via gravity (density differential between two immiscible liquids leads to one of them rising above the other). This design, when designed properly (or even improperly) provides a certain tank length, width and depth that provides a wide, quiet spot in the pipeline to give oils time to rise. This design (also known as an API separator) generally provides a discharge oil concentration of 100 ppm based on a 150 micron droplet size. The API type design relies on a large water volume. This correlates to a tank size that can be 5 times the size of an equally sized coalescing separator.

The coalescing design is known by many names ie. parallel plate, corrugated plate, slant rib coalescer so on and so forth. However, the concept, operation and design are generally the same. The coalescing concept is based on having a large surface area in contact with the wastestream (coalescing plates). The more surface area provided, the more enhanced the separation process will typically be. By using the coalescing media, the size of the tank is reduced and a higher performance is attained than by gravity separation. Pan America's Flopak coalescing design provides a discharge oil concentration of 10 ppm or less with an oil droplet size of 30 or as small as a 20 micron oil droplet.





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