

# An introduction to the Evodos Spiral Plate Technology®

## Redefining Particle Separation

### Introduction

Many industries have long faced the same challenging task: mechanically separating fine particles of <10 micron. The new and patented *Spiral Plate Technology®*, developed by Dutch company Evodos, now offers a formidable process improvement. It substantially accelerates and improves fine particle separation.

By completely redefining this separation process, Evodos fundamentally changes the ability of businesses to separate fluid mixtures. This paper describes the Evodos *Spiral Plate Technology®*, the mechanics of the *Dynamic Settlers®* and its key benefits for various organizational objectives.

### Concept

One key aspect that traditionally makes the particle settling process time-consuming, is the length of the path these particles must traverse before reaching their settling point. Solving this challenge required the development of brand-new technology, aimed at shortening this distance to a minimum. The *Spiral Plate Technology®* successfully solved this puzzle, based on the thin layer laminar flow principle.

This *Spiral Plate Technology®* achieves this with integrated spiral plates, mounted at a short distance from one another, thus minimizing the distance particles must traverse within the feed mixture. By having this mixture flow in a laminar way, artificial gravity is created, which accelerates the settling process. Together with the strongly reduced distance, it provides for an excellent cut-off rate, without using any chemicals. Furthermore, this particle separation method optimizes the energy transfer between the machine and the products, making it an energy-efficient solution.

### Discharging benefits

In addition to these separation cycle benefits, the *Spiral Plate Technology®* is also advantageous in the discharge cycle. As the discharge technology operates quite gently, even sticky substances are discharged as a near-dry and consistent cake.

### Static and dynamic settlers

The basic theory behind the Evodos *Spiral Plate Technology®* can be compared to a static settler. However, as artificial gravity is added to the process, this static process now becomes dynamic. The Evodos solutions are therefore defined as *Dynamic Settlers®*.

## 1. The benefits of dynamic settling

Before exploring the technical details, the initial helicopter view below specifies the abilities of this solution. This chapter explains how it contributes to critical business objectives, while also defining the corresponding benefits and explaining how these benefits are measured.

### The *Spiral Plate Technology®* is able to:

Mechanically remove solid particles (down to <2 micron) from your fluid process, with multiple applications in various industries and processes. These include:

- Waste stream treatment
- Solid control processes
- Production stream treatment
- Valuable solid recovery
- Enhancing existing production processes

### This helps organizations to attain the critical objectives of:

- Optimizing the quality of fluid processes
- Reducing waste management expenses
- Increasing product value
- Achieving a fully circular process
- Extracting valuable solids from fluid processes
- Decreasing carbon footprints

### Which helps them to, amongst others, achieve the following:

- Product stream process optimization
- Sustainability and circularity objectives
- Additional key differentiator from competitors
- Process cost savings

### The benefits are measured by:

- Actual cost savings
- Improved product extract quality
- Reduction of raw material consumption
- Separation effectiveness
- Waste reduction
- Business growth
- Reduced environmental footprint

## 2. The Evodos technology

To fully grasp this new technology, let's first take one step back to rediscover the principle of a static separator. In this type of separator, the time needed by solid particles to settle is determined by:

1. The difference between the particle's specific mass and the liquid (heavy particles sink faster).
2. The size of the particles (big particles sink faster).
3. The liquid's viscosity (e.g., particles sink more quickly in water than in oil).
4. Gravity pulling particles to the bottom of the tank (higher gravity makes particles sink faster).
5. The depth of the tank (particles settle more rapidly in shallow tanks).

The first three aspects cannot be influenced by any type of settler, as they are specifically related to the composition of the fluid and particles. What remains to accelerate the process, are gravity (4) and the settling distance (5).

Natural gravity does separate particles, but often takes a long time. In rivers for instance, gravity eventually causes particles to settle on the riverbed, as is shown in image 1.

Using the same example: many substances can be perfectly left to nature to have them settle in rivers. However, if these substances are either valuable and worth harvesting, or are hazardous to the environment, they must be extracted.

In this case, particle separation and discharge becomes a necessity and the process speed and efficiency determines its costs and benefits. The Evodos *Spiral Plate Technology*® is able to rapidly extract even the tiniest, stickiest and softest particles.

The next page explains how this process works.

Image 1

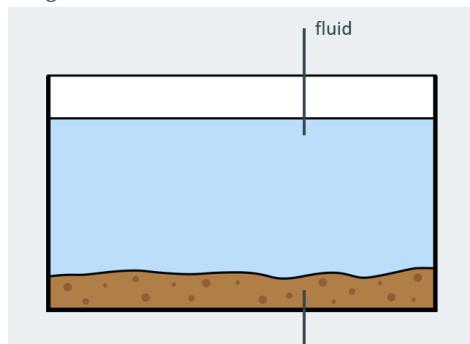
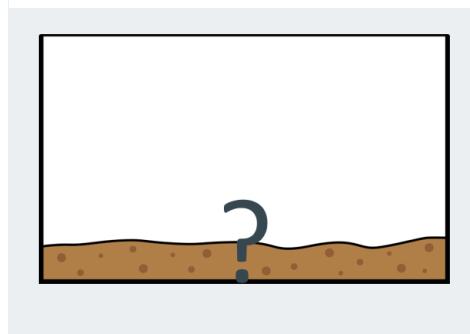


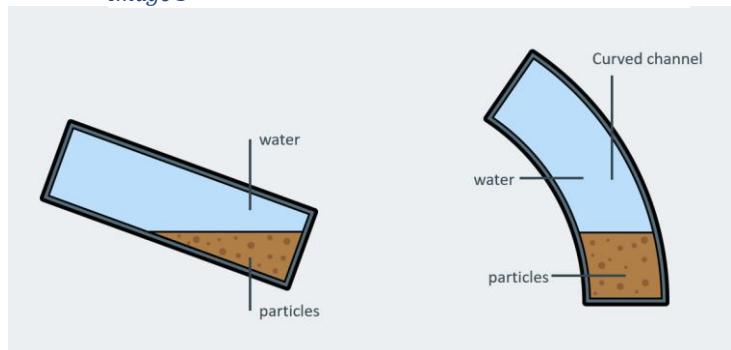
Image 2



The first step of the Evodos process is to increase the gravitational force. By applying centrifugal force to the liquid that contains the particles, artificial gravity is created. This makes gravity ‘work harder’ and strongly reduces the time particles need to settle.

Second: particles settling on a large surface are harder to extract and discharge. By tilting the surface (image 3, left), the surface is reduced. Even better however, is to add a curve to the settler (image 3, right). This creates an optimal way for collecting particles, as both the distance and surface are reduced to an absolute minimum.

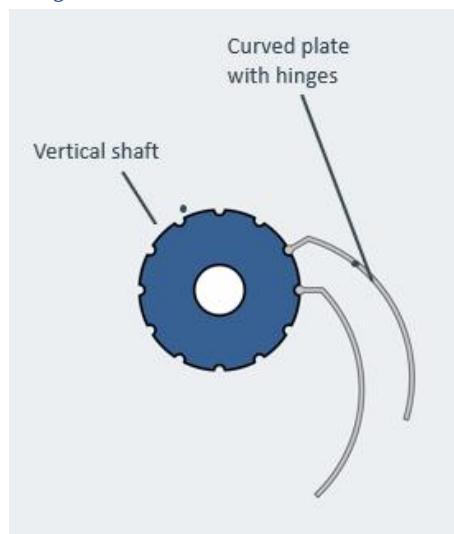
Image 3



In the *Spiral Plate Technology*®, Evodos engineered and integrated curved channels, by attaching curved plates that are hinged to a shaft (image 4).

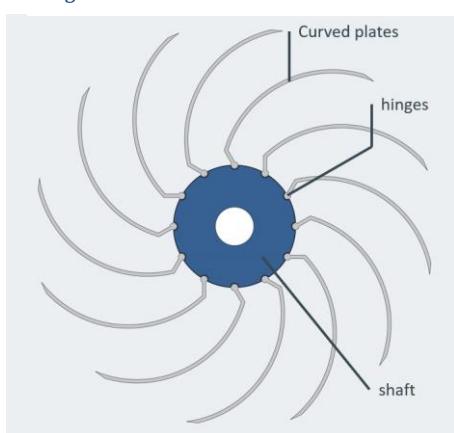
The shape of the *Spiral Plate Technology*® plates, causes the system to operate like the tilted horizontal settler shown in image 3. This set-up ensures optimal separation efficiency and solid separation. (image 4, cross sectional view)

Image 4



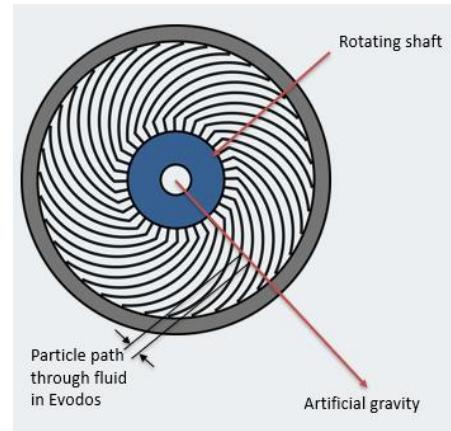
The hinged plates (image 5) are at the heart of what the *Spiral Plate Technology*® does: separating **and** discharging ultra-fine particles as small as 1 micron. This brand-new innovation was granted patent protection.

Image 5



Shown on image 6 is a cross-section of a *Spiral Plate Technology®* plate pack, in which the plates are positioned when the sliding drum has closed. The distance between two individual plates is no larger than approximately 7mm.

Image 6



As the **radial** distance between two plates is approx. 7 mm, the maximum path particles must traverse before settling on a metal surface therefore always is < 7 mm.

This significantly reduced path particle must travel through the fluid, results in a major increase of separation efficiency.

Image 7

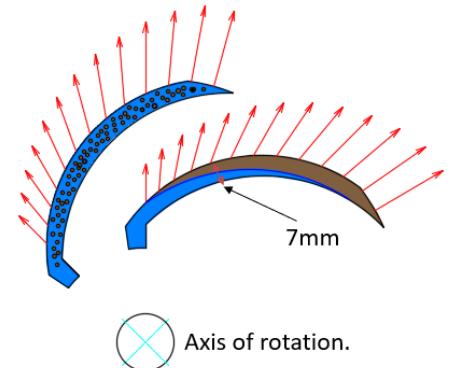
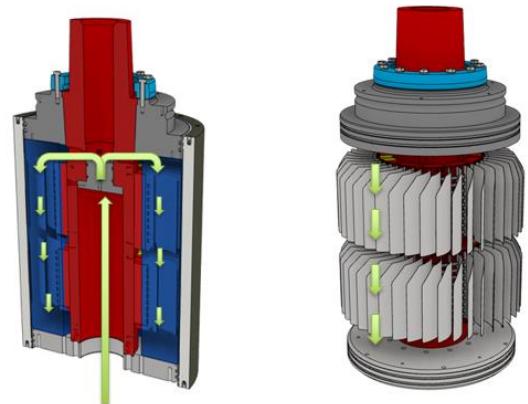
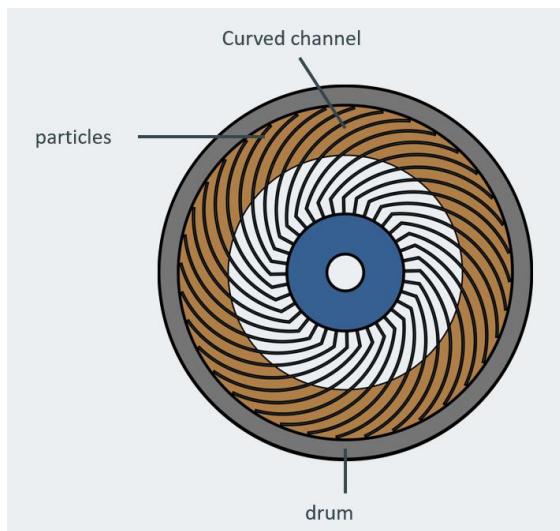


Image 8



During the process, the fluid mixture flows parallel to the main shaft. This means it flows in a vertical direction, in a so called laminar flow pattern. The plates ensure that multiple laminar flow patterns occur inside a single plate pack. Each of them represents an individual settler.

Image 9



The shaft, the curved channels and the outer drum all rotate at the same speed. As different elements of the machine are not exposed to friction, no wear and tear occurs.

The system rotates at a high velocity, thus creating artificial gravity. The fluids move in a continuous laminar flow, parallel to the main shaft. Artificial gravity works on the vanes at a  $\pm 45^\circ$  angle and applies a centripetal force on the fluid caught between the vanes of 2,000 - 4,500 x G.

All particles with a higher specific density than the fluid, will move slower than the fluid and travel towards the concave side of a plate as they are subjected to artificial gravity.

Due to the minor distance between two individual vanes, each particle only has to cross a particularly small distance ( $\sim 7\text{mm}$ ) to reach a plate, where it settles.

Once the bowl is half full, the system automatically switches to discharge mode. In this mode, all remaining fluid is pumped out of the system, after which the drum slides to its 'up' position. As a result, the curved plates are released from their hinges.

(Image 10, longitudinal sectional view).

Image 9

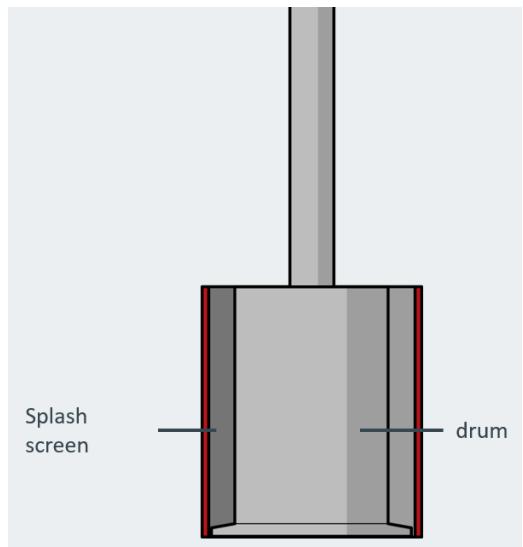
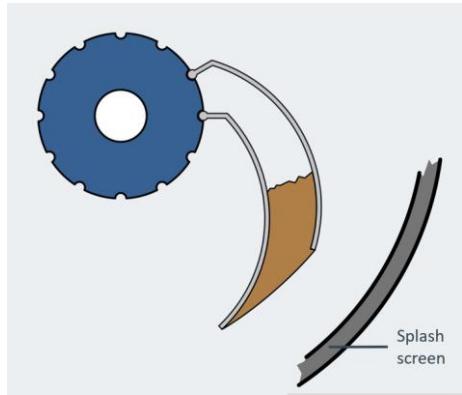


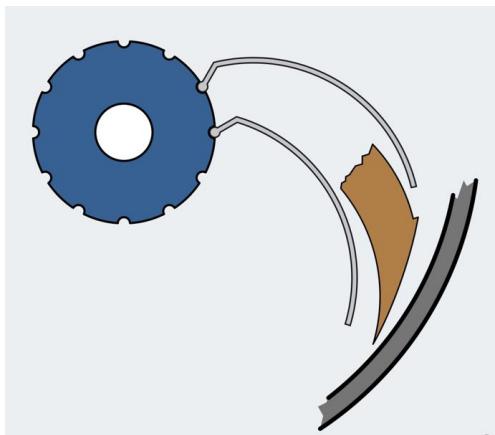
Image 10



The plates now swing outwards as the shaft counter-rotates in discharge mode (figure 11).

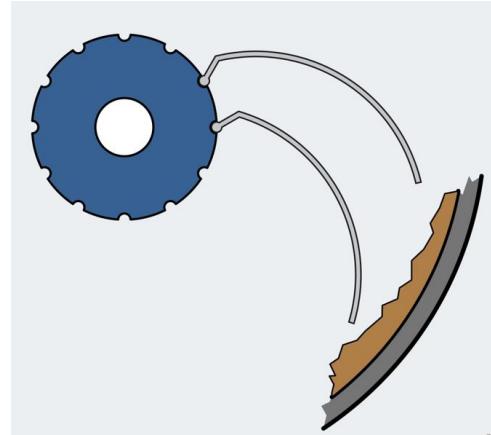
As the curved plates counter-rotate, the space between them increases. This helps artificial gravity to release the collected particle cake onto the splash screen (image 12).

Image 11



As the shaft counter-rotates at approx. 1,000 rpm the last particles detach from the curved plates and coat the inner side of the splash screen (image 13).

Image 12

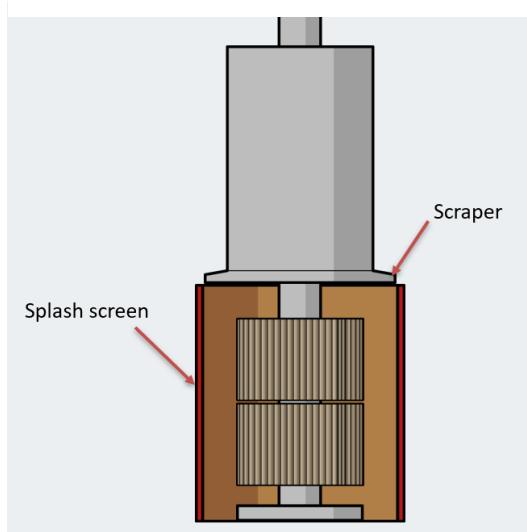


A scraper is installed on the bottom of the drum. Once the discharge mode is nearing completion, the drum is lowered and the particle cake is scraped from the splash screen into a bin or onto a conveyor. This fully automated discharge cycle only takes a few minutes and requires no manual action whatsoever.

While the drum is in its downward position, it locks the plates back into their 'in' position, preparing them for a new separation cycle. The entire PLC controlled sequence will then automatically repeat itself.

To watch a complete cycle of the Evodos 50, [watch this video on YouTube](#).

Image 13



### 3. Key benefits

#### *A revolution in fine particle separation*

The Evodos solution is designed to process mixtures which could, until now, only be processed with the aid of flocculants/coagulants, or contain soft, sticky or abrasive materials, or are slurries such as algae broths.

#### *Separation efficiency*

The Evodos separation efficiency and cut-off rate rise well above all existing industry standards. The *Spiral Plate Technology®* enables high separation efficacy by applying thin layer laminar settling, with an optimal settling area and the use of artificial gravity. The maximum particle trajectory is reduced to <7 mm.

#### *Independent of solid types*

All solid types can be separated and discharged. Solids may be abrasive, soft, gel-like, greasy, sticky, or any other texture. Evodos has a proven track record of successfully discharging them. Solids, which can even be non-permeable, can also be processed regardless of the mixture's permeability.

#### *Low energy consumption*

Evodos applies laminar flow, which requires a highly effective energy transfer between the machine and the mixture. Another positive effect of this laminar flow is its low energy consumption.

#### *Nearly dry discharge in the form of a consistent cake*

As process liquids are extracted before the discharge process commences, the solids are exceptionally dry. Within the drum, all solids settle based on the optimum packing theory. This ensures a nearly dry discharge of solids, with no more than minor amounts of process liquid remaining in the pores.

#### *Gentle discharge*

A gentle separation and discharge process allows sensitive cells – including the most fragile algae such as Dunaliella, Isochrysis and Diatoms – to remain fully intact. Injection of the liquid into the system is done gently and at a limited gravitational force of 300 G's, thus creating the paste or solid discharge in a gentle and non-pressurized process. As the discharged organic cells are not damaged, they have a long shelf life.

#### *No chemicals required*

All particles are separated without chemicals such as flocculants and coagulants. This lowers costs and simplifies the operator process, who no longer has to add different quantities of chemicals to compensate for feed flow variations. As long-chain chemicals create larger pores, the discharged cake is also much dryer. Evodos relies on the optimal packing theory, which reduces pore size to a minimum.

#### *No temperature increase*

Evodos is designed for a minimal energy demand, resulting in <0.2°C differences between the feed and discharge effluent flow.

#### *Minimal noise and vibrations = minimum maintenance*

Applying a free axis of rotation results in minimal vibration, noise and maintenance needs.