

**CHEMICAL FREE MECHANICAL REJUVENATION OF OIL BASED DRILLING MUDS**

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**SUMMARY**

The Evodos *dynamic settler*<sup>®</sup> is a novel approach to solids/liquid separation. It outperforms what is on the market today for (ultra) fines removal from oil based drilling muds.

While drilling, oil based mud accumulates fines. In particular, the ultra-fine (<10 micron) solids affect the fluid flow properties of the drilling mud. The Evodos *dynamic settler*<sup>®</sup> will remove these fines, including the ultra-fines, in a purely mechanical way. Your mud can be recycled by reducing the mud weight to the level that you desire, without adding new base fluid.

On top of this, together with the solids, part of the water present in the oil based mud is removed by the Evodos *dynamic settler*<sup>®</sup>. Hence the oil water ratio and the electrical stability of the drilling fluid are improved simultaneously.

The conclusion is clear: Through the application of the Evodos *dynamic settler*<sup>®</sup> you can recycle your used drilling fluid back to a virtually virgin state. You may either do this at the drill site or at the mud plant. Each option gives tremendous benefits.

The fines that are removed from the drilling mud are discharged as a rather dry cake, with low oil content. This will significantly reduce your disposal costs.

The Evodos *dynamic settler*<sup>®</sup> is robust. It is designed to process abrasive material. All components that wear due to the flow of the mud through the Evodos *dynamic settler*<sup>®</sup>, are concentrated in one assembly. This assembly, called *process cartridge*<sup>®</sup>, can quickly be exchanged for ease of maintenance. The Evodos is simple to operate and maintain and it is largely self-cleaning.

We report here the successful application of the Evodos *dynamic settler*<sup>®</sup> in processing oil based drilling muds.

**TEST RESULTS**

A variety of Oil Based Muds were processed with an Evodos *dynamic settler*<sup>®</sup> in North Dakota/USA and Saskatchewan/Canada during July-September 2014. An independent lab has measured the results.

The Evodos *dynamic settler*<sup>®</sup> can process oil based drilling muds optimally up to a specific gravity of 1.2 kg/l or 10 PPG. More solids rich muds can best be

first run through a decanter to achieve the optimum mud weight for subsequent processing through an Evodos *dynamic settler*<sup>®</sup>.

Please note that all data presented below, are based on processing Low Gravity Oil Based Muds with the Evodos *dynamic settler*<sup>®</sup>. These muds already have passed a shale shaker and a decanter. In this manner the Evodos is optimally used in removing (ultra) fines.

Hereafter you find the results of 3 separate tests, which have been averaged for confidentiality reasons. Here the definition of ‘Feed’ is the mixture that is fed into the Evodos and the definition of ‘Product’ is defined as the effluent of the Evodos.

Weight reduction

After processing with the Evodos *dynamic settler*<sup>®</sup> the mud weight is reduced with over 16%. Note that the specific gravity of the oil phase is 0.78. See figure 1.

	<u>weight ppg</u>	<u>weight kg/l</u>
Feed	9,1	1,09
Product	7,6	0,91

Figure 1: mud weight

As the Evodos process is purely mechanical, chemical free and without thermal shock, the physical and chemical profile of the processed base oil is not affected.

Particle size

The following table shows a significant reduction in (ultra) fines in the effluent. Given are the particles size in microns for similar distribution percentiles of the feed and the product.

	<u>D10</u>	<u>D50</u>	<u>D90</u>
Feed	2,36	7,95	35,91
Product	0,45	1,12	3,52

Figure 2: particle size distribution (table)

Figure 3 shows the same information in a graphical format:

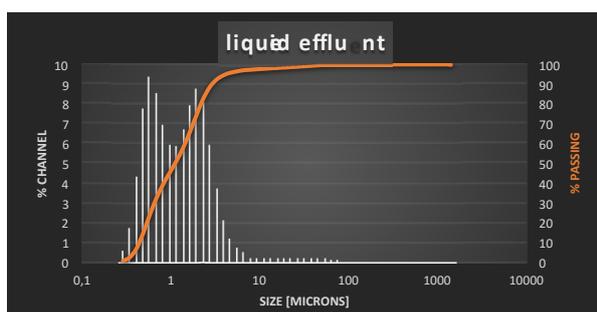
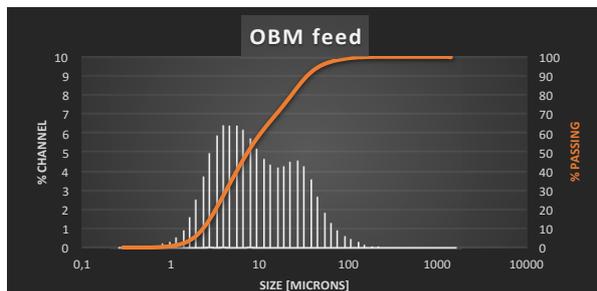


Figure 3: particle size distribution (graphs)

Oil/water ratio improvement

The following table shows the improvement in the oil/water ratio of the feed compared to the product:

	<u>Oil</u>	<u>Water</u>
Feed	85%	15%
Product	96%	4%

Figure 4: oil/water ratios

Electrical stability improvement

Electrical stability is one of the essential properties of oil-based mud. It is considered a measure of its emulsion stability. After processing the drilling mud with Evodos the electrical stability increased on average by 130%. See figure 5.

	<u>ES</u>
Feed	822
Product	1893

Figure 5: electrical stability

Plastic Viscosity improvement

	<u>cP</u>
Feed	11
Product	4

Figure 6: viscosity

The table clearly shows a significant reduction in viscosity.

Discharged solids

The Evodos *dynamic settler*<sup>®</sup> discharges the solids as a cake with high dry solids content as demonstrated in the following figure 7:

Oil	20 weight%
Water	14 weight%
Solids	66 weight%

Figure 7: cake composition

The following graph shows the particle size distribution in the discharged solids cake.

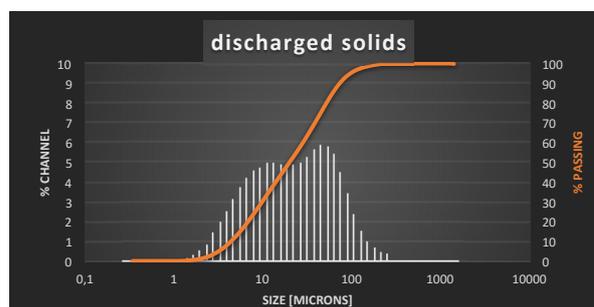


Figure 8: particles size distribution of the discharged solids

**BENEFITS**

Up until now large amounts of oil based muds are disposed of after use because of too high ultra-fine solids content. Now with the Evodos *dynamic settler*<sup>®</sup> there is a better alternative. Processing oil based drilling mud with the Evodos *dynamic settler*<sup>®</sup> will give a:

- signification reduction in (ultra) fines
- reduction in mud weight
- improved oil/water ratio
- higher electrical stability
- improved viscosity
- no chemicals used
- no dilution so prevents mud volume growth
- concentrated discharged solids

These results indicate significant benefits compared to other mud recycle alternatives. This allows a fundamentally new approach for both usage at the rig site as on the mud plant.

#### Usage at the rig site

The Evodos *dynamic settler*® may be used onsite to maintain optimal constant drilling fluid quality without dilution.

This can be achieved by processing 15-20% of the mud with the Evodos *dynamic settler*® in a kidney setup. The Evodos *dynamic settler*® has the required flow capacity for this application.

The Evodos *dynamic settler*® effectively **eliminates the need to dilute weighted used mud with new low-density fluid**, resulting in significant cost savings.

#### Usage at the mud plant

The Evodos *dynamic settler*® can collect **reusable mud** from the waste by mechanically removing the ultra-fines at the mud plant.

Only the solids from the mud are processed in a thermal unit.

**Thermal desorption units run more economically** since only the concentrated cake needs to be processed.

### **SPIRAL PLATE TECHNOLOGY**

Evodos redefined separation by accelerating nature through the use of spiral plate technology®.

Stokes' law explains the resistance or drag a particle experiences in a fluid and is used to interpret a particles settling behaviour as a function of the particle, gravitational force and the fluids viscosity. Laminar flow of the fluid is essential and such conditions enhance the ability for a particle to settle under gravitational forces. Evodos developed *spiral plate technology*® that enhances gravitational forces, similar to centrifuges, but also minimizes settling distances and maintains laminar flow of the fluid during the treatment process.

The spiral plates allow an optimal energy transfer between the Evodos machine and the mixtures being separated by it. By reducing the travel distance of particles, separation processes that were impossible before, are in your reach now.

The key characteristic of the Evodos *dynamic settler*® is a plate pack where the surface of the plates runs parallel with the machine's axis of rotation (Fig. 9). The arrangement of these plates is such that the maximum settling distance of a particle is less than 7 mm. These plates form thin layers through which the mixture flows in a laminar way. By creating artificial gravity through rotation, the settling

process is accelerated. What is unique about this approach is that fluid to be processed is accelerated to the rotational speed almost instantaneously and shear in the bowl is minimized reducing mechanical wear and emulsion breakdown.



Figure 9: Evodos spiral plate pack

This design is therefore robust with respect to the high abrasive nature of drilling mud solids. Unlike scroll centrifuges, the wear of outer scroll flights does not occur in the Evodos *dynamic settler*® because they are pressed to and rotating at the same speed as the drum.

The Evodos system has been effectively commercialized in other industries. Now the equipment is adapted to meet the requirements in the Oil & Gas industry.

### **ABOUT EVODOS**

Evodos is a Dutch high-tech company purely focusing on mechanical separation of liquid/liquid and liquid/solid streams.

Evodos was born as a result of thinking outside the box by starting from scratch. Not focussing on how to improve existing technologies, but on how we can respond to today's and tomorrow's separation challenges. Years of research have led to the introduction of the Evodos *dynamic settler*®. By accelerating nature's laws, we have challenged and extended the standard in separation technology.

**MORE INFORMATION**

When you would like more information on Evodos and its *dynamic settler*® please contact:

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