

Dynamic Settling - A New Technology of Mechanical Solids Separation for Enhanced ECD Control

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Abstract

Dynamic settling is a mechanical solids separation technology that targets the problematic ultra-fines below 10 microns. Since the introduction of shale shakers in 1922 we have seen various improvements to enhance solids separation and minimize associated fluid losses. However, ultra-fines (1-10 microns) can up to today only be controlled via dilution. Dilution hides the problem and does not remove the root cause. It increases volumes which is against the main principle of waste management. Dynamic settling technology minimizes or even eliminates the required dilution volumes by removing the root cause in a cost effective manner.

Introduction

Since the introduction of Shale shakers in 1922 we have seen various improvements to enhance solids separation and minimize associated fluid losses. However, ultra-fines (10-1 micron) can only be controlled via dilution. Dilution hides the problem and does not remove the root cause. It increases volumes which is against the main principle of waste management.

Improved drilling technologies enable us to reach and develop ever more complicated ERD and Ultra-ERD wells have an increasing step out ratio with longer horizontal sections.

In addition to control the cost per foot drilled, programs with multi-pad or factory drilling are providing economic and operational benefits.

These activities also have a more adverse effect on the operational lifetime of the NAF and RDF drilling fluids. An increasing challenge is the control of the solids in the ultra-fine range below 10 microns. Conventional technologies like the decanting centrifuge are technically limited in removing ultra-fines and have a relatively high OOC on their solids discharge. The alternative of dilution increases the volumes generated and merely hides the problem.

Dynamic settling is an innovative mechanical separation method that extracts these ultra-fines below 10 microns creating an alternative to dilution on site or at the LMP. It generates significant benefits in the operational, economic and environmental aspects of the drilling process.

Dynamic settling technology

To overcome the issue of mechanical separation of fines below 10 microns, a new mechanical separation technology has been developed. The challenge was to design a technology where the path that particles must travel before they settle, is minimized. The solution was found in using a large number of curved plates mounted in a circular bowl at close distance between each other to split the total fluid flow into a large number of flow segments. The fluid flow rate is then set such that laminar flow occurs within these segments. In addition, the flow within these segments is then subjected to high G forces of up to 4,500xG.

Within these segments the particles have a minimal travelling distance before they settle against a curved plate and then slide along the curved plate to the outside of the bowl. The combination of a minimal travelling distance under laminar flow conditions and a high artificial gravity, results in an excellent capture rate of very small particles down to 1 micron. Moreover, no chemicals are needed to realize this result. In addition, this configuration ensures an optimal energy transfer between machine and fluid.

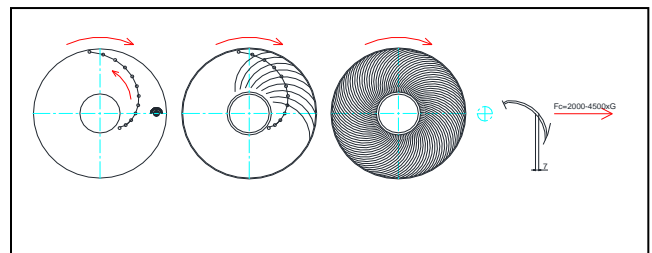


Fig.1 Thin layer flow in between the spiral plates

The use of the curved plates not only has benefits in the separation cycle but in the discharge cycle as well. The discharge technology is very efficient and even sticky materials are discharged in the form of a dry cake.

This new technology is based on the same process as occurs within a static settler but with added dynamics due to the increased G forces. We therefore refer to our technology as dynamic settling.

Removing of ultra-fines from drilling fluids

This innovative dynamic settling technology can mechanically remove ultra-fine solids from drilling fluids. These ultra-fine solids, largely consisting of low gravity drilled solids, are generally smaller than 10 microns and build up in a mud system during the drilling process because existing Solids Control Equipment (SCE) cannot remove these ultra-fines.

The conventional solution is to dilute the mud system with base oil to reduce the level of ultra-fine solids or to build new mud. Dilution increases cost for building new mud, storage, transport and disposal.

These ultra-fines hinder efficient drilling due to increased risk of differential sticking, higher torque and decreased rate of penetration and formation damage.

An extra advantage of using a dynamic settler while drilling is that due to the removal of the particles below 10 microns the PV of the drilling fluid is improved and hence also the ECD values.

By processing the effluent from the conventional decanter, the technology is a simple add-on to the existing operational infrastructure.

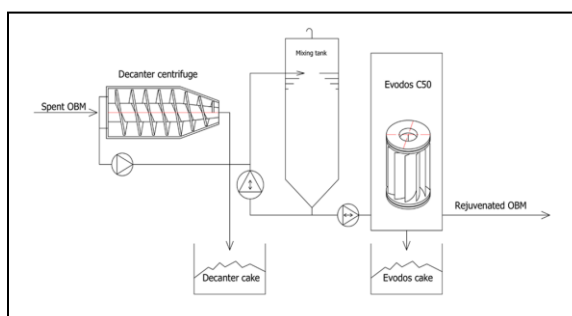


Fig. 2 Operational set-up of the dynamic settler

Field performance data

To establish the effectiveness of the dynamic settling technology a large NOC in the UAE set up a field demonstration with their RDF's. A calcium bromide NAF is being used to support their long term ERD drilling activities from artificial islands. Due to the accumulation of ultra-fines below 10 micron the fluid requires significant conditioning at the drilling site and at the liquid mud plant. Due to the remote location significant costs are involved on the logistics side via boat and truck transfers. In addition, environmental restrictions

increased the waste treatment cost per barrel. All adding up to an increased cost per foot drilled.

Based on the 'waste management triangle' principal and operational requirements a number of success criteria were agreed upon in advance the following performance targets for this demonstration above and beyond current decanting technology by:

- Mud weight reduction of 10%
- Additional solids reduction 30-40% post decanter
- PV improvement 15-20%
- Mechanical separation without chemicals to reduce the environmental impact
- Emulsion of the RDF not to be affected
- Low OOC with solids to minimize fluids loss and disposal costs.



Fig.3 Waste management triangle

During the field demonstration over 100 samples were taken from the feed and effluent as well as solids from the decanter centrifuge and from the dynamic settler. A quarter of these samples were additionally processed at the NOC's own laboratory for verification and potential discrepancies. None of which were found. The field results matched the laboratory results.

- MW reduction from 10.2 to 8.5 Ppg. (-16,1%)
- Solids content reduction 18,4% to 9,3% (-49%)
- PV reduction @ 150F 13 to 9 cP (-31%)
- OOC decanter = 20%, Dynamic settling = 11,1%
- D50 decanter = 2.99 μ , Dynamic settling = 1.86 μ
- Of the 100% treated effluent from the decanter 83% was returned as cleaned fluid by the dynamic settler

Table 1 Particle size analysis of solids in feed and effluent

Average PSD	Evodos Feed μ	Evodos effluent μ	% reduction
D10	1,43 μ	0,78	-45%
D50	2,99	1,86	-38%
D90	7,89	3,46	-56%

Graphical presentation of sampling results

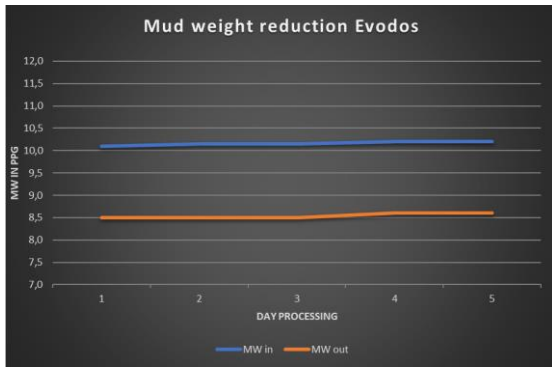


Fig.4 Observed mud weight reduction

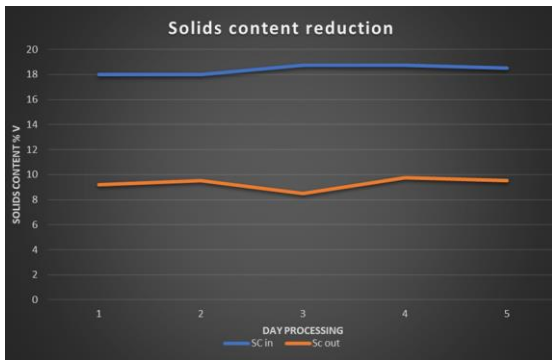


Fig.5 Observed solids content reduction

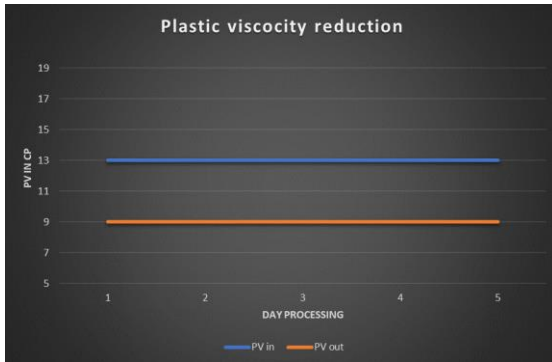


Fig. 6 Observed plastic viscosity reduction

Acknowledgments

We thank all people and organizations that assisted to perform the field demo safely and successfully in the UAE.

Nomenclature

Symbols used in the text not are explained in the body of the text:

ECD = Equivalent circulating density

ERD = Extended reach drilling

LMP = Liquid Mud Plant

NAF = Non-Aqueous fluids

NOC = National oil company

OOC = Oil on cuttings

PSD = Particle size distribution

PV = Plastic viscosity

RDF = Reservoir drilling fluid

Conclusions

1. Dynamic settling technology is a valid and cheaper alternative to dilution in reducing ultra-fines from NAF RDF drilling fluids and improves significantly the solids removal capabilities over and above current decanting technologies
2. Removing the ultra-fines below 10 microns improves the PV and has a positive effect on the ECD values
3. By treatment at source logistical and environmental cost and hazards are minimized