# Removal of solids from well flow using dynamic desander technology boosts production and simplifies interventions

### by Dmitri Gorski, Senior Process Engineer, BRI Cleanup

*Dmitri Gorski*
*PhD, Senior Process Engineer,*
*BRI Cleanup*
*dg@bricu.no*

Sand and other solids are present in the production flow of most of the producing wells today. Statoil highlighted the value of dealing with solids production topside instead of using expensive well completions more than 10 years ago (Andrews at al.; 2005). In this SPE paper, the Statoil engineers reported that the use of sand control completions was minimized when developing the Statfjord and Gullfaks fields. This strategy was described as a success. Not only the predicted significant gain in production acceleration could be realized, but also an increase in reserves (IOR) could be demonstrated. The authors did not propose any methods for separation and disposal of sand topside upon the utilization of the above described production strategy. Back then, few options for dealing with produced sand topside were available. The approach was rather to establish a Maximum Acceptable Sand Rate (MASR) value based on the capacity of the process system on-board to deal with the incoming sand. This paper suggests a way of significantly increasing the MASR value using novel technology for continuous removal of sand from the well flow topside. The technology is based on hydrocyclone separation, enhanced using a motor-powered impeller. The method has been extensively tested in Norway and abroad during the past 14 years.

Most of us know how much damage produced solids can do to the topside facilities. Sandblasting of piping systems and various downstream equipment will soon enough lead to erosion damage. In worst case, this can result in loss of containment and hydrocarbons on deck. Sand and solids also tend to plug process systems, leading to a need of cleanouts. A common example of this is production separators, where a lot of sand accumulate if not taken care of upstream. In the case of separators, there are now online jetting systems which help flush the sand out. However, this does not eliminate the risk of erosion upstream, and the jetting does lead to production disturbances.

Hydrocyclones are traditionally used for inline separation of solids from liquids. A hydrocyclone is a simple equipment that has been in use, virtually without modifications, since the end of the 19th century. Today, hydrocyclones are used everywhere: from the automotive industry and mining to home appliances. The principle of operation is simple: an orifice at the inlet of the hydrocyclone increases the velocity of the fluid flow to a point where sufficient centrifugal force is created in the hydrocyclone vessel to force most of the solids particles to the walls. There the particles sink to the bottom, where they are discharged. The "clean" liquid overflow contains significantly less solids and can be sent to the next processing stage. High fluid velocity is detrimental for the performance of the conventional hydrocyclone. Any separation process requires energy, and in a conventional hydrocyclone this energy comes from the well flow itself. This energy conversion is always associated with a pressure drop, where pressure loss is translated into increased velocity of the fluid. There is no way around this fundamental disadvantage of conventional hydrocyclones. In fact, Statoil's own technical guideline (TR3006) requires a pressure drop of 2-3 bars over a conventional sand hydrocyclone to ensure efficient separation. Another disadvantage is the high velocity of flow itself which leads to equipment erosion. Several cases of hydrocarbon containment loss occurring due to this phenomenon have been registered on the Norwegian shelf in the past years. Liners or inserts are used to protect the inside of the hydrocyclone from the erosive flow, although they get worn out and need to be exchanged periodically. Flow orifice, located at the inlet of a conventional hydrocyclone, is optimized only for a narrow range of well flow and pressure. If flow and pressure changes, the orifice must be exchanged as well. Flow and pressure are very seldom stable in a producing well, here illustrated with an example from a Norwegian installation (see Figure 1). Laws of physics dictate that separation in a conventional hydrocyclone, where inlet flow is subject to large variations, will be just as unstable.

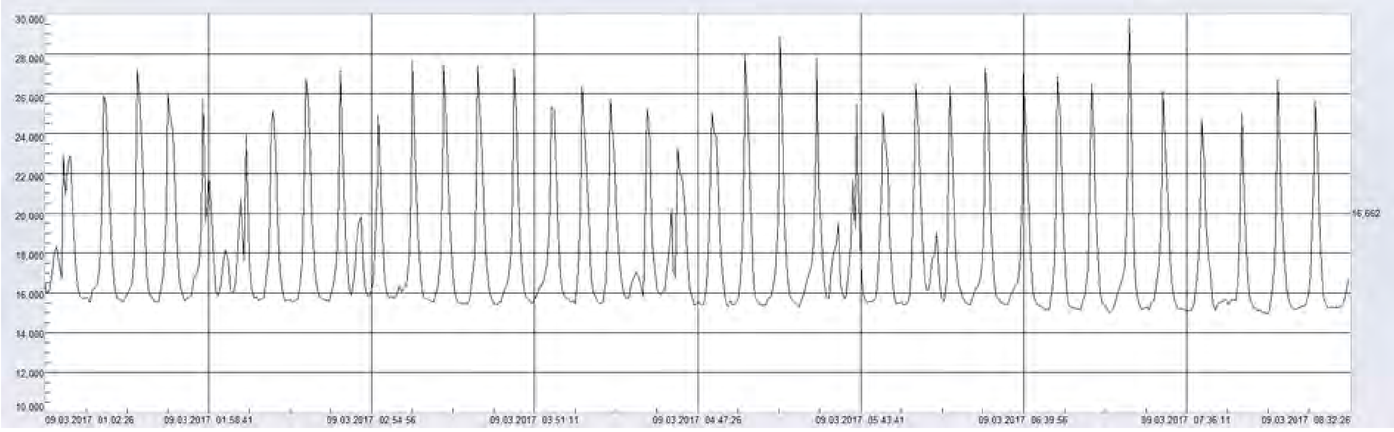

*Figure 1. Example of pressure variations in a slugging well at the North Sea*

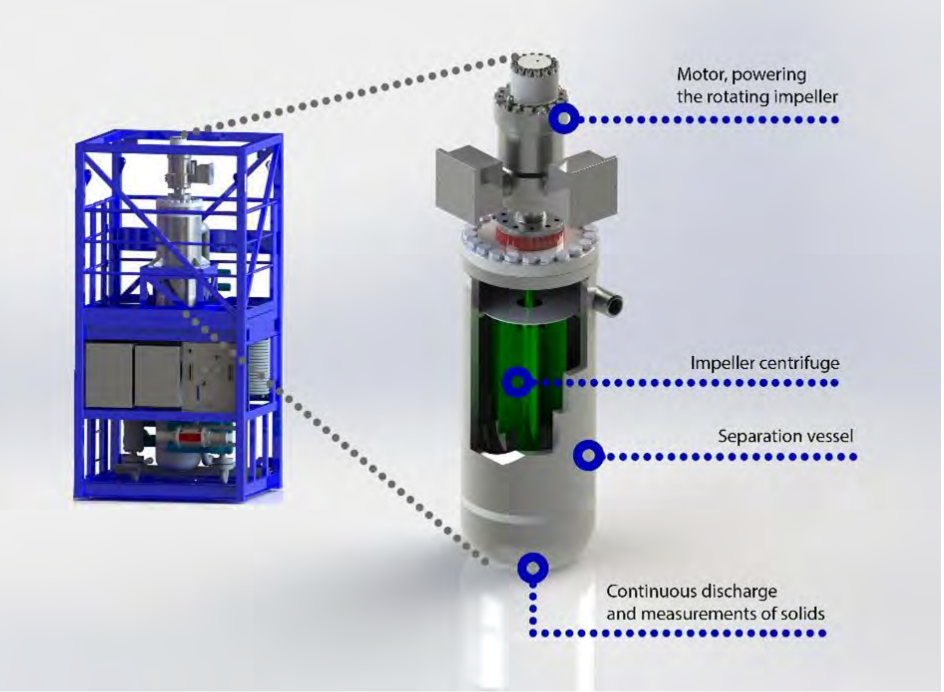

*Figure 2. Figure 2 Dynamic Desander System™ with enhanced view of the separation chamber. Solids are disposed in the lower collector tank, which is periodically isolated and flushed while the system is in continuous operation. This process is completely automated.*

At the same time, it is becoming more and more clear that significant savings can be made by integrating a desanding hydrocyclone into a topside processing facility. A lot of trials, where hydrocyclones have been used for inline cleaning of process stream from solids, have been carried out over the past 15-20 years. The first wellhead desander was deployed in 1996 on the Shell Brent field in UK, and since then there have been several installations worldwide (Rawlings; 2014). Trials with a bulk desander on Gullfaks C platform on the Norwegian shelf showed savings of at least 20 million NOK due to reduced need of well interventions alone (FourPhase; 2016). Numbers from multiple wellhead desander installations in Asia are not officially available, but a significant increase in production can be assumed there. However, most of the conventional hydrocyclones that exist on the market today are bulky, manually operated, and lack automation and integrated monitoring of separated solids (Halliburton; 2017, Schlumberger, 2017; eProcess; 2017). Additional washing systems are often required to remove oil rests from the separated sand. Some of the existing conventional hydrocyclones are more compact than others, and some are equipped with a certain degree of automation and monitoring (FourPhase, 2015). Yet none of the conventional hydrocyclones employ a separation principle that is significantly different compared to hydrocyclones of the 19th century. The need to improve shortcomings of conventional hydrocyclones to overcome their disadvantages has been there for some time.

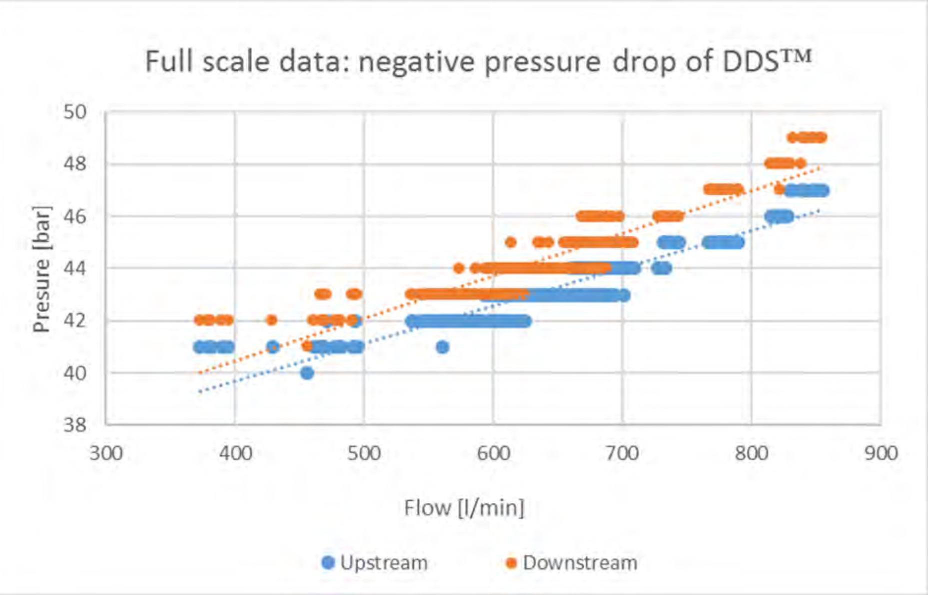

*Figure 3 Approximately 1-2 bar of pressure is generated in Dynamic Desander (offshore data), while conventional hydrocyclones are bound by the laws of physics to operate with a pressure drop.*

Finding a way to decouple the energy driving the separation of solids from the energy of the well stream would vastly improve the fundamental working principles of a hydrocyclone. If this is achieved, the separation process would no longer be as unstable due to instabilities of the well flow. A possibility of providing additional energy to the separation process would also open up, thus making the separation potentially more efficient and controllable. Finally, dependence on the unreliable inlet nozzles, and the need of protective liners, might be eliminated. The first idea of how to achieve all this formed in the late 1990s in Norway. Experiments where an impeller, powered by an electric motor, was inserted into a hydrocyclone vessel led to the development of the first dynamic hydrocyclone. Further research into this concept elsewhere firmly defined the term "dynamic hydrocyclone" as describing motor-powered impeller in a hydrocyclone vessel (Jiao et al.; 2006, Zhou et al., 2014). This approach represented first principal improvement of the hydrocyclone separation principle in more than a century. The patent granted for dynamic hydrocyclone technology was sold several times, and is now owned by BRI Cleanup, a small Norwegian company located in Ågotnes outside of Bergen. BRI Cleanup is the only company offering dynamic hydrocyclones today under the brand of Dynamic Desander System™, see Figure 2.

The advantages of Dynamic Desander technology over conventional hydrocyclones include:

Two-stage separation in one vessel (hydrocyclonic separation is enhanced with centrifugal action of the impeller), which guarantees superior performance independently of the flow.

No need for inlet nozzles and liners, which significantly improves HSE aspects as well as leading to better operational characteristics.

No pressure drop (and in fact an increase in pressure as illustrated in Figure 3).

Dynamic Desander System units are highly automated and provide real-time data on the weight of separated solids and other process parameters. They are fully integratable into platform systems. Each unit consists of upper separation vessel and lower accumulator vessel. The sand, separated in the upper vessel, sinks into the lower vessel, which can be discharged to a recipient of choice (e.g. sand skip or rig's cutting reinjection system). The separation process is continuous and does not stop even during the sand discharge sequence, which only takes a few minutes. Another unique characteristic of DDS™ is its ability to clean the sand while it is separated and discharged. No additional cleaning equipment is normally required, which simplifies the disposal of the sand if brought to shore. In some parts of the world, where it is permitted to discharge the sand overboard, the sand even meets the strict authority cleanliness standard without the need of additional treatment.

When a conventional hydrocyclone is utilized, there is often a need to install subsequent filter unit to remove the smallest particles (Arefjord and Malinauskaite; 2017). This auxiliary equipment is most often not required when DDS™ is employed and removal of particles with sizes down to 5 microns have been recorded.

Deployment of the Dynamic Desander System™ on an offshore platform in Malaysia led to doubling of production for some of the connected wells. In Norway, the system is often in use on well interventions and flowback operations. Integrated into a coiled tubing (CT) package, the DDS™ gives coiled tubing operators real-time information about the amount of solids coming from the well. It also prevents any solids in the returns from entering coiled tubing fluid circulation or platform processing systems. Recently, dynamic hydrocyclones made an appearance on the US market, where efficient dealing with the return of solids has been an unresolved issue for unconventional fracking operations.

A unique capability of the DDS™ is to handle variations in flow and large amounts of gas, while simultaneously maintaining high separation efficiency due to dual separation action proved to be detrimental for its success. Based on the proven track record of the DDS™ technology, its compact size and the potential for automated continuous operation, it could be suggested that there finally is a permanent solution to the topside solids issue. Benefits described by Statoil engineers back in 2005 can finally be realized.

*Figure 4. BRI Cleanup Dynamic Desander unit in unconventional fracking operation in USA.*

***References***

1. *Andrews, J. S., Kjorholt, H., & Joranson, H. (2005, January). Production enhancement from sand management philosophy. A Case Study from Statfjord and Gullfaks. In SPE European Formation Damage Conference. Society of Petroleum Engineers.*
2. *Arefjord A. and Malinauskaite G. (2017). "Using Dual Desander and Stackable Filter Unit for Cleanout after Concentric Coiled Tubing Operation". SPE International Bergen One Day seminar, SPE paper SPE-185940-MS*
3. *eProcess (2017). "Wellhead desander". Retrieved from http://eprocess-tech.com/products/facilities-sand-management/wellhead-desander/*
4. *FourPhase (2015). "5k DualFlow unit". Retrieved from http://www.fourphase.com/4phase/wp-content/uploads/2015/04/FourPhase_DualFlow_TechSheet_Web.pdf*
5. *FourPhase (2016). "Overcoming offshore production challenges – what are your production objectives?". Retrieved from http://www.fourphase.com/4phase/wp-content/uploads/2015/10/Offsnet_FOURPHASE_Whitepaper.pdf*
6. *FourPhase (2017). "Interventionless kick-start & sand cleanout of well C-19 & C03". Retrieved from http://www.fourphase.com/interventionless-kickstart-sand-cleanout-of-well-c-19-c-03-2*
7. *Jiao, J., Zheng, Y., Sun, G., & Wang, J. (2006). Study of the separation efficiency and the flow field of a dynamic cyclone. Separation and Purification Technology, 49(2), 157-166.*
8. *Schlumberger (2017). "Cyclonic Desander". Retrieved from http://www.slb.com/~/media/Files/testing/product_sheets/surface/cyclondesand_ps.pdf*
9. *Halliburton (2017). "Wellhead desander and accumulator". Retrieved from http://www.halliburton.com/public/ts/contents/Data_Sheets/web/H/SWT-WellheadDesander-H010995.pdf*
10. *Zhou, Y., Mingfei, Z., & Ma, C. (2014). Experimental and numerical investigations of a dynamic cyclone. Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy, 228(5), 536-549.*

---

# WELL CLEAN OUT AFTER REPERFORATION 98% SEPARATION EFFICIENCY

## Shell Gannet, North Sea

**Challenge**

Two wells were planned for cleanup flow after reperforation using wireline intervention. The aim of performing the cleanup was to enhance production from the wells post reperforating. Once the FourPhase solids removal system was mobilized, the scope of the operation was expanded by two additional wells.

Operational considerations:
– High expectation of sand during the initial cleanup

**Solution**

There was a high expectation of sand during the initial cleanup, therefore the use of the FourPhase DualFlow solids removal system was chosen for the collection of any sand produced to surface assuring high separation efficiency and minimal space requirements due to system's compact design. The FourPhase system continuously separated and removed solids which were then flushed to external skips on the hatch deck. The cleaned return fluids were routed to an unused wellhead to allow access back into the production stream.

**Result**

– No recorded HSE incidents.
– No recorded equipment downtime
– 912 kg of solids separated during the cleanout operation.

Successful reperforation operation met clients' expectations and resulted in FourPhase solids removal system being requested for upcoming operations.

*Text provided by Giedre Malinauskaite*
*Marketing Manager, FourPhase*

FOUR PHASE