

## SANDTINEL CASE STUDY: NORTH DAKOTA BAKKEN

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Sandtinel performed a 4-day field trial in November 2020 for a partner in an initial drill-out in North Dakota in the Bakken. This case was notable for the very large volumes of sand collected from two wells by two 48" Sandtinel sand separator units over the course of only a few days. One of the wells had a 48" G2-S Defender sand separator, and the other similar well had a 48" Maverick G4-S sand separator.

Sand estimates for this trial were performed with hourly sand samples taken upstream and downstream of each of the Sandtinel units. This measurement technique has some known problems (sampling bias), but in general gives a good picture of separator efficiency.

The case details are listed below with the peak operating condition as recorded by the client.

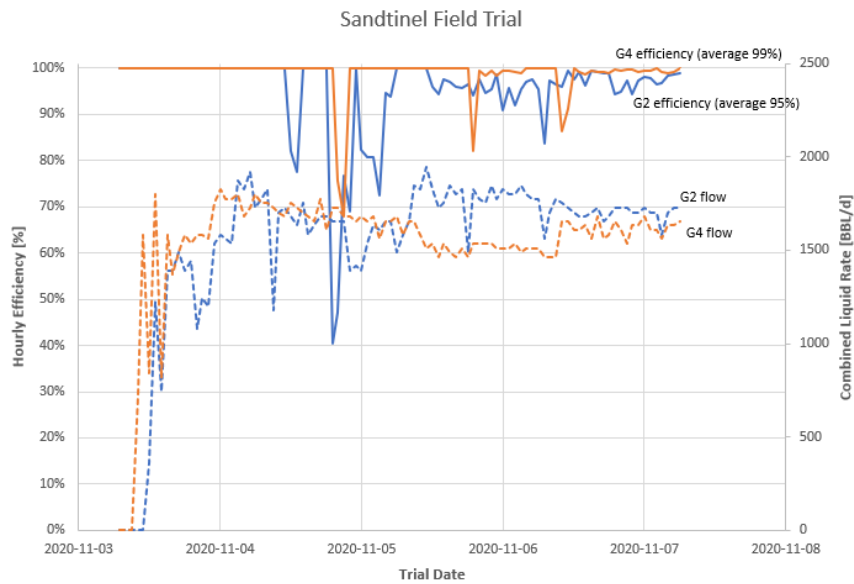
PARAMETER	VALUE
Basin	Bakken
Location	Williston
Peak gas	1.4 MMSCFD
Peak liquids	1920 BBL/day
Water cut	35%
Operating pressure	1000 psi
Sand capture	23,400 lb
Test duration	4 days

This field trial showcases the high separation efficiency of the Defender and especially the Maverick sand separators even at very high oil cuts (average of 65% for this trial). Oil presence is usually detrimental to sand separator performance for three reasons:

- Oil and water typically form an emulsion when agitated which is more viscous (thicker) than either of the two liquids by themselves
- Light sand fines can float on the surface tension of the interface between the oil and water layers when the liquid is *not* agitated
- Oil bubbles float in water, and can lift small sand grains to the separator outlet

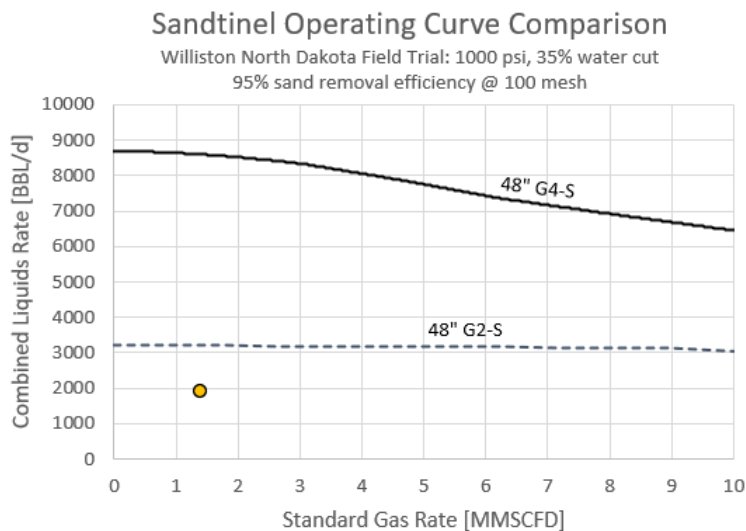
The Sandtinel Maverick includes new patented technology to handle higher cuts of oil than any other mechanical sand separator. The G4-S Maverick uses no filters or any chemical additives to achieve greater than 95% separation efficiency for fines down to 140 mesh in size.

There was over 23,000 lb of sand captured in this trial in the Williston basin between the two sand separators. Upstream and downstream sampling shows the performance of the Sandtinel system:



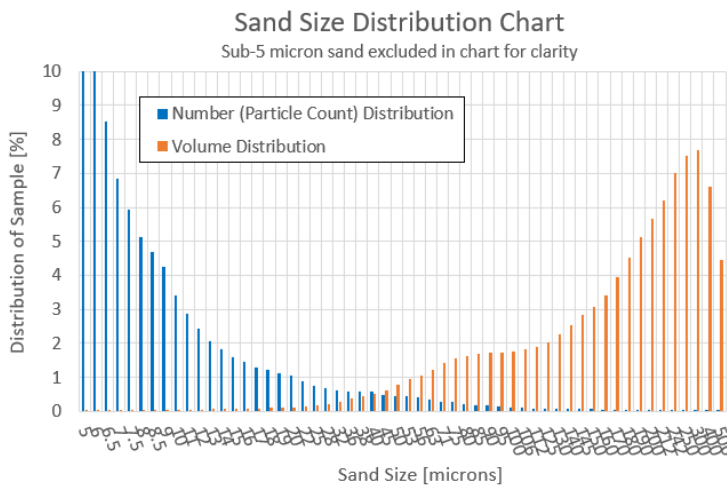
This curve shows both the hourly flow rates measured for each parallel sand separator, as well as the measured hourly efficiency of sand removal via upstream and downstream sampling. The separation efficiency of the G2-S Defender was 95% sand removal over the course of the trial; the separation efficiency of the G4-S Maverick was over 99% sand removal. Both separators saw approximately the same amount of sand, approximately 2,900 lb of sand per day each, with hourly dump operations performed.

Sandtinel prepares high level operating curves which demonstrate the envelope of flow rates where our separators will be effective. These curves allow our partners to make strategic decisions about when to move and how to operate their sand separators. The operating curves for these two sand separators are shown in the figure below:

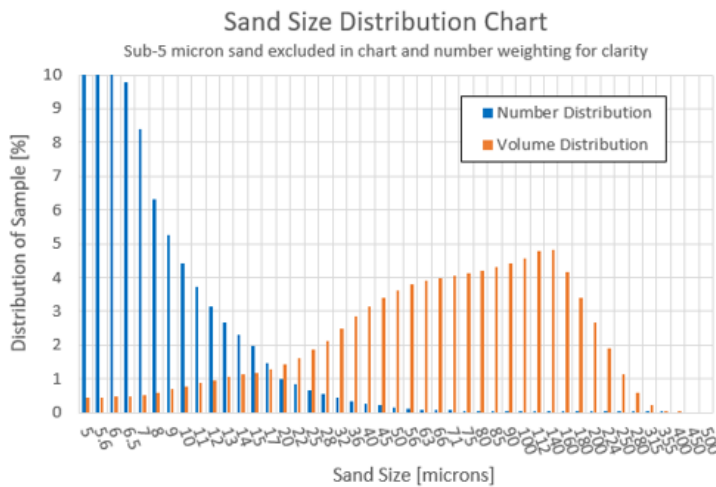


This operating curve shows the estimated envelope where the Sandtinel sand separators will provide best in class sand separation efficiency, beyond any other mechanical separator on the market. While inside this curve, our partner was guaranteed to be able to see at least 95% separation efficiency. However, reports from the field for the next generation Maverick G4-S were a sand removal efficiency of **over 99%** (only ~60 lb of carryover per day).

The sand used for this flowback was a typical 100 mesh sand blend. Like most mechanical separators, Sandtinel removes a larger proportion of large sizes of sand than the smaller fines. We tested a sample upstream and downstream of the G4-S Maverick in this field trial using laser diffraction in our lab to determine the size of sand being removed:



**Upstream of G4-S**  
d50: 236 microns



**Downstream of G4-S**  
d50: 73 microns

The G4-S removed the vast majority of the sand in the system, leaving primarily some of the “fines” smaller than 100 microns. The d50 (median diameter) of the sand changed from 236 microns upstream to only 73 microns downstream of the separator. Larger sand causes higher erosion and damage to equipment on site.

The results of this analysis are consistent with Sandtinel's performance prediction and the observed performance of the G4-S Maverick. In this trial both the G2-S Defender and the G4-S Maverick were able to remove over 95% of the sand returned to the surface. Their presence allowed the well to be opened more aggressively to enhance overall production without risking damage, wear, sand accumulation, and chargebacks.