NORTH SEA – DUTCH SECTOR

This case history offers a perfect opportunity to evaluate NeoTork, as it was utilized in a side-track from an existing well (NS1). It is then possible to compare **NeoTork**'s performance to a well that had been drilled just a few days earlier in very similar conditions, crossing the same lithology.
This case history will highlight the value of using **NeoTork** by comparing the NS1 and NS1x drilling performances.

Application Description

NS1 had been abandoned at a depth of 2998 meters (m) and the BHA was lost-in-hole following a washout.
A side-track (NS1x) was kicked off from 2503m. Following this, a clean-up run was done with a Milled Tooth and a successive run was made down to 2645m using an insert. At this point, a StingBlade PDC bit was run together with a directional assembly (RSS). NeoTork was located approximately 20m from the bit.
The lithology to be drilled was identical to NS1; the wells were on exactly the same path with hole angles ranging from 25° to 30° and identical azimuth (+/- 210°). The drilled rock consisted mostly of chalk, slightly argillaceous in places, with traces of marl and anhydrite and occasional traces of chert. The maximum TVD offset recorded between the two wells was 9m. Accordingly, this comparative analysis doesn't include lithology, given that it had been the same for both wells.
Similarly, as NS1x had been drilled just a few days after NS1 on the same drilling rig, by the same main contractors, further simplifying the analysis.
Various drill bits were utilized on NS1 (roller cones insert and PDCs). The PDC run of particular interest was the one which drilled a portion of the very same interval as that drilled by NeoTork. These two comparable runs are the main focus of this case study.

Reference Well NS1

The NS1 well was drilled in the early summer of 2017. The well was effectively a side track from an old, existing well starting at the depth of 2770m. The NS1 bit record is presented below. As previously mentioned above, we will focus on the PDC drill bit run # 4, as it was pulled out at a similar depth than NeoTork. Although not an identical design to the one run on NS1x (as it was much heavier set), this run offers a good comparison.

	Bit #	Bit Type	Depth In (m)	Depth Out (m)	Interval (m)	Dull Grading	ROP (m/hr)
NS1	1	Milled Tooth	2718	2725	7	NOT GRADED	0.45
	2	TCI	2725	2798	73	2-8-LT-S-E-2-BT-PR	3.36
	3	TCI	2798	2848	50	3-6-LT-S-F-I-BT-PR	1.92
	4	PDC	2848	2977	129	2-2-WT-A-X-I-CT-PR	3.64
	5	PDC	2977	2998	21	LIH	1.46

Well NS1x

NS1x is a side-track from NS1. A first run was completed with a Milled Tooth followed by an insert run. NeoTork was then inserted in the BHA, approximately 20m from the bit, above the RSS.
The below bit record shows the performance of the three bits used during the new 8 ½ section. A washout cut short run 3 (NeoTork). The PDC bit (examined on surface) was determined to be in 'as new' condition and was rerun. It drilled just 61 meters before being pulled out due to poor ROP.

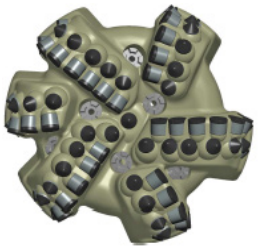
	Bit #	Bit Type	Depth In (m)	Depth Out (m)	Interval (m)	Dull Grading	ROP (m/hr)
NS1x	1	Milled Tooth	2503	2533	30	2-5-BT-M-E-I-WT-BHA	1.65
	2	TCI	2533	2645	112	2-2-WT-A-E-I-NO-TQ	1.87
	3	**PDC**	**2645**	**2964**	**319**	**1-1-WT-A-X-I-NO-PP**	**9.76**
	3RR	PDC	2964	3025	61	2-4-WT-A-X-I-BT-PR	2.02

Comparative Analysis

Bit Wear

The PDC bit utilized on NS1x was an aggressive design (only 41 cutters) and while expected to deliver a good rate of penetration (ROP), it is more exposed to premature wear. The image below shows that StingBlade bit on surface, having drilled 319m. As can be seen, there is minimal, if any, wear in spite of the fact that it drilled through three intervals of rocks with chert presence (for a total of over 60m out of the 319m drilled).

IADC Code:	M322
Blade Count:	6
Cutter Size:	16 mm
Total Cutter Count:	41
Face Cutter Count:	20
Gauge Length:	3 in



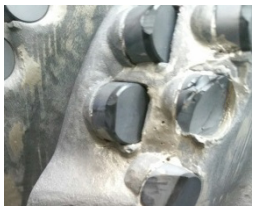
319m Drilled (32.7 hrs)
Average ROP 9.76m/hr
Dull 1-1-WT-A-X-I-NO-PP

This same drill bit was successively rerun (without NeoTork) in a very similar lithology, again with some moderate traces of chert. However it drilled only 61m with a ROP of only 2.02m/hr before being pulled out with significant damage (see images right).

61m Drilled (30.2 hr)
Average ROP 2.0 m/hr
Dull 2-4-WT-A-X-I-BT-PR

It is also interesting to compare the bit wear on the NeoTork run to the one from the PDC bit run on NS1, especially as it was a much heavier set bit with 8 blades (not 6) and 105 cutters (not 41). That PDC bit drilled only 129m from 2848m to 2977m over 35 hrs (3.64 m/hr).

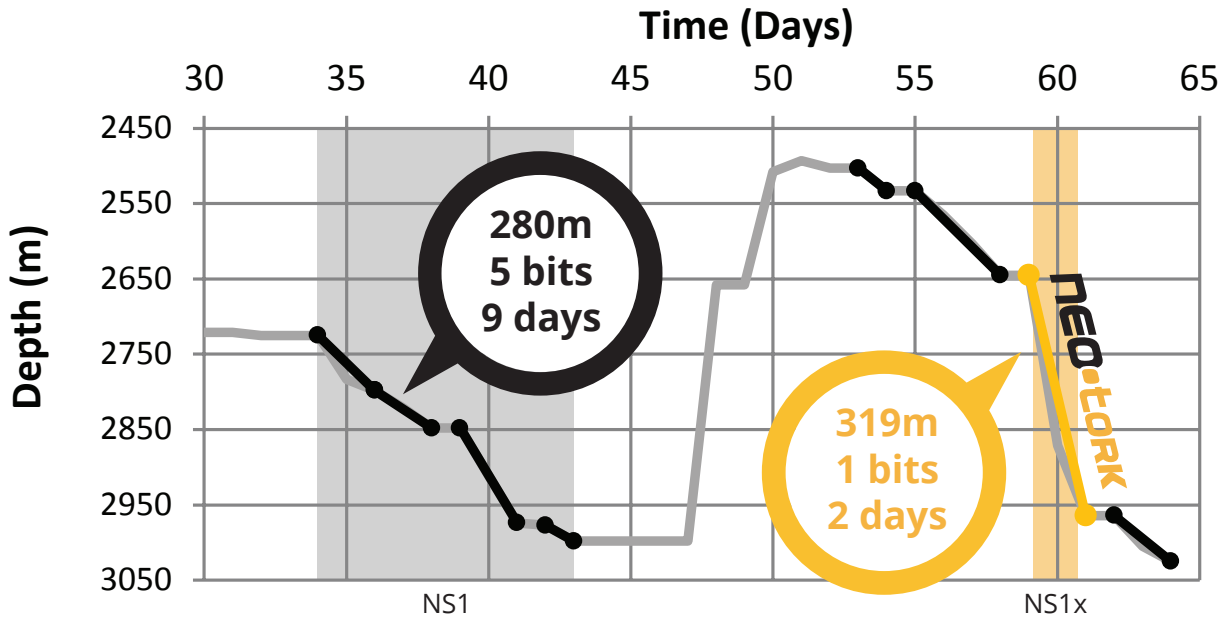
IADC Code	M432
Blade Count	8
Cutter Size	13mm
Total Cutter Count	105
Face Cutter Count	72
Gauge Length	3in



129m Drilled (35.00 hr)
Average ROP 3.64 m/hr
Dull 2-2-WT-A-X-I-CT-PR

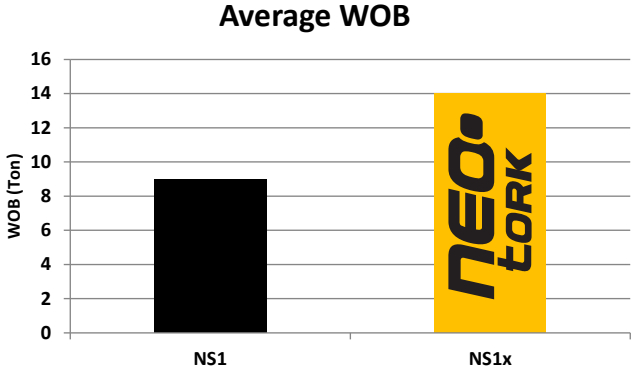
ROP

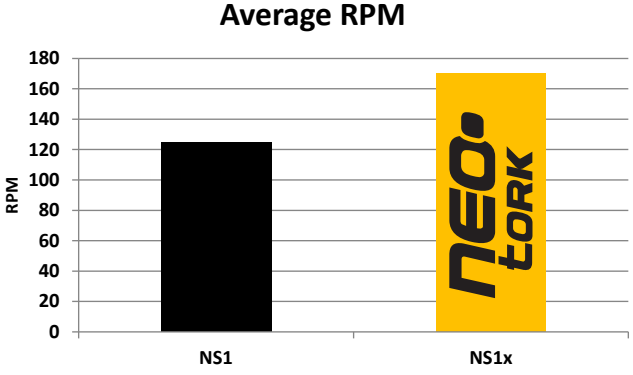
Based on results from previous wells, the general expectation was for ROP to improve when using NeoTork in NS1x. That prediction turned correct as NeoTork increased ROP by more than three times, not meeting but exceeding expectations!
As shown in the graph, it required 5 bits and 9 days to drill the same interval achieved by NeoTork in only 2 days, with 1 bit. It is fair to highlight that the bits used in NS1 were not capable of delivering the same level of ROP as NS1x as they were either roller cones or much heavier set PDCs.
However, NS1 run 4, where the PDC bit was pulled out at a similar depth than NeoTork (2977m vs 2964m) clearly demonstrates the improved ROP NeoTork achieved in the same interval.



The above chart also illustrates the drop in ROP when the StingBlade bit was rerun without NeoTork (from 2964m to 3025m). It drilled 61 meters at 2.02 m/hr before being pulled out, severely damaged.

The improvement in ROP showcased during the NeoTork run was made possible because of improvement in drilling parameters. Due to the steady torque observed on surface and the lack of vibrations and/or stick-slip signalled from bottom, the parameters utilized during the NeoTork run were much higher than on NS1. WOB was increased on average over 50% and RPM 40%. The below charts shows the differences between the two wells.





Summary and Conclusion

There is clear evidence of improvements in performance for both ROP and bit life by using NeoTork on well NS1x, demonstrated by comparing the outcome of the runs achieved on the preceding sidetrack (NS1). Both wells were identical in all key characteristics, offering a perfect benchmark to evaluate ROP and bit life.

On NS1x, the NeoTork assembly drilled 319m (from 2645m to 2964m) in 32.7 hrs (9.76 m/hr). This compares very favourably to NS1, where it took nine days and 5 bits to drill 280m (from 2718m to 2998m). This dramatic improvement in ROP was due in part to the utilization of a more aggressive drill bit but also because of the higher drilling parameters made possible by NeoTork, across the entire run. The steady nature of downhole and surface readings as a direct result of NeoTork's action to reduce stick-slip and vibrations downhole, meant enhanced parameters could be employed. On average WOB increased by 50% and RPM by 40% delivering much more specific energy at the bit and subsequent improved ROP.

NS1 run number 4 gives the clearest illustration of the benefits of using NeoTork as it was completed using a PDC bit, that was much heavier set than the one utilized on NS1x (105 cutters vs 41).
That bit was pulled out of hole after only 129m due to slow ROP and showed clear signs of wear, with flat and chipped cutters all over the cutting structure (2–2–WT-A). Conversely, the much lighter PDC bit that was run with NeoTork came out 'like new' (1–1–WT) despite having drilled nearly three times more footage.

This bit was rerun just after the NeoTork interval in similar lithology, but drilled only 61m at 2.02 m/hr before being pulled out with severe damage (2–4–WT–A) due to low ROP.

These results demonstrate NeoTork's capacity to deliver better performance in terms of bit life and ROP, while limiting downhole vibrations. The improvement in ROP is due to the superior parameters achievable as NeoTork both improves downhole dynamics and also protects a lighter-set bit from vibrations and slip-stick.

		STD BHA	NEO·TORK®
		NS1	NS1x
Section Drilled	(m)	280	**319**
Number of Days		9	**2**
Number of Bits		5	**1**
Average ROP	(m/hr)	2.48	**9.76**
Average WOB	(T)	9	**14**
Average RPM		125	**170**