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Technical Paper

Evaluation of Sampler with integrated zero leakage valve on Aker BP ULA platform

E. Verloop M.Sc. - KPS - The Netherlands
P. Verloop M.Sc. - KPS - The Netherlands
E. Sveinsvoll - Aker BP - Norway
S. Øvrebø - Aker BP - Norway

Abstract

Automatic Sampling is one of the measurement methods most used to determine the quality of crude oil and condensate feeds, i.e. the water content and crude composition. As with all moving parts, automatic samplers are subject to wear. Especially in the cases of maturing production fields or locations where sand in combination with high pressure can be present, premature leaking of the sampler can occur. A new sampling design containing an innovative zero-leakage-valve was found to cope with these harsh environments.

The new sampling technology was tested on multiple locations e.g. on Oselvar tie in to Ula and on Valhall export oil and compared by Aker BP to traditional sampling designs from different brands not having a zero-leakage-valve. Tests were performed on different crude oil/water mixtures.

Test results showed that traditional samplers not having a zero-leakage-valve lasted on average for 1-2 months. This new sampler design with integrated zero-leakage-valve is now already lasting for more than 1-2 years. Furthermore, it was found that the sampler batch reports showed a more 'spot on' performance factor using the new design, indicating an improvement of the overall accuracy.

We can conclude that the new sampler design with integrated zero-leakage-valve tested at the Olsevar and Valhall fields has proven that a substantial reduction in maintenance cost can be achieved, together with a more reliable and accurate performance.

Introduction

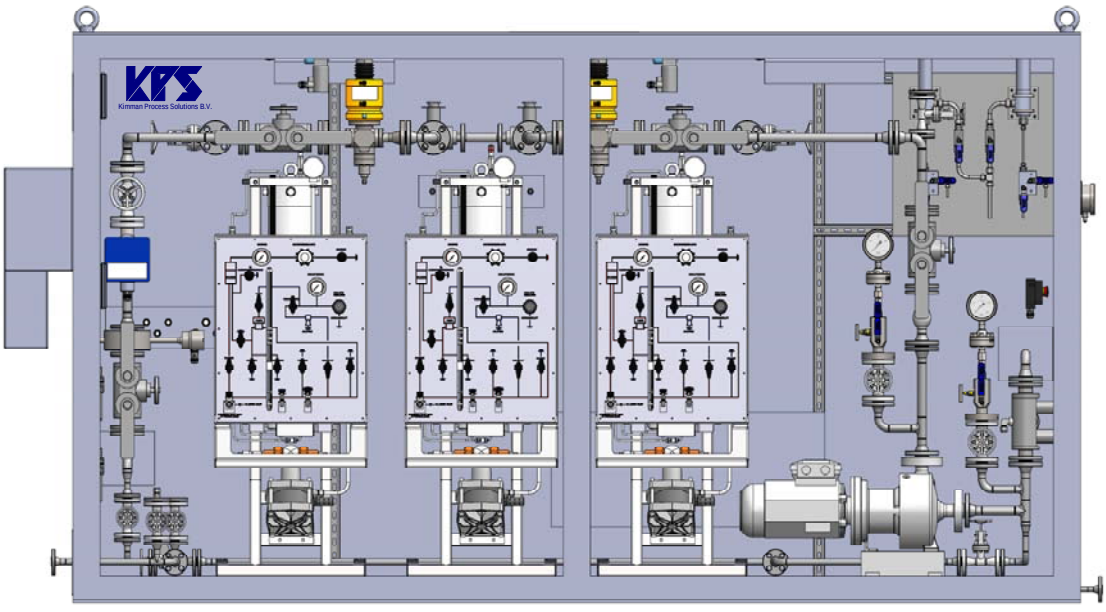
Auto Sampling is one of the measurement methods most used to determine the quality of crude oil and condensate feeds, i.e. the water content and crude composition. Proper sampling can result in loss reductions of up to 1% of the total batch volume. Therefore it is essential that the accuracy and reliability of the sampling equipment is guaranteed at all times. Next to that, operators of refineries, storage terminals and offshore locations are attempting to constrain their operational and maintenance costs. With this said, the ideal situation would be to have an automatic sampler design which can guarantee its performance for long periods of time resulting in less maintenance and downtime, and most important: less oil losses.

An evaluation was done by operator Aker BP on a new sampling technology at the Ula and Valhall platforms, and compared to traditional sampling designs from different brands. This to improve their sampler performance and maintenance requirements. The paper will describe the field comparison study made by Aker BP, and how the new sampler improved their operations.

Case study background

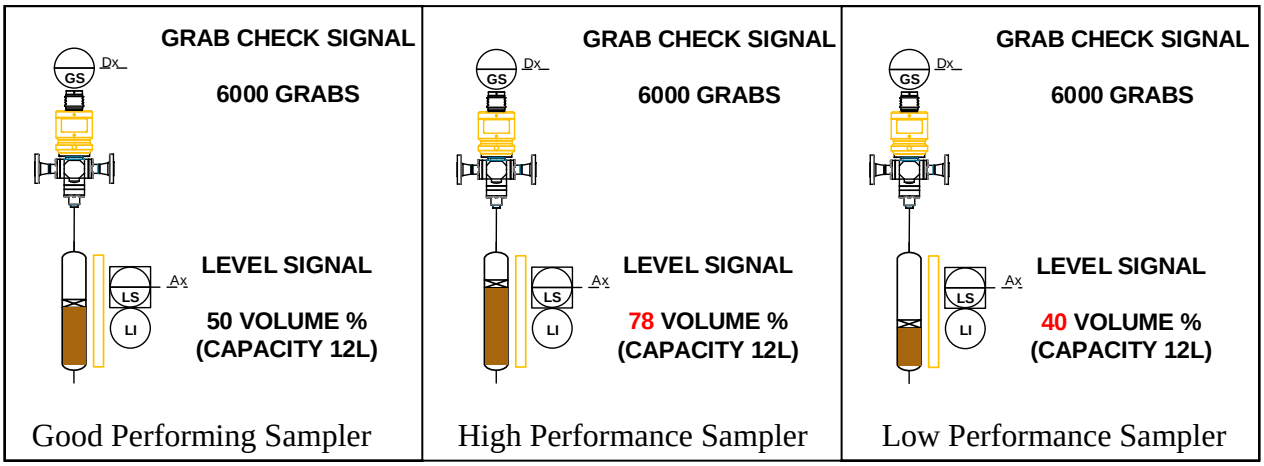
Metering at the Ula oil production platform is required to reduce uncertainty in the overall oil allocation metering. The oil being produced is typically a low viscose, low density condensate oil with sometimes some waxy components and occasionally some flashing. Overall the water content can vary usually between 0-5%.

Typical sampling systems involve a daily and monthly sampler, which extract small 1cc grabs to pre-charged constant pressure cylinders. Please find a picture of such a typical sampling system designed and manufactured by KPS per below:



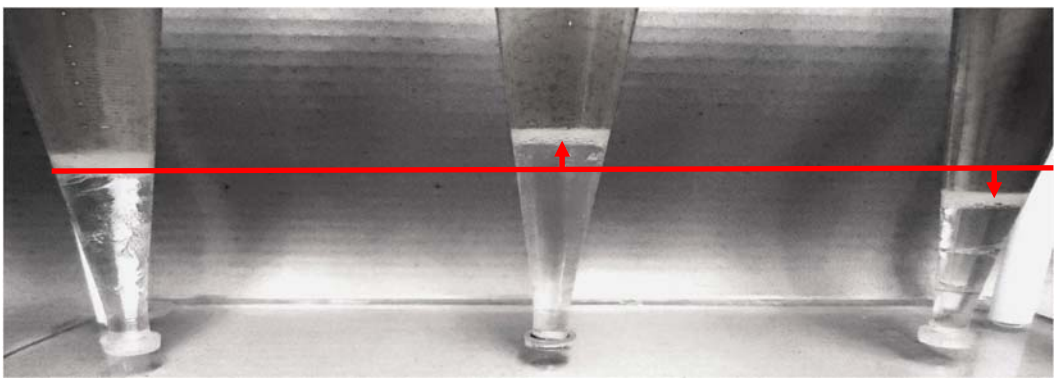
Performance factor

At Aker BP the performance factor is monitored by a level measurement, measuring the filling rate of the cylinders based on the flow proportional grab count from the sampler. According to the ISO 3171 variations up to 10% are allowed, larger variations indicate a leakage of the sampler from the process into the cylinder (over-performance) or back into the process line (under-performance). See pictures per below describing this phenomenon:



Aker BP experienced a reliability rate from the samplers with a mean time between failures of every 4-6 weeks on Valhall oil export and every 8-10 weeks on the Oselvar tie in to Ula. Taking into account the replacement, logistic costs and revision or repair cost, operational expenditure was very high.

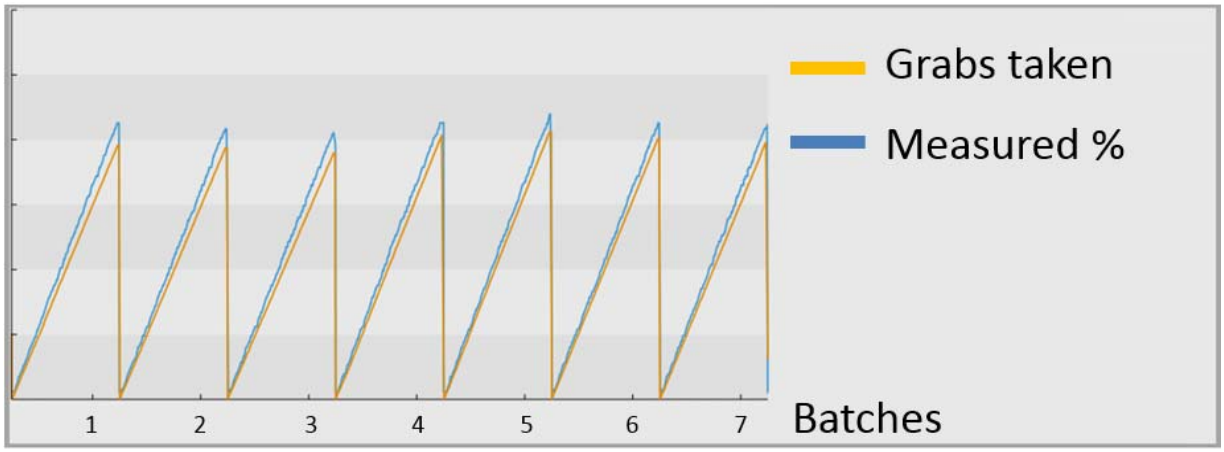
The levels measured on the sample receivers vary sometimes between 80% and 150% of the expected sample volume, and are therefore inaccurate for allocation purposes as control of the isolating and extracting actuations are lost. Previous research conducted by KPS et al [3] for a particular crude oil application quantified the effects of a low performance sampler and high performance sampler on the overall sampling accuracy. See picture per below:



Actual Water ***High Performance Factor*** ***Low Performance Factor***

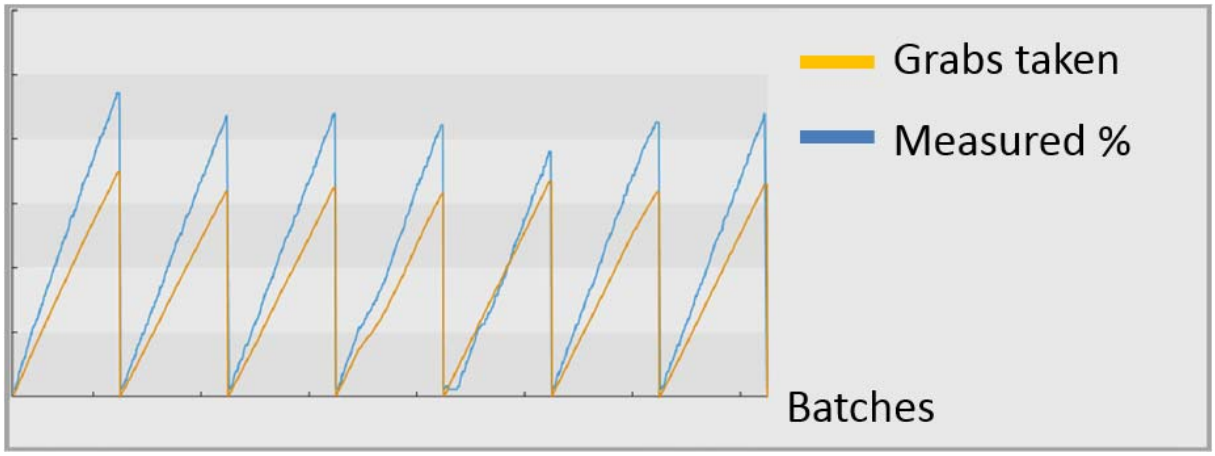
These results confirmed the effect of a deviating performance factor on the actual crude oil sample composition. Hence a different water percentage in the receiver cans relative to the percentage actually being transferred through the pipeline was found.

During multiple batch periods, sampler performance was measured and represented in the figure below. A newly or revised sampler placed in the sampling system will have a measured volume matching the calculated volume, based on its calibrated grab volume times its grab count. Generally some lag is expected due to the filling of the sample volume between the sampler and the receiving cylinder. This lagging volume can explain the large lag and performance at the beginning of the sampling process, while at the end of the process the lag is very marginal.



Sampler performance at initial state

Over time the sampler can experience wear and the measured volume will show an ever increasing lag compared to the calculated sample volume. Please find an example of this in the next figure. A deviation between the calculated and measured volume is allowed of 10%, after which sample content is not representative anymore.



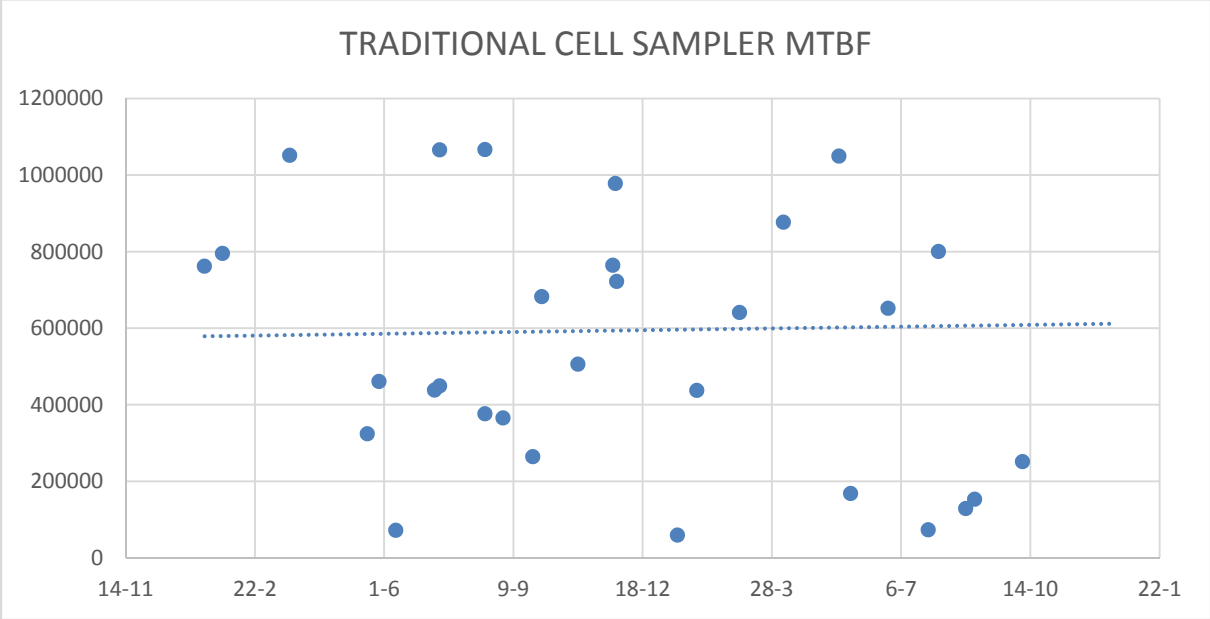
Sampler performance at time of failure

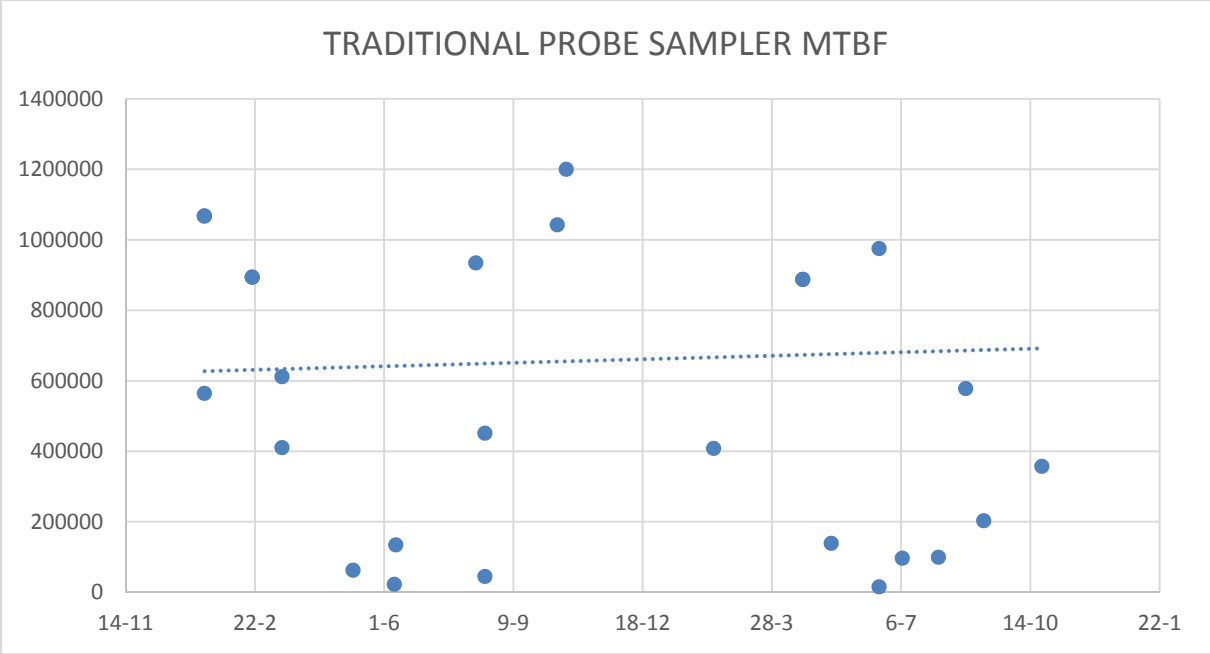
Causes of failures traditional samplers

Leaking or malfunctioning samplers immediately results in dismissal of the sampling batch report as the data is not consistent. Results from the composition analysis based on a malfunctioning sampler cannot be used for allocation or fiscal transfer. To provide insight into failure rates, the failure interval over a period of two years for around 100 samplers has been monitored by KPS and presented in the following figures. Traditional samplers were used at typical locations which transferred both light as well as heavy crudes. The selection of samplers sampling light and heavy crudes give a good insight in all failure mechanisms instead of only focusing on lights or heavy crudes.

After each failure all samplers were revised by replacing all nonmetallic parts and repairing or replacing damaged metallic parts by experienced engineers. Samplers were tested thoroughly before re-installation in the transfer line or system.

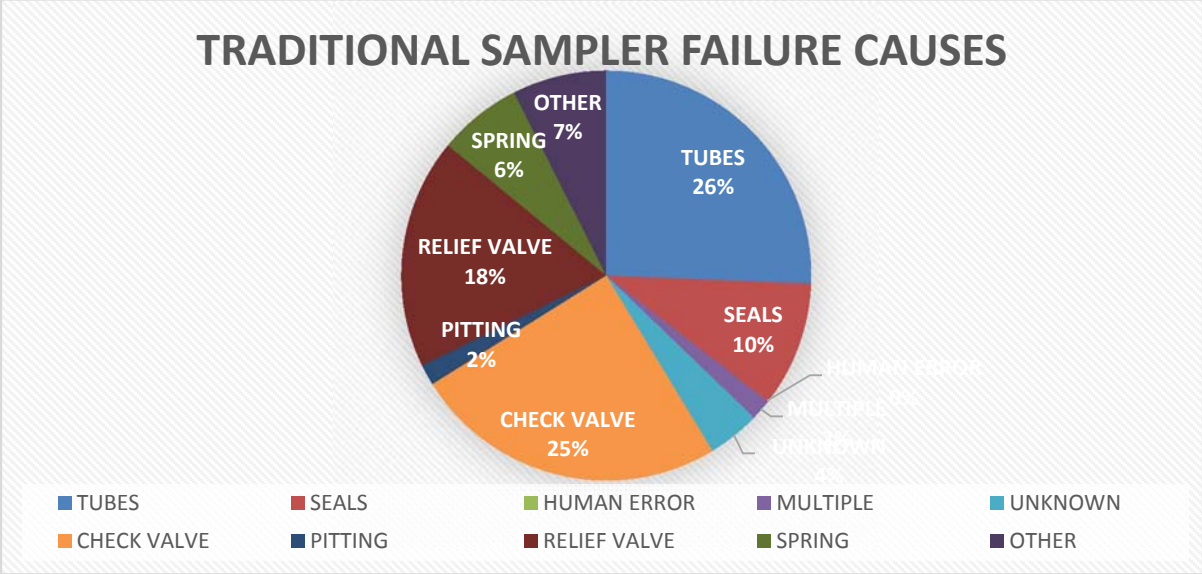
During the evaluation period the amount of grabs were monitored and the failure causes were evaluated through the KPS quality management system. In this process multiple failure causes of traditional samplers were identified, and they were normalized over the amount of samplers with similar causes.





Data from these tests indicate that there can be unpredictable behavior with traditional samplers, having malfunctions varying from 20k up to 1.2M grabs. Average sampler lifetime for traditional probes and cell samplers are around 600k grabs which depend on several influencing factors. Factors such as the type of crudes handled, sand and other solid content, waxes, line pressure, sampler mechanism etc.

Due to the large variation of crude types these factors could not be monitored, however the causes of failure could be evaluated and provide a clear insight into the failing mechanisms, which is indicated in the diagram below:



General performance degradation was caused by a failing Relief Valve or Check Valve mechanism while external leakages where caused by tube or seal failures.

By addressing each type of failure the following effects are likely to be experienced:

1: Overall sampler lifetime is extended.

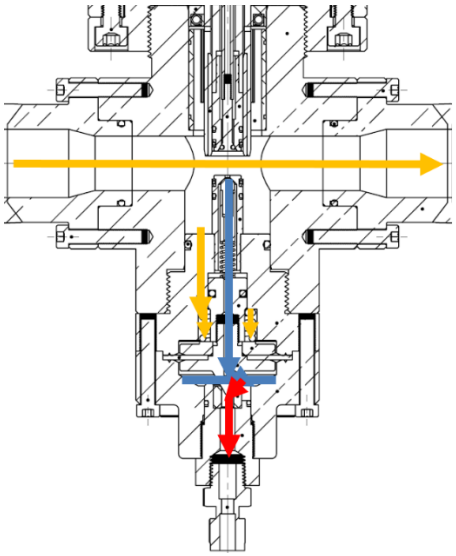
2: Performance degradation is more gradual and sampler exchange can be planned between batches or maintenance intervals.

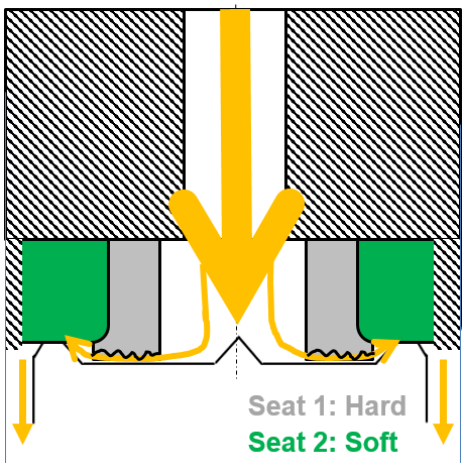
3: General accuracy is higher as dependency on crude and water properties are reduced due to less leakage.

Evaluating a new sampling technology

Experiencing a lot of sampling reliability issues, Aker BP started looking for samplers which could cope with their process conditions and started evaluating a sampler with an integrated zero-leakage-valve. This sampler design replaced the traditional check valve and relief valve with a pressure balanced regulated check valve and a retracted seal check valve. By using the pressure balanced check valve, the seal pressure is much lower than with the traditional samplers reducing the amount of wear of the check valve. Furthermore, the

retracted seal check valve consists of a retracting valve body assuring less wear of the soft seals and reducing leakages. See pictures per below.





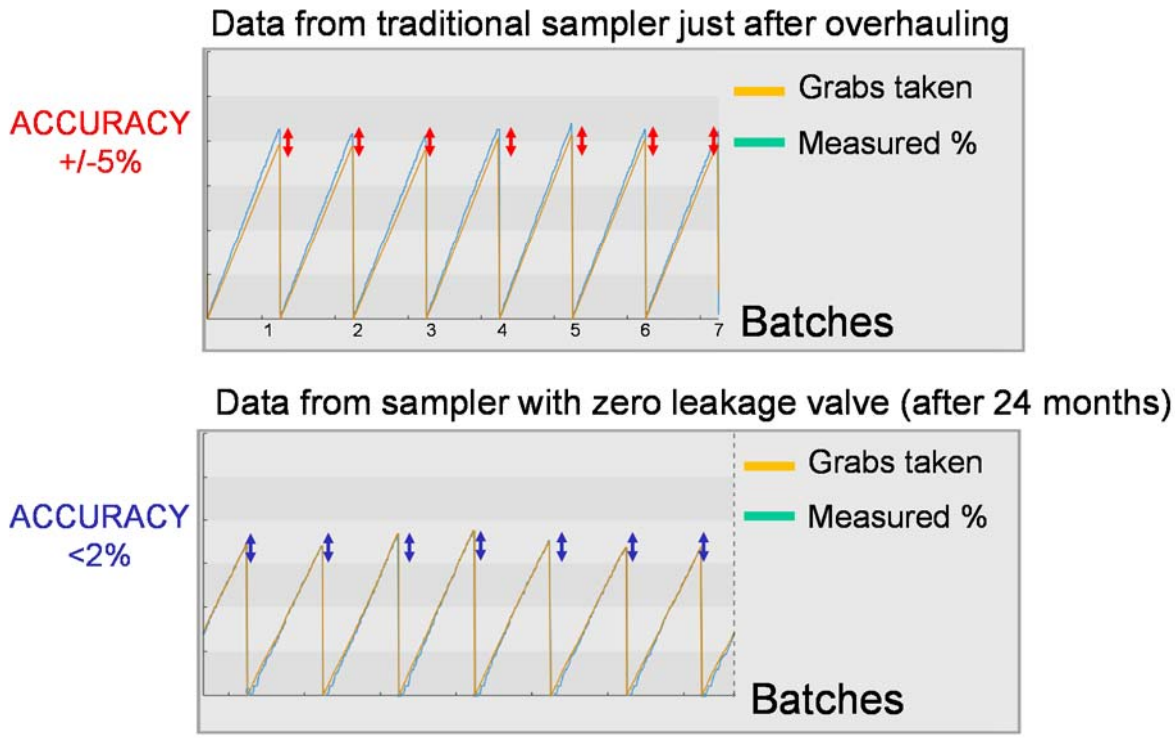
Patented Design

Results with new sampler technology

Two of samplers with zero leakage valve were installed, one in January 2015 on the Oselvar sampling system and one on the Valhall sampling system in June 2016. At the time of writing (June 2017) both samplers are still in operation without performance degradation, with a total grab count at the Oselvar of around 4M and the Valhall passing the 2M mark. MTBF rates were reduced by a factor 15 on Oselvar and a factor 13 on the Valhall.

	Traditional sampler	**Sampler with zero-leakage-valve**
Failure rate Oselvar:	8-10 weeks	> 120 weeks
Failure rate Valhall:	4-6 weeks	> 52 weeks

Apart from the availability and reliability of the zero leakage samplers, there was also an increase of grab performance noticeable which can be found in the following pictures.



Due to the balanced pressure mechanism and the sealing mechanism of the zero-leakage-valve, grab volume was more precise and not susceptive to pressure changes. Traditional samplers showed a general variation of around 5% in total performance when newly installed, while zero leakage samplers showed variations of up to 2% even after 24 months of operation.

Since the introduction of this sampler design with integrated zero-leakage-valve, data has been collected by KPS from more than 90 units, which indicates a more robust performance and on average a sampler lifetime that is 4 times longer compared to traditional designs. With this said, the sampler with integrated zero-leakage-valve shows promise for future sampling locations.

Conclusion

A sampler designed to have a constant performance factor over long periods of time is a key factor in achieving a truly representative sample collection and less oil losses. We can conclude that the new sampler design with integrated zero-leakage-valve tested at the Olsevar and Valhall fields has proven that a substantial reduction in maintenance cost can be achieved, together with a more reliable and accurate performance.

References:

[1] ISO 3171 (1988) Petroleum liquids -- Automatic pipeline sampling

[2] API MPMS 8.2 (1995) MANUAL OF PETROLEUM MEASUREMENT STANDARDS CHAPTER 8 - SAMPLING SECTION 2 - STANDARD PRACTICE FOR AUTOMATIC SAMPLING OF LIQUID PETROLEUM AND PETROLEUM PRODUCTS

[3] Automatic Liquid Sampling: Oil losses versus Operating cost - Authors: E. Verloop M.Sc. (KPS) and P. Verloop M.Sc. (KPS) August 2013

[4] Aker BP report- Authors: E. Sveinsvoll (AkerBP) and S. Øvrebø (AkerBP) August 2017

[5] KPS water injection proving records

[6] Site comparative data