

CLAMP-ON WATER CUT MEASUREMENT AND FLOW RATE RESULTS FROM OFFSHORE TEST WITH A UK NORTH SEA OPERATOR

Field Trial Results comparing XSENS Meter for Water Cut and Flow Rates against incumbent Coriolis Meters.



CLAMP-ON WATER CUT AND FLOW RATE TESTING

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XSENS is proud to be the first company in the world to have developed a clamp-on water cut meter that can measure water cut in the whole range 0-100% with an accuracy of +/-1% absolute.

A UK North Sea Operator asked XSENS to test our technology on two different pipelines on their Offshore platform against incumbent Coriolis Meters and manual water cut sampling. The goal was to see how accurate the XSENS Meter measures water cut with varying water cut ranges, compared to sampling data and calculation of water cut based on densities of oil and water from the inline Coriolis Meters. Since the XSENS Meter also measures flow rate, it was also of interest to the Operator to learn how accurate the XSENS flow rate data is compared to data from the Coriolis Meters.

The Clamp-on Meter from XSENS was a portable test unit that could be easily moved from one pipe to another, instead of a fixed unit intended for permanent installation. The live test sequences were witnessed by Operator's personnel. Reference data from the client were shared with XSENS after delivering its measurement results to the Operator. The trial was carried out in August 2023.

WHAT'S INSIDE THIS ISSUE:

Comparative testing of the XSENS clamp-on flow rate & water cut meter against Coriolis meters provided favourable results. There was also a strong correlation between XSENS water cut measurement and water cut estimate calculations derived from water and oil densities measured by the Coriolis meters.

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TEST CONFIGURATION

For the first test at location D103, the XSENS Meter was installed on a 6" pipe downstream of two Coriolis Meters installed on two separate 3" pipes (stream 1 and 2). These two 3" streams upstream of the XSENS Meter were comingled into the 6" pipe where the XSENS Meter was installed. The second test at location D104 was the same set-up as for D103.

Before starting the tests, one water cut sample was taken from each stream. This was used to calculate the Speed of Sound (SoS) for oil and water and to measure the density for oil and water used in the Coriolis Meter for water cut calculations.

Once the test was completed, XSENS shared the test results with Operator. They subsequently shared an Excel log for the Coriolis meter for the same time period as the test. Data was logged at 1 minute intervals, and was utilised to compare flow rates and calculate density for water cut.

During manual sampling to determine densities for water and oil, it was noted that there were significant variations in density. This will add uncertainty to the water cut estimates from the Coriolis meter.



TEST RESULTS WATER CUT (1/4)

Below figures highlight the Water Cut measurement results on location D104 and D103 with the XSENS Clamp-On Water Cut meter. The collection was interrupted at one point due to a short raw-data transfer issue. This gave us a small blind spot in the data set marked as A in Figure 1.

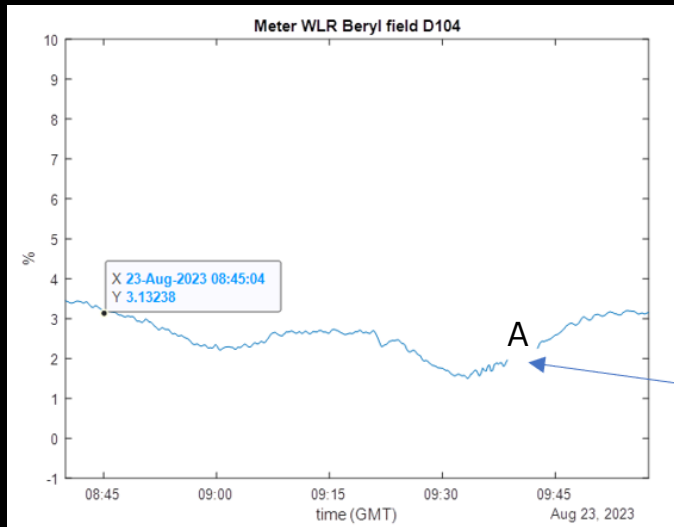


Figure 1 Water cut from Xsens on D104. Timed from 08:40 to 10:00 Aug 23rd

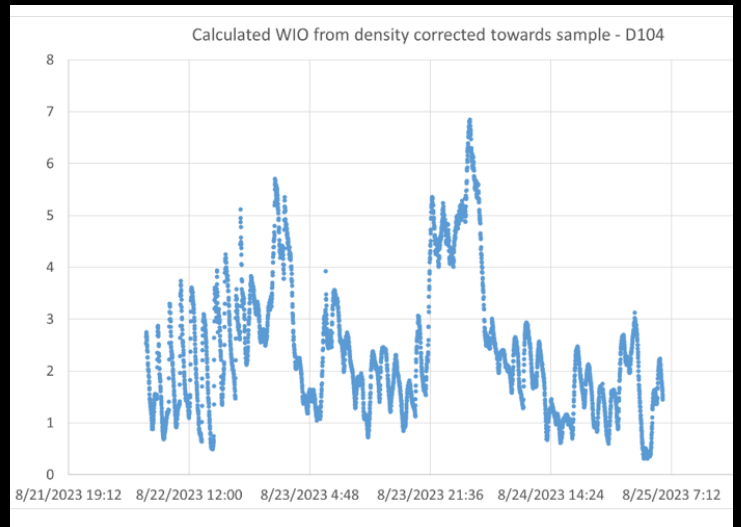


Figure 2 Calculated water cut from Coriolis Meter with corrected density by manual sample 22-25 August

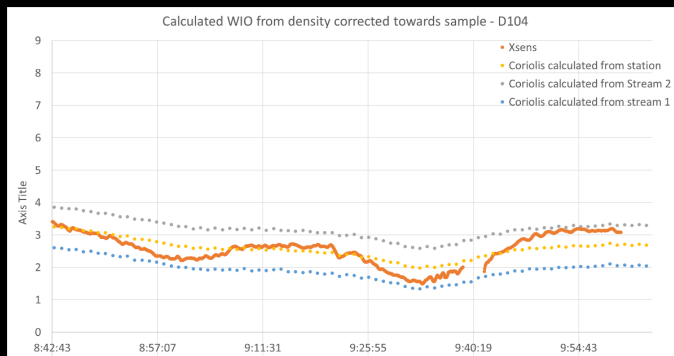


Figure 3 Water cut comparison between Coriolis and XSENS Meter during the test on D104

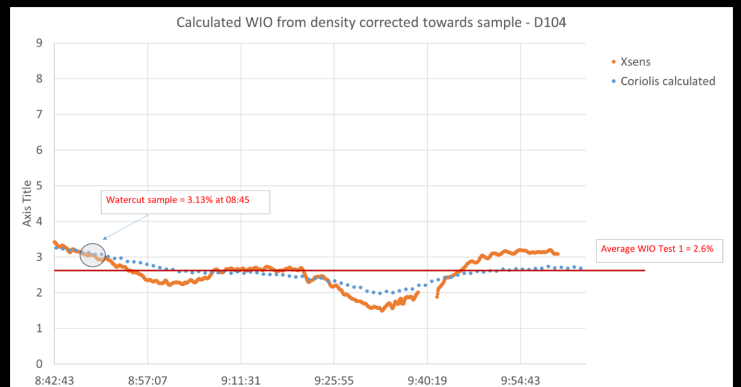


Figure 4 Same as Figure 3 but with average from Coriolis only. Average measured WIO from XSENS and Coriolis with sample value and time also given.

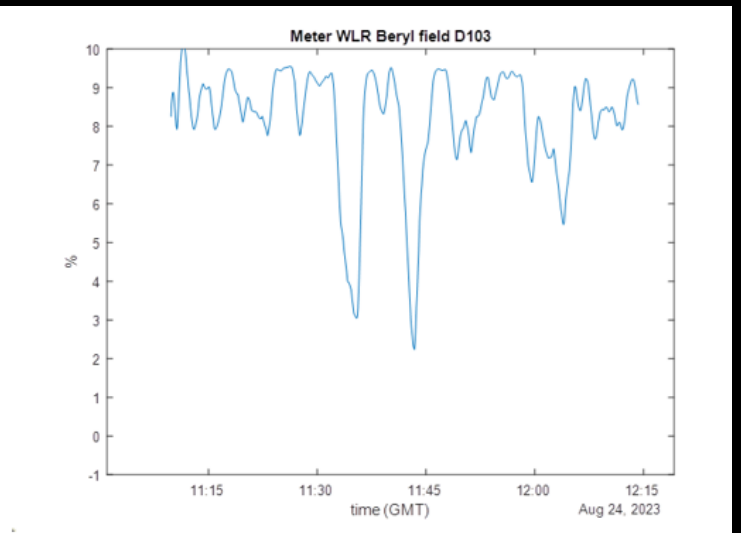
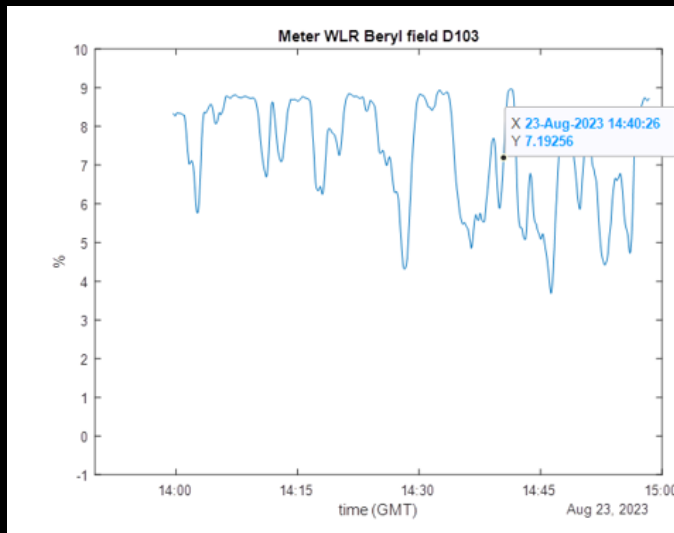


Figure 5 Water cut from Xsens Meter on D103 (Aug 23rd and Aug 24th)

TEST RESULTS WATER CUT (2/4)

Figure 6 and 7 show the calculated Water In Oil (WIO) ratio at location D103 from Coriolis density readings corrected towards manual samples.

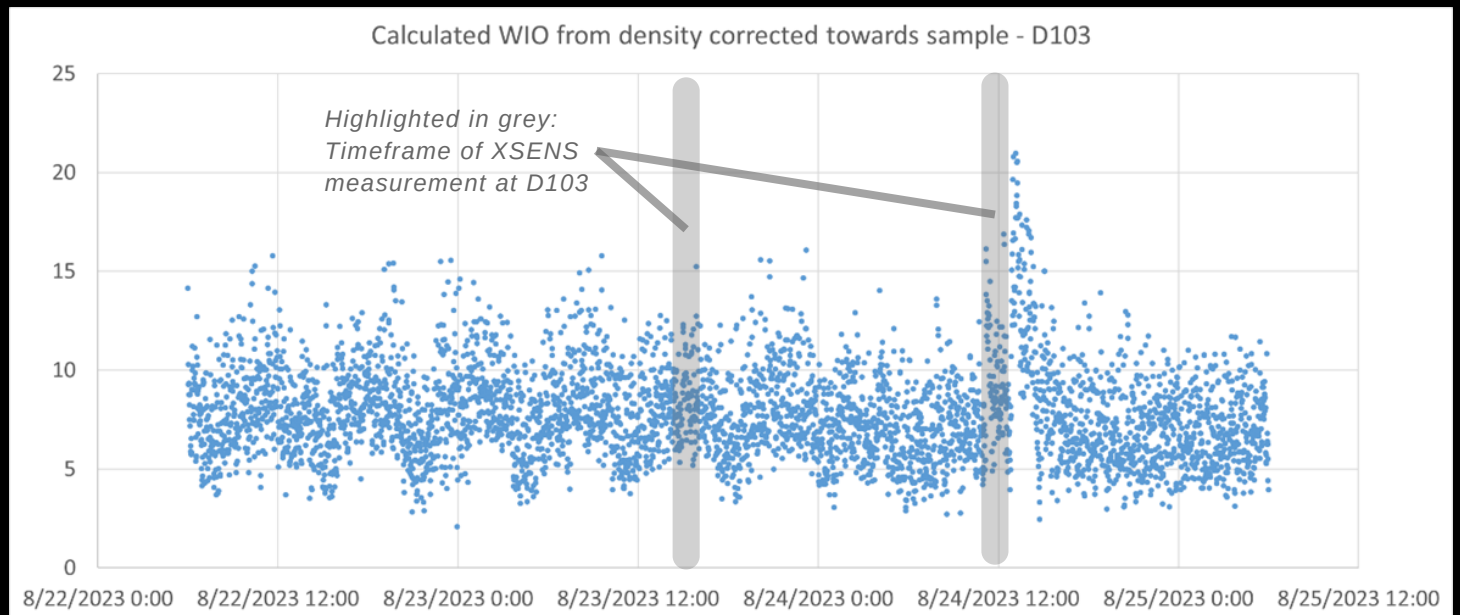


Figure 6 Calculated Water cut from measured density from Coriolis Meter data log

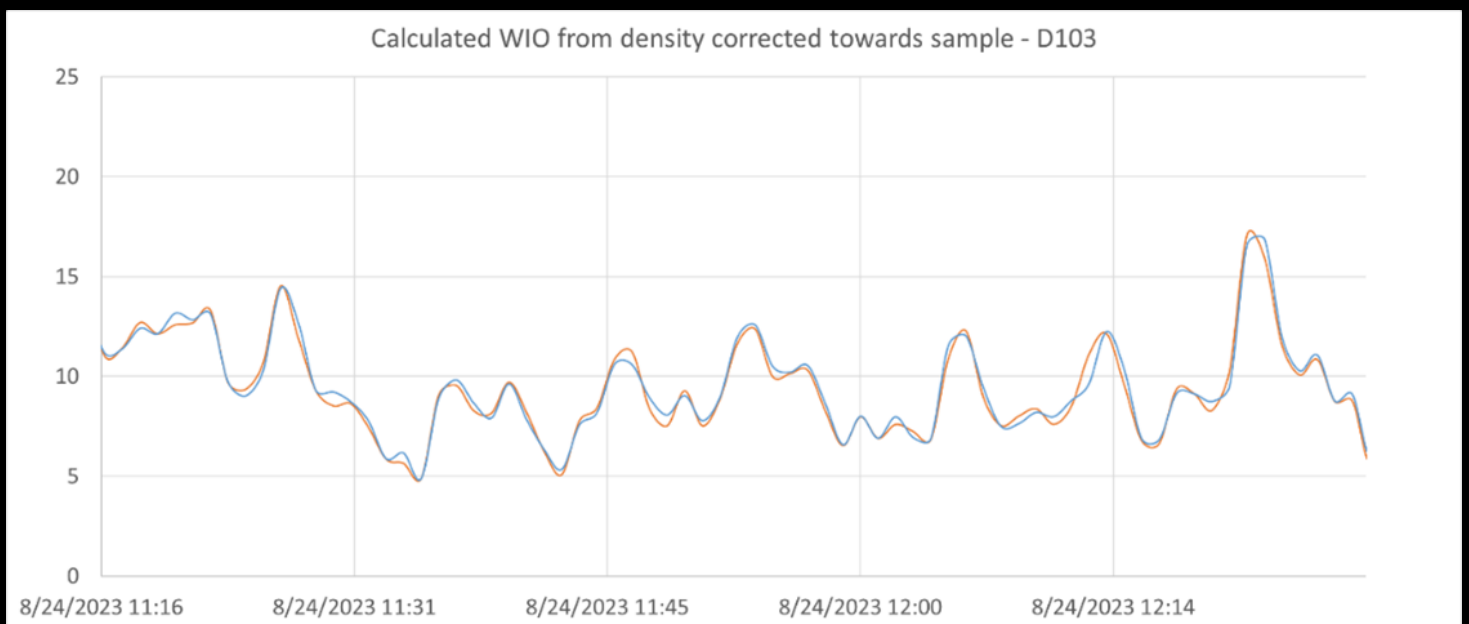


Figure 7 Water cut from the two Coriolis averaged over 5 min



TEST RESULTS WATER CUT (3/4)

The blue dots in Figures 8 and 9 represent the calculated Water in Oil (WIO) from Coriolis meter density measurement at location D103. The grey line is the water cut measurement of the XSENS ultrasonic clamp-on meter at the same location.

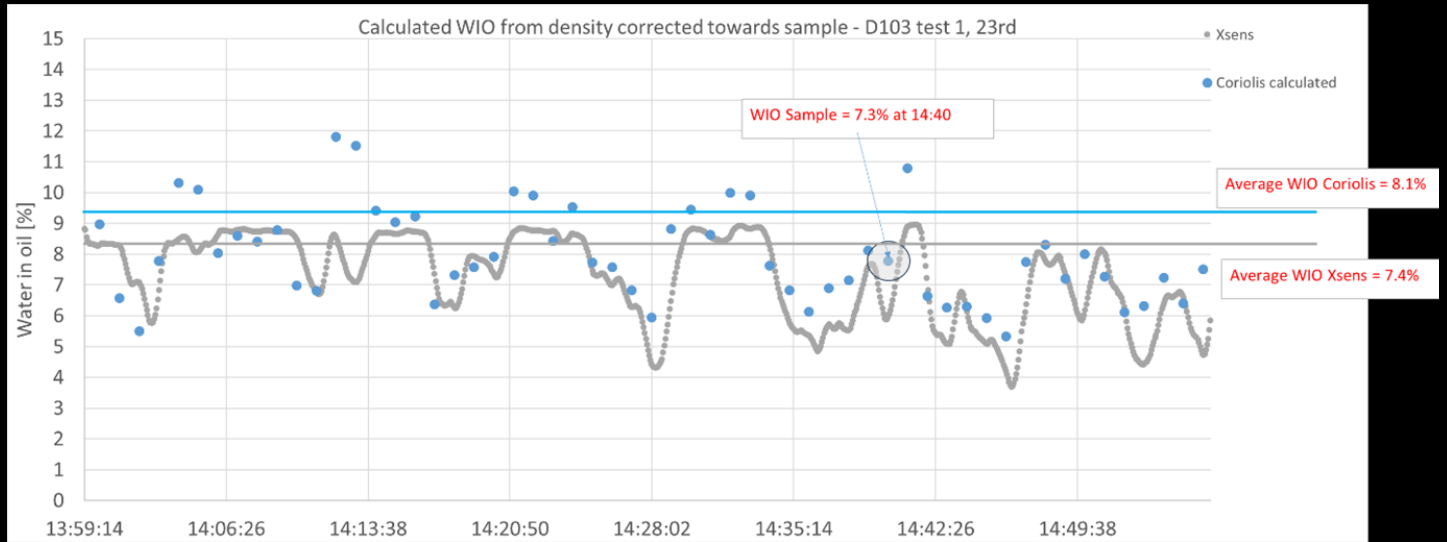


Figure 8 Water cut comparison between Coriolis and XSENS Meter Aug 23rd

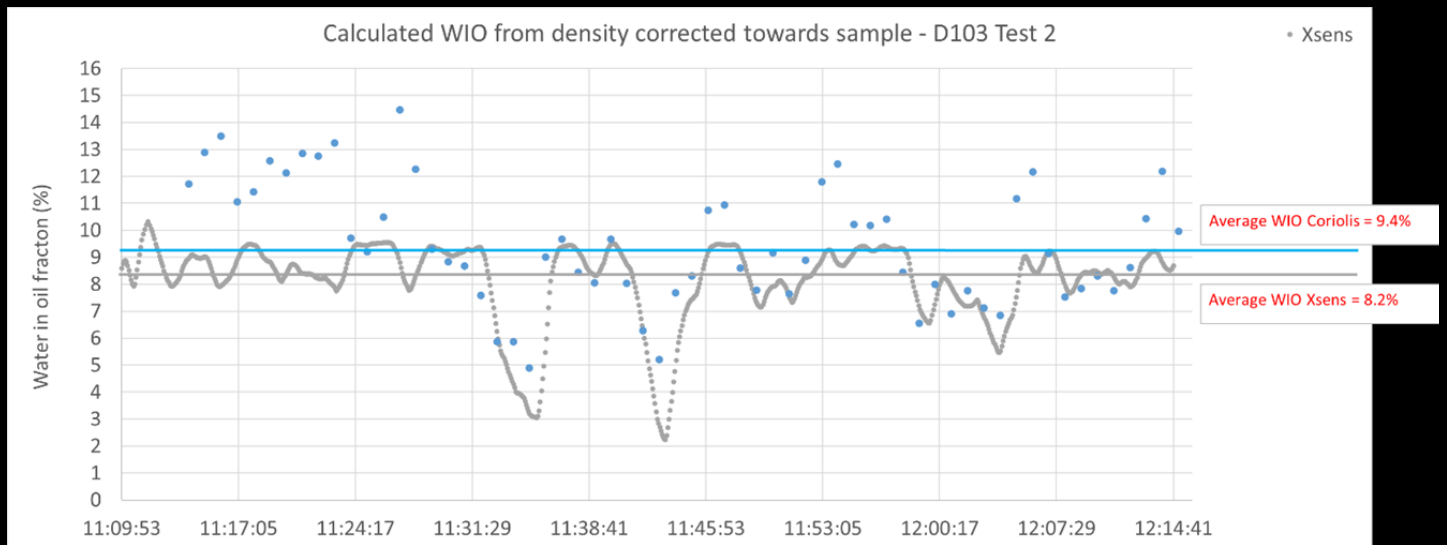


Figure 9 Water cut comparison between Coriolis and XSENS Meter Aug 24th



TEST RESULTS FLOW RATE ON D103 AND D104 (4/4)

The figures below show the results of the Flow Rate measurement provided by the same XSENS Meter which can measure both Water Cut and Flow Rate with the XSENS clamp-on ultrasonic technology. This is compared to the inline Coriolis meters at D103 and D104.

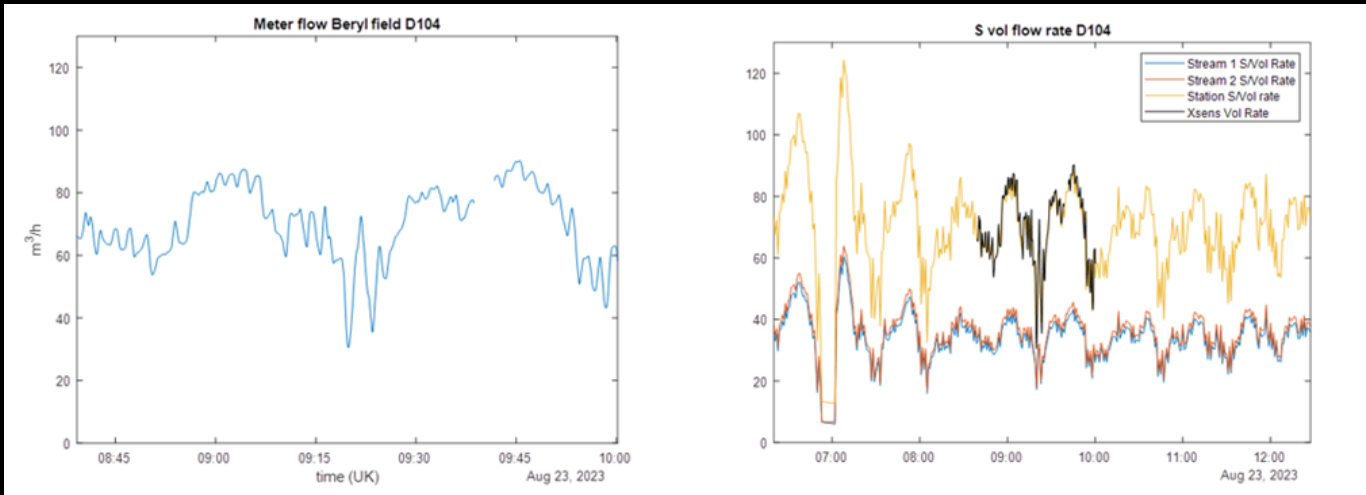


Figure 10 Coriolis flow compared to XSENS flow on D104 (Aug 23rd)

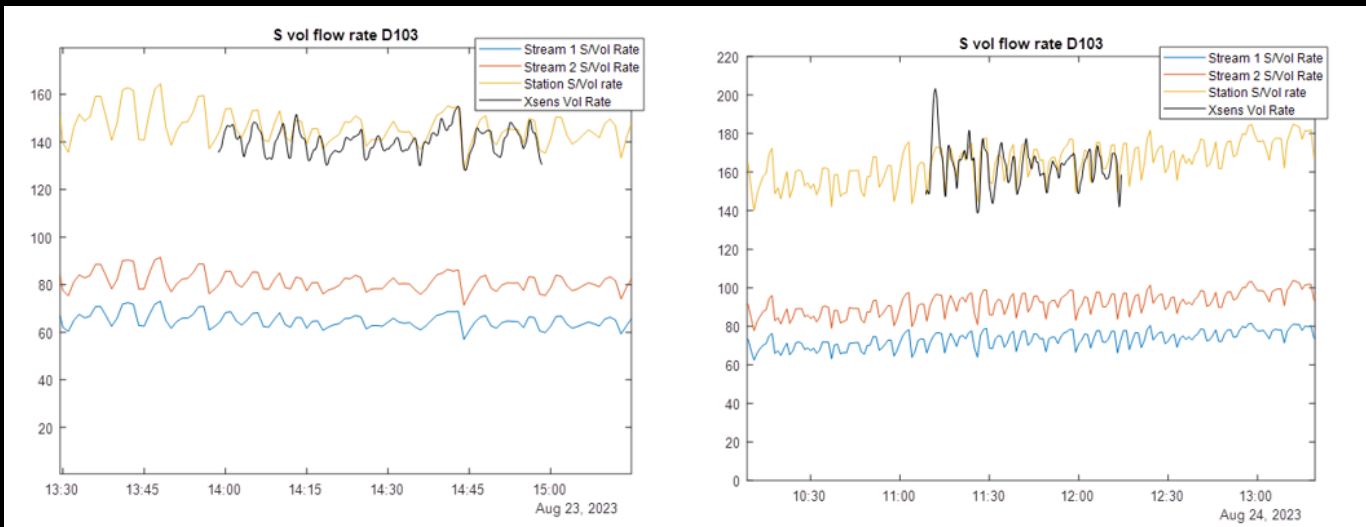
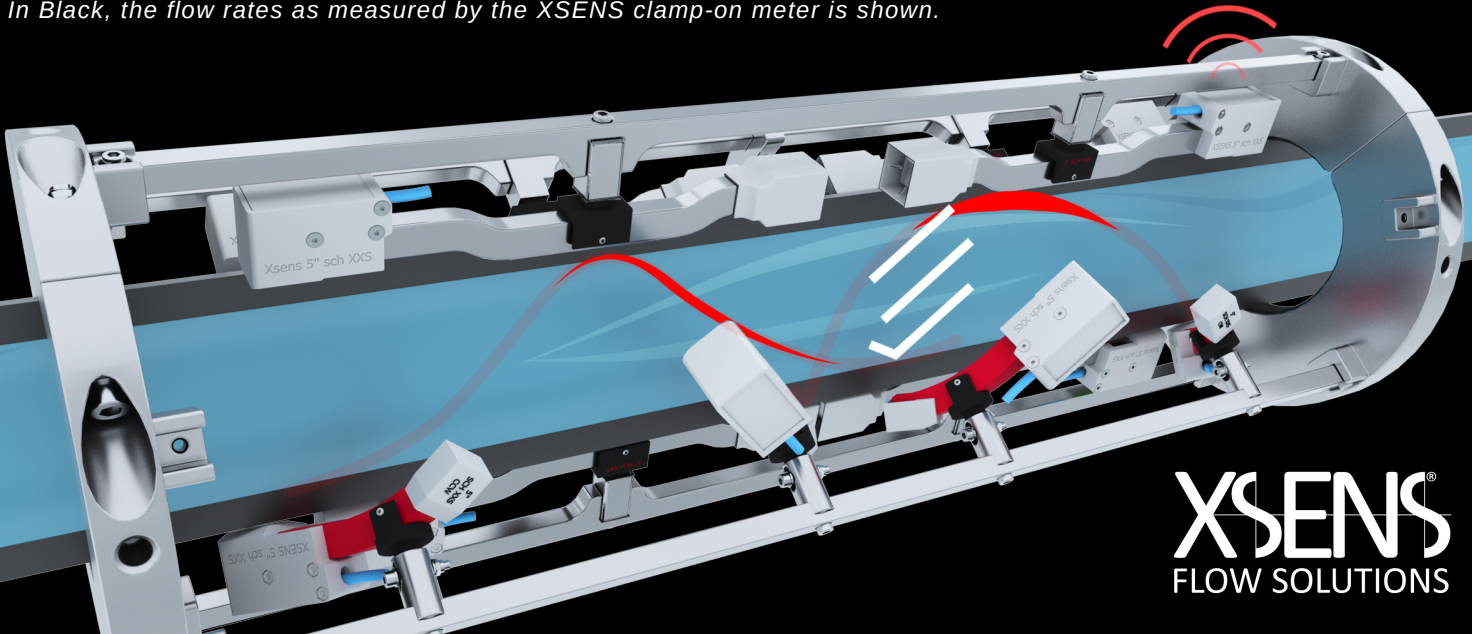


Figure 11 In each graph (23 and 24 August) of the D103 location, the Orange line is the total flow rate of the two Red and Blue lines combined. Red and Blue show the flow rate of each of the Coriolis meters on the 2 x 3" lines. In Black, the flow rates as measured by the XSENS clamp-on meter is shown.



SUMMARY OF TEST RESULTS

DISCUSSION

Ultrasonic water cut readings from XSENS were consistent with water and oil density-based water cut readings from the Coriolis meter. Due to quite rapid changes of densities during manual sampling it is easy to see that such settings of density in the Coriolis meter could cause significant offset in the range of -3 to +12% in water cut readings for the Coriolis measurement. This is especially visible on location D103.

The accuracy in density measurement from the Coriolis meter is also dependent on the variation in flow rate and water cut. The lower the flow rate is, and the closer the mixture of oil/water is to 50%, the higher the deviation in measured density and the larger the variation in Coriolis measurements.

The uncertainty in the Coriolis calculated water cut is very dependent on (amongst others) the accuracy in sampling versus the measured mixed density. Results from locations D103 and D104 on this offshore platform show that it is not practical to use the Coriolis for water cut measurement with an acceptable accuracy.

Flow rate measured by the XSENS Meter on the 6" line on both D103 and D104 locations showed similar flow rate as the accumulation of flow rates from the two Coriolis Meters on each of the 3" lines and followed the same pattern when compared for the same period.

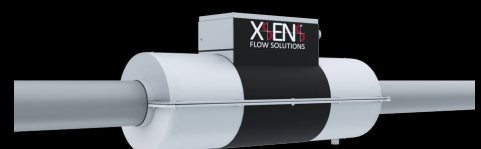
CONCLUSION

- For location D104, Water Liquid Ratio (WLR) measured by the XSENS clamp-on meter was, on average, within 0.2% absolute of the calculated value from the Coriolis meter, and within 0.1% of the manual sample.
- For location D103, Water Liquid Ratio (WLR) measured by the XSENS clamp-on meter was, on average, within 1.2% absolute of the calculated value from the Coriolis meter, and within 0.7% of the manual sample.
- XSENS believes that the WLR measurements from the XSENS Water Cut measurement is significantly better than the calculated water cut from mixture density, and this can be seen in the results from location D103.
- The flow rate comparison between the XSENS Meter and the two Coriolis meters is very consistent and follows dynamic changes as can be seen from the plots.
- Due to the innovative axial and helical sensor technology developed by XSENS, providing better measurement coverage across the flow profile than the installed Coriolis meters, XSENS believe that the installation of permanent meters measuring both water cut and flow rate will provide results that are equal to, or better than currently achieved.

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