SENSIA
Rockwell Automation + SLB

+ CASE STUDY

Simplifying complexity to maximize efficiency in FSO metering system operations

Sensia's integrated approach to optimize measurement, sampling, and control

Key highlights

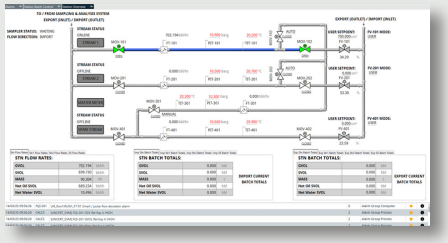
+ **Self-Verifying Meters (SVM):** Patented Caldon ultrasonic technology delivering a quantitative evaluation of meter performance with a live uncertainty output determined from first principles.
+ **Live Uncertainty Analytics:** The live uncertainty output from the SVM feeds into our live uncertainty model within TRUST dynamically calculating the overall system uncertainty.
+ **CapEx & OpEx Reduction:** It is estimated that the Sensia solution saved around ~60 tons in weight, whilst significantly reducing operational costs by reducing system complexity, i.e. high integrity valves, prover and instrumentation, both in terms of maintenance and periodic verification.
+ **Jiskoot Sampling:** Our bi-directional CoJetix ensures representative sampling across the complete application turndown without compromise. Equipped with online density and BS&W, the system also includes our Inspec controller for performance monitoring.
+ **Pressure Drop Reduction:** 1 Bar System Pressure Drop Reduction, reducing pumping Energy, offload time and risk of demurrage.

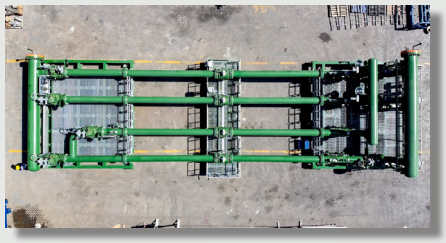
Our client operates a large FSO in Africa, offloading 1M bbl. With no existing metering system there was a high reliance on determining product volume by way of manual ullaging, estimated to be around ± 5%, which could potentially amount to an exposure of $4M per month. In addition, every manual ullage had to be witnessed by the government authority at a cost of around $10K per month. A metering system was procured from a 3rd party however it was subsequently cancelled due to incompliances, therefore Sensia were contacted to evaluate the application.

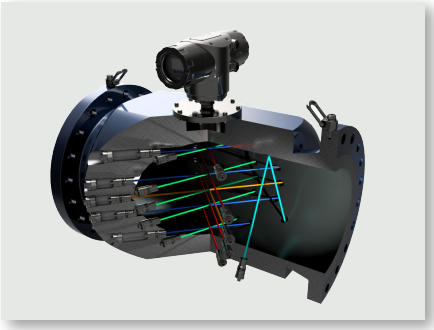
The application is bi-directional, where the desire was to install a custody transfer metering system to meet international standards as well as the local regulatory guidelines, whilst addressing several significant application challenges.

Challenges

+ **Weight and Space Constraints:** It was found that the existing deck could not support the footprint and weight of a traditional metering system configuration including a bi-directional prover.
+ **Contractual Offload Time:** The originally proposed system was Coriolis based and included a bi-directional prover exceeding weight and footprint limits with a system pressure drop of ~4 bar. The directive was to design a system which minimizes footprint, weight and pressure drop where the latter facilitates faster offload times.
+ **Bi-directional Flow Needs:** To develop a system which did not require a complex mechanical interchange upstream to route flow and was truly bi-directional.
+ **Regulatory Compliance:** Local regulations favored an in-situ prover, however this added ~60 tons in weight. Sensia evaluated and worked with the end user and government regulator on alternative approaches.
+ **Representative Sampling:** A bi-directional sampling system ensuring compliance with the relevant local and international standards whilst achieving representative sampling over the complete application turndown.







Result

During system design many considerations must be balanced to meet the contractual offload requirements whilst optimizing the metering system. Our Sensia, Caldon SVM, facilitated a compact metering system with a significant reduction in system pressure loss, delivering weight and footprint savings along with faster offload times whilst reducing pumping energy.

Quality is as important as quantity where as little as 2-200ml of sample can determine the value of the overall batch. Unlike fast loop designs where turndown is restricted by the pressure drop over a static mixer, our Sensia, Jiskoot CoJetix ensures that a representative sample is captured over the complete batch, including ramp-up and top off where there is a possibility of higher-water content at the start and end of the batch.

The Sensia, Swinton metering control system ensures proper execution and management of the offload ensuring optimized execution, traceability and auditability of operations. Our live system uncertainty model ensures confidence in the offload by estimating system uncertainty, triggering an alarm should it deviate from a predetermined threshold allowing the operator to drill down and identifying the source of uncertainty and take appropriate action.

Through market leading technologies and significant application expertise, Sensia have the capabilities to deliver proven solutions optimized for floating vessels. We believe that this results in smarter systems, lowering CapEx and OpEx whilst reducing any potential for financial exposure.

Solution

In-situ proving generally offers the lowest uncertainty by verifying the flow meter under exact operating conditions. Although government regulations will mandate provers in certain countries where flexibility exists many floating vessels have chosen alternative methods due to cost, size and logistics. These alternative approaches could include periodic verification of the primary meters, or the use of master metering. Each approach has its advantages and disadvantages both commercially and technically. As this project was sensitive to considerations such as weight, space and pressure drop, and although the government regulations preferred an in-situ prover both the end user and government regulator were open to other methods.

As an alternative to the prover (bi-di or SVP), the Caldon SVM 289Ci was considered. The SVM 289Ci was specifically developed to address the desire of ultrasonic technology to be able to self-diagnose its performance. Further to significant correspondence between Sensia, the end user and government regulator, a 6-month process of evaluating our test data, certification and a visit our Caldon ultrasonic technology centre to evaluate a calibration and our dynamic live uncertainty calculations was undertaken. As well as complying with international and metrology standards the SVM 289Ci is certified to in accordance with DNV-RP-A203 technology qualification for the most stringent L-AAA with accuracy class level ± 0.25%. This certification includes a diverse range of tests, and concluded that the diagnostic ability of the meter, making use of the U-SVM uncertainty evaluation, is very high.

The SVM 289Ci was approved for use by the government regulator, resulting in 2 x primary streams with a standby and master meter, facilitating significant complexity reduction and a low-pressure loss system. The master meter would not be required but given it was the first SVM deployment this was a compromise against removing the prover. The SVM 289Ci is approved to OIML R137 Class 0.3 with a minimum of 5D upstream and no requirement for flow conditioning. In this instance as the deck supports were designed for a certain load, Sensia decided to make the system longer than it would usually be required so that the load could be spread across multiple pads. For future projects where the deck design has no limitations, the system can further benefit from a smaller footprint where advantageous.

In terms of quality, custody transfer or allocation type automatic sampling systems are vitally important. As product prices change and the final product quality measurements become more critical on a specification basis to the supplier, shipper and the customer. Automatic sampling systems allow the quality of the product to be measured to a specific degree of uncertainty. When an automatic sampling system is designed and applied correctly, the uncertainty is minimized. Designing a truly representative automatic sampling system is not a simple task as it involves evaluating all the system variables such as location, pipeline mixing, product properties, extraction, sample handling and sample analysis.

To meet the turndown of the application, and limit pressure drop, equipped with online density and BS&W, our bi-directional a Jiskoot CoJetix was selected over a fast loop design ensuring compliance with ISO 3171 and API Chapter 8 Section 2 Automatic Sampling Standards.

The final key component of the system was measurement control and automation. Along with Caldon and Jiskoot, our Sensia Swinton TRUST control system has been used globally on a wide range of floating vessel projects. TRUST is designed for high accuracy applications with the flexibility to deliver a range of features from secure station totalization, virtual flow computing, condition-based monitoring to intuitive navigation and system management. For this project our system was set up with individual stream flow computers and a master meter stream, along with an interface to the Jiskoot Inspec sampling controller. To complement the SVM our live uncertainty system module was incorporated to enable the operator to evaluate the batch offload in terms of measurement units and relative % uncertainty. This helps ensure traceability and also quickly identify any sources of additional uncertainty, resulting in immediate action.

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