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Practical experience with on-line gas densitometers

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PRACTICAL EXPERIENCE WITH ON-LINE GAS DENSITOMETERS

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SUMMARY

The Frigg gas field was discovered in July 1971 and gas began flowing through the pipeline to the St Fergus shore terminal in September 1977. Approximately one third of Britain's gas is supplied by Frigg, which underlines the importance of the gas custody transfer metering system at St Fergus. In addition, the pipeline takes gas from Occidental's Piper field and Texaco's Tartan field and this additional gas is metered offshore on MCP01 before entering the Frigg to St Fergus pipeline. This paper describes the experience gained using on-line gas densitometers in both onshore and offshore conditions.

(1) Total Oil Marine p.l.c. is the Operator of the Frigg Natural Gas Transportation System on behalf of the Frigg UK Association comprising TOTAL OIL MARINE p.l.c. and ELF UK Ltd, and of the Frigg Norwegian Association comprising TOTAL MARINE NORSK, ELF AQUITAINE NORGE A/S, NORSK HYDRO A/S and STATOIL. ELF AQUITAINE NORGE A/S is the operator of the field installations.

1. INTRODUCTION

Gas from the Frigg field is transported 365 km to a shore terminal through two 0.81 m diameter pipelines. The shore terminal is at St Fergus, Scotland, and it is here that the gas is treated and metered before sale to the British Gas Corporation.

At the intermediate manifold, booster platform, MCP01, situated 170 km from shore, the Frigg pipeline takes in additional gas from Occidental's Piper field and Texaco's Tartan field.

The present maximum capacity of the two lines is approximately 66 x 10^6 sm^3/day, carrying an average daily quantity of 200 tonnes of condensate extracted at St Fergus. By October 1983 compression will have been installed on MCP01, and then the maximum capacity will be boosted to approximately 76 x 10^6 sm^3/day.

Metering of the gas is carried out at three locations: Frigg for the Frigg field gas production (metering done by EAN); MCP01 for Piper and Tartan gas (metering done by TOM); St Fergus gas terminal for the combined gas handed over to BGC. In this paper we shall be concentrating on the experience gained on on-line density transducers at St Fergus and MCP01.

The metering at St Fergus gas terminal and on MCP01 is open for inspection at any time by UK Department of Energy and Norwegian Petroleum Directorate inspectors.

It will probably not be surprising that due to the differing environments with an onshore terminal and an offshore platform, the

experiences gained on on-line gas densitometers are not the same, and the variations between the two systems are described in this report.

However, both systems do have a common point of gas off-take. This is the upstream static pressure tapping on the orifice plate carriers.

2. DENSITY MEASUREMENT AT ST FERGUS SHORE TERMINAL

When the terminal first became operational, the method of measuring operating density was to use Solartron 1794 transducers (one for each metering tube) installed adjacent to the metering tubes in an environmentally controlled room. This room maintains a constant temperature of 20 °C about the orifice plate carriers and metering transducers.

Although this environmentally controlled room prevented ingress of moisture (and hence corrosion) into the transducers, it became apparent that errors could possibly be introduced into the measured value of operating density due to temperature discrepancies occurring between the gas inside the metering tube and the gas inside the density analyser. Tests were therefore carried out to estimate the magnitude of this error, and to overcome the problem two possible solutions were investigated:

1) The first solution was to place the analyser in a thermostatically controlled enclosure which maintained the enclosure at the same temperature as the gas in the metering tube.

2) The second solution was to replace the existing transducers with Solartron 7810 transducers in pockets in the metering tubes downstream of the orifice plate carriers. Positioning the transducers in pockets in the gas stream thus ensured a good correlation between the temperature of the gas inside the transducer and the temperature of the gas stream.

The conclusions gained from the tests on these two alternative proposals were that both solutions worked extremely well, but that on the grounds of reliability, low maintenance costs and overall economy the second proposal should be adopted. This was duly carried out in Spring 1980 and this is the existing system in use at St Fergus. Since the 7810 transducers were installed, there have been very few transmitter failures.

At the present time we are replacing our existing analogue flow computers with Spectra-Tek digital flow computers. This has enabled us to incorporate a velocity of sound correction to the operating density measurements, which could not previously be done with analogue flow computers.

The density transducers are calibrated every six weeks "in situ" in the metering tubes using high purity nitrogen at a static pressure of 42 bars gauge.

Finally, the arrival of the Spectra-Tek computers has enabled us to carry out a "back-up" density calculation using the compressibility method of AGA NX19, and this "back-up" calculation is used to monitor the measured density values. An alarm is set off when the

difference between the measured and calculated densities exceeds a preset value.

3. DENSITY MEASUREMENT ON THE MCP01 OFFSHORE PLATFORM

On the offshore platform, MCP01, the experience gained on density measurement is rather different. When Occidental's Piper gas first started flowing into MCP01, the density transducers in use were AGAR "in-line" densitometers. For calibration purposes the sensing elements needed to be wound completely out of the metering tubes, with calibration being carried out once every month. Additionally, since the gas arriving on MCP01 was not as "clean" as that obtained in the metering station onshore, or after a "pigging" of the Piper to MCP01 line had taken place, there were times when the sensing elements had to be wound out of the tubes to be cleaned.

In the harsh North Sea environment, corrosion gradually set in on the winding mechanisms and translating spools. This gradually created more and more difficulty in maintaining the operability of the density transducers, notwithstanding the time and gas expended when depressurising the metering tubes to lift out the density transducers. A decision was therefore taken to change to Solartron 7811 (high pressure) density transducers in pockets downstream of the orifice plate carriers in the metering tubes. The system changeover was completed by April 1983.

The method of calibration offshore is also different to that onshore. On MCP01 a vacuum check is carried out every month, and providing

the vacuum check is satisfactory the transducer is accepted. If the vacuum check is unsatisfactory, the unit is stripped, cleaned according to the Solartron Maintenance Guidelines, and then replaced. A second vacuum check is made and if satisfactory the unit is accepted. If found to be unsatisfactory, the unit is sent back to Solartron for repair.

Although it is still very early in the life of this new system, some difficulties have arisen in its operation. Due to the gas not being so clean and dry as in the onshore terminal, the transducers need more attention than those onshore, and there have been more complete transmitter failures. However, we are now slowly overcoming all the initial problems.

4. CONCLUSIONS

Thanks to the changes which have been introduced, better reliability and accuracy is being achieved in gas density measurement. However, it is of the utmost importance to have "clean", dry gas on which to make the density measurement, otherwise increased inaccuracy will occur with possibly transmitter failure in addition.

It is hoped that the paper will form a basis for discussion of practical density measurement problems at the North Sea Flow Metering Workshop 1983.

References

[1] Paper presented at the North Sea Flow Measurement Workshop, a workshop arranged by NFOGM & TUV-NEL

Note that this reference was not part of the original paper, but has been added subsequently to make the paper searchable in Google Scholar.