Fra Styret:

Årsmøtet ble gjennomført ifm Temadagen i Oslo den 19. mars. Protokollen vil bli lagt ut på NFOGM's hjemmesider innen kort tid.

Temadag 2010
Av Håkon Moestue, FMC Kongsberg Metering AS

NFOGM temadag og årsmøte 2010 ble avholdt 2010-03-19 på Grand Hotel i Oslo. Gjennomgangstema var "Norge som gassnasjon", og ulike aspekter ble belyst i til sammen ni innlegg om bl.a.:

- Gassled, som et meget omfattende nettverk for transport av - og "regnskap" for - svært store gassmengder,
- Måleteknikken, i fortid, fram til nåtid og utfordringer videre,
- Flere ulike myndigheter - med ulike roller - og flere ulike regelverk som operatører og leverandører må forholde seg til.

Glem SFT, fra 2010-01-18 er det KLIF som gjelder: "Statens forurensningstilsyn" har skiftet navn til "Klima- og forurensningsdirektoratet". Klimakvoteforskriften forvaltes av KLIF. Den er meget omfattende og detaljert - og er relevant for måling og rapportering av brenselgass og faklet gass. Kravene er til dels forskjellig fra krav i ODs måleforskrift.

Måledirektivet MID var igjen i søkelyset. Siden innlegget om samme tema på Temadagen 2008 er det nå akkumulert mer erfaring med implementering av MID. Fra leverandørsiden var det nokså klar melding

ut: Økte kostnader og ingen nevneverdig nytte.

Ellers er det alltid interessant og nyttig med oppdatering på måleteknikken. Denne gangen var det også et innlegg om analyse/kvalitet av naturgass fra et fagmiljø vi ikke møter så ofte: forskningsmiljøet.

Alle innlegg kan finnes på NFOGMs sider: http://www.nfogm.no/

Gjennomføringen av temadagen var meget strøken, uten bomslag så vidt vi kunne notere. Irene har kontroll. Grand Hotel tilbyr omgivelser med sjel - og plettfri service. Svært mange benyttet muligheten til å delta på middagen etter NFOGM årsmøte, samt overnatting. Vi finner grunn til å berømme musikken etter middagen, denne gangen med interne krefter, The Reciprocity Band: Bjørn Borgersen voc., Knut Skårdalsmo g., Per Lunde g., Øivind Ullenes g., Lars Solberg b., Tore Lindsetmo dm. og Bjørn Bjerkelund perc.

Se stemningbilder fra Temadagen på siste side i nyhetsbrevet

LIQUID MIXING CALCULATIONS

Av Morten Marstein, FMC Kongsberg Metering AS

- Examples from Gjøa Oil Export fiscal metering system

Introduction

There has been an increased focus on quality metering over the last few years. Operators and engineering contractors now admit there is more to fiscal metering than just flow measurement. Quality metering in this context is used as a common word for online sampling and measurement of density, composition and other fluid parameters that affect the quality and price of the petroleum product.

A liquid metering system generally includes at least one automatic sampler for taking out a portion of the produced or off-loaded volume to a separate receiving can. This extract of liquid is then analysed in a laboratory to determine the properties of the liquid, such as density, viscosity, water content, vapour pressure, H_2S content etc. For continuous metering on pipelines, Norwegian authorities (NPD) require online density and water-in-oil measurement in addition to automatic sampling on daily and monthly basis.

Sampling devices can be mounted into the main pipeline or they can be mounted in a bypass loop (fastloop) system. If density and watercut measurement is required, the common solution is to mount the samplers, density transducers and watercut meters into a common pumped fastloop arrangement.
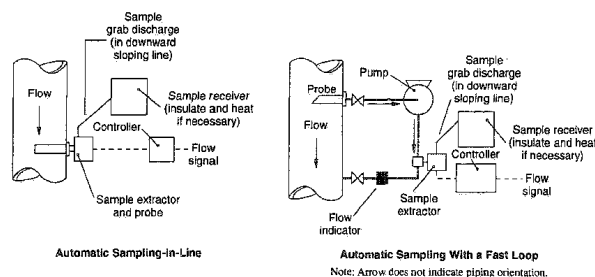

Figure 1—Typical Automatic Sampling Systems

Figure 1. Inline and fastloop sampling arrangement

Whether the design includes inline or bypass line quality metering devices, it is important that the fluid is homo-genious at the sample take-off location. An inline sampler or a take-off probe for a fastloop line both have an opening of only a few millimeters, whereas the pipeline diameters can be 200 mm (8") or larger. As an example, with low flow rate in a horizontal pipe the water will separate by gravity to the bottom of the pipe and the sampling point at the tip of the probe will see "dry" oil although the actual water content may be 10 or 20%.

OIL / WATER MIXTURE

IN PIPELINE

LOW FLOW RATE POOR MIXTURE
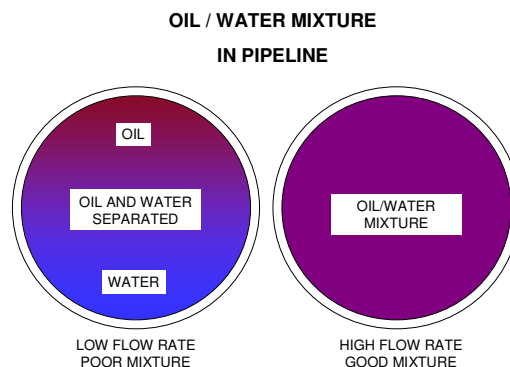
HIGH FLOW RATE GOOD MIXTURE

Figure 2. Separated oil/water flow in pipeline

Norwegian authorities and the majority of the international petroleum industry refer to the recognized standard ISO 3171 "Petroleum liquids - Automatic pipeline sampling" for evaluations on homogenious liquids and mixing requirements.

Mixing calculations

The main principle in the ISO 3171 standard is to calculate the water-in-oil concentration across the pipe section from top to bottom in a horizontal pipe. ISO 3171 recommends a C_1/C_2 ratio of 0.9 or higher, where 1.0 indicates a completely homogenious mixture.

$$\frac{C_1}{C_2} \geq 0.9 \quad \text{Very good mixing}$$

$$\frac{C_1}{C_2} \leq 0.4 \quad \text{Poor mixing, high potential for}$$

water stratification

C_1 is the water concentration in the top of the pipe
C_2 is the water concentration at the bottom of the pipe

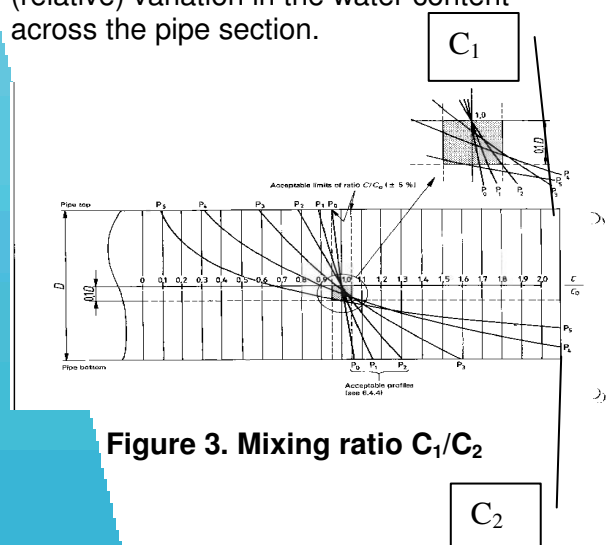This recommendation allows for a ± 5% (relative) variation in the water content across the pipe section.

Figure 3. Mixing ratio C_1/C_2

Example 1:
If the overall water concentration is 1%, a mixture such that C_1 is 0.95% and C_2 is 1.05% is regarded as a well mixed liquid since the C_1/C_2 ratio is above 0.9.

$$\frac{C_1}{C_2} = \frac{0.95\%}{1.05\%} = 0.904 \quad \text{Very good}$$

mixing, no further actions required.

Example 2:
A distribution of water such that C_1 is 0.8% and C_2 is 1.2% gives a C_1/C_2 ratio of 0.67.

$$\frac{C_1}{C_2} = \frac{0.8\%}{1.2\%} = 0.67 \quad \text{Intermediate}$$

mixing, actions required to improve mixing.

Annex A of ISO 3171 lists detailed equations to be used and step by step calculation method for obtaining a value for the C_1/C_2 ratio based on inner pipe diameter, flow velocity and fluid properties. The described method is detailed and hard to follow.

NFOGM released in 2004 revision 2 of Handbook of Water Fraction Metering. The handbook is based on ISO 3171 and outlines simple equations for watercuts below 15% that are easy to implement into a spreadsheet in order to find the resulting C_1/C_2 ratio. Input parameters are:

- Water density
- Hydrocarbon density
- Inner pipe diameter
- Oil viscosity
- Flow velocity
- Interfacial tension between water and hydrocarbon (initial/typical value given)

The handbook is available on:
http://nfogm.no/

Example 3, Critical velocity in horizontal pipe (Gjøa Oil Export):
Critical velocity in horizontal pipe (ISO 3171 / Handbook of Water Fraction Metering) using Gjøa Oil Export properties in an 8-inch pipe.

Input parameters:

Rho_w	1025	kg/m3
Rho_hc (*)	740	kg/m3
Sigma	2.50E-02	N/m
D (*)	0.21158	m
μ (*)	0.636	cP

Results:
Calculation for C_1/C_2 ratio of 0.9 gives a critical velocity of 13 m/s (1650 m3/h), valid for up to 15% watercut.

The design flow rate for Gjøa Oil Export is 615 m3/h, less than ½ of required flow rate. Thus, probe mounting into a horizontal pipe without any other mixing arrangements was not an option on the Gjøa project.

The critical velocity largely depends upon the viscosity. If the viscosity had been 5 cP instead of 0.636 cP, the critical velocity would be reduced from 13 m/s (1650 m3/h) to 5.4 m/s (680 m3/h).

Vertical Pipe Flow
ISO 3171 does not differentiate between horizontal and vertical pipe flow. The Handbook of Water Fraction Metering introduces a method for calculating minimum required velocity with respect to watercut in a vertical pipe. The minimum required velocity is much less in a vertical pipe than in a horizontal pipe. Generally, an inline sampler or a liquid take-off probe should therefore be mounted into a vertical pipe section.

Example 4, Critical velocity in vertical pipe (Gjøa Oil Export):
Critical velocity in vertical pipe (Handbook of Water Fraction Metering) using Gjøa Oil Export properties and pipe size as in Example 3.

Results:
Calculation for 15% watercut gives a critical velocity of 2.3 m/s (289 m3/h). The critical velocity is much lower, in fact less than 20% of the velocity required for horizontal pipe.

The calculation model for vertical flow depends on the volumetric water content (watercut). Calculation for 0.5% watercut, expected as maximum on Gjøa, gives a critical velocity of 0.27 m/s (34 m3/h).
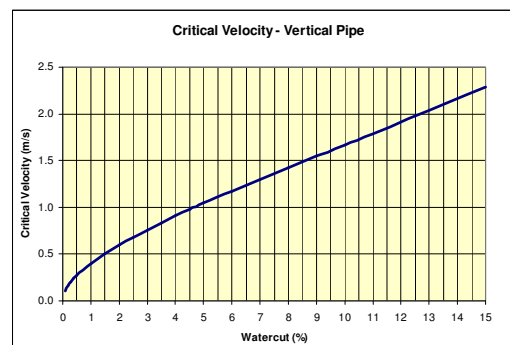

Figure 4. Critical velocity in vertical pipe for Gjøa Oil Export

The advantage of installing the probe into a vertical pipe section is clearly seen in Example 3 and 4 above. Probe installation into a vertical pipe was chosen for the Gjøa project.

Fastloop mixing calculations
Mixing calculation must be carried out also for the fastloop. The traditional filosophy of isokinetic sampling, where the velocity of the sampled fluid in the take-off probe equals the velocity of the main flow, can only be applied to sample extraction from a horizontal pipe. Typical pipe size for fastloop piping is 1", 1 ½" or 2". Conservative calculations should be done based on horizontal piping if analyzers and grab samplers are mounted in horizontal sections of the fastloop. Pressure drop calculations must be done based on the critical flow rate. The fastloop pump must be dimensioned to handle the calculated critical flow rate and the resulting pressure drop. Alternatives in case of non-homogenious liquids

If the mixing calculations indicate a non-homogenious liquid, i.e. the actual fluid velocity is below the critical velocity for homogenious mix, then one or more of the

following alternatives must be evaluated and applied:

1. Change to vertical pipe instead of horizontal pipe.
2. Reduce pipe size to increase the velocity.
3. Install static mixer upstream of probe/sampler location.
4. Install jet mixer upstream of probe/sampler location.

Alternative 1, **vertical piping** is the obvious choise where space is available since critical flow is reduced by at least ¼ compared to horizontal pipe.

Alternative 2, **reduced pipe size**, will induce increased pressure drop. Length of reduced pipe size in order to re-establish a good mix is not well defined.

Alternative 3, **static mixer**, is commonly used for re-establishing a good mix. The supplier of static mixers will calculate the type and size of static mixer needed to obtain $C_1/C_2 = 0.9$ based on process conditions and pipe size. The sample extraction point must be located between ½ and 3 diameters downstream of the static mixer. Increased pressure drop must be accounted for. The pressure drop will be estimated by the supplier.
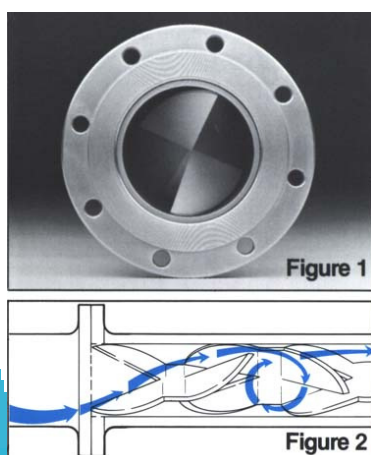
Alternative 4, **jet mixer**, consists of a pumped loop with a special return nozzle into the main flow stream, adding energy and mixing in the main pipe. This is a very effective but costly arrangment, and a good alternative where added pressure drop from a static mixer is unacceptable.

Static mixer arrangement for Gjøa Oil Export

The Gjøa project has installed an 8-inch pipe section with sample take-off probe and inline watercut meters for vertical installation, upward flow. A static mixer has been included to re-establish a homogenious oil/water mix at the take-off point and to avoid water separation at low flow rates. See Figure 6 for details.
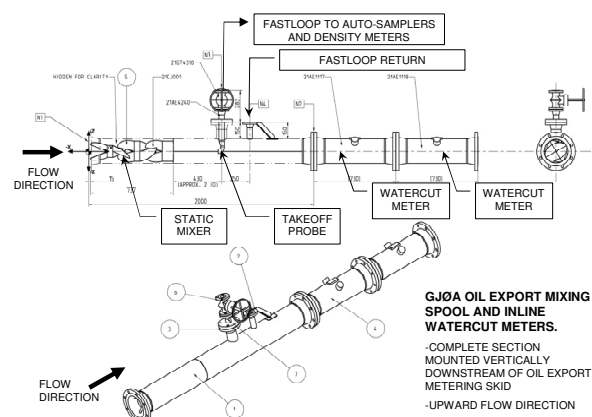
Figure 6. Static mixer and inline watercut meters for Gjøa Oil Export fiscal metering.

Figure 5. Static mixer (typical)

IKM VALVES AS, DISTRIBUTØR AV GENERAL VALVES

Av Rolf Lohne, IKM Valves AS

Fra Nyttår ble IKM Valves AS, distributør for Cameron - General Valves.

Flere målestasjoner er idag utstyrt med ventiler fra General Valves.

Stemningsbilder fra Tema Dagen i Oslo 2010