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Technical Paper

Digitalization of metering monitoring from multiphase to flare applications

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1 INTRODUCTION

As of today, multiphase flow meters (MPFM) are largely deployed for well production monitoring, mainly for subsea installations (more than 220 MPFMs are installed in Totalenergies assets).

Monitoring of this complex equipment is key to ensure its reliability and accuracy, as the production figures per well are then used to forecast the production, to optimize the well production and for reservoir monitoring. This is even more critical in assets where MPFM are used to allocate the production. Previously MPFM oversight was performed by suppliers 2 times per year, but these costly operations were not always valuable.

For 15 years, Remote metering monitoring in Totalenergies (TTE) has been developed to initially monitor our MPFM fleets with an increasing expertise on technologies, fluid properties and monitoring. Today it's almost all the MPFM installed that are monitored by head quarter, with regular feedbacks to affiliates.

Figure 1- Headquarter Remote monitoring Technical Room names SPECTroom

More recently this monitoring has been extended to all flow meters involved in the daily official production figures (Production Oil/Water/Gas, Fuel gas, water injection, gas injection, Fiscal export values), the flow meters of fuel gas & flare streams to meet TotalEnergies' ambition to reach net zero by 2050.

2. AUTOMATIZED WEB-BASED TOOL

In 2014, the monitoring has been automatized with a web-based tool, so-called "WIDE", developed by Widetech Belgium cpy.
This software embeds an in-house thermodynamic tool, but also various functionalities including:

- Dashboarding
- Input data analysis and quality control (missing/frozen/out of range…), prior to carry out any calculation
- Automatic reporting
- Data reconciliation based on mass balance approach
- Molecular weight calculation
- Alarming (in the software or by email)
- Virtual metering (machine learning)

- Tracking of modification (configuration…)

The software checks if the meter's configuration remains in line with production's, process's and fluids composition's variations. Raw data from meter are used to recalculate the actual flowrate, using thermodynamical equation and meter's specialist know-how. This backup calculation is therefor used for comparison, analysis and/or for overriding. In case of any deviation between recalculated data and meter data is detected, the application sends an alarm to the client, who is the final decision maker to implement the correction.

The recalculated data are also used by other TotalEnergies entities (including reservoir, well performance, process, mass balance teams, flare monitoring…) and as of today 200 persons got access to software as regular end-users.

3. REMOTE METERING MONITORING (RMM)

As of today, 16 production sites are under monitoring and this monitoring encompasses roughly 220 multiphase flow meters and 600 other type of flow meters (mass meter / ultrasonic / orifice plate / vortex…).

The monitoring includes the following activities:

- Comparison of pressure, temperature, delta pressure with nearby measurement
- Operating envelope monitoring
- Static point analysis to validate the configuration in place
- Conversion of actual to standards conditions comparison with thermodynamics calculation
- Back calculated flowrates

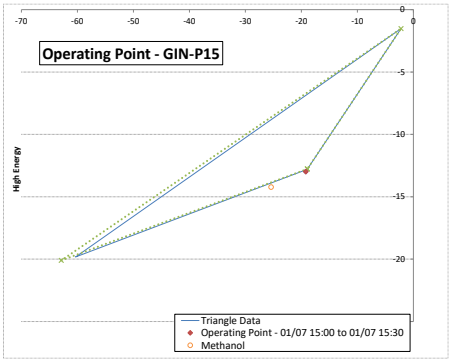

Figure 2- Static points

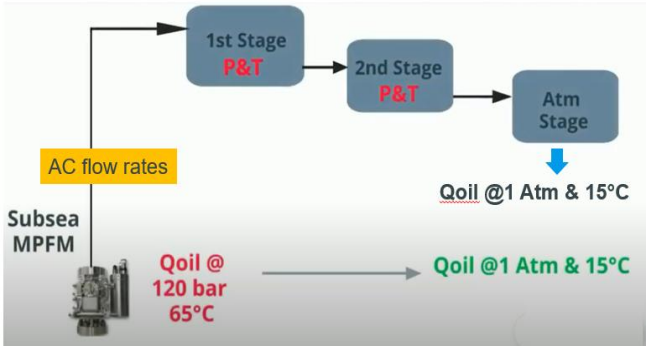

Figure 3- Conversion to Standards conditions' comparison

4. ADVANCED MONITORING

Considering the increasing scope of MPFM meters under monitoring, development of automatic solution to facilitate the monitoring became an obvious need.
It consists of automatic data acquisition of raw MPFM measurement available in the data historian, thermodynamic and script calculation.

Quality control is done on acquired raw data prior any use or calculation. Conversions from Actual to standards are computed and compared with any flow meter to take account process conditions change and review configuration accordingly.

Static points are detected and analyzed, reducing significantly the time required by the specialist, in increasing the reactivity.
In addition, the tool is used to proposed backup solution when a MPFM sensor is in fault but also to back calculate the past when initial configuration is found incorrect.

5. PROCESS' METERING MONITORING

Topside / Downward measurements are also analyzed and compared with global thermodynamical model, feed by process real time P&T conditions and streams routing (valve status). At each point of the process, thermodynamical calculation could be processed and compared against flow meter or analyzer measurement (mass, liquid, oil, water &gas flow rate, density, compo, speed of sound).

For example, if the simulation provides a similar gas composition than the one from gas chromatograph installed at the fiscal gas export, the simulated composition could be used all along the gas process to validate / review the technical flow meters, all along the production chain.

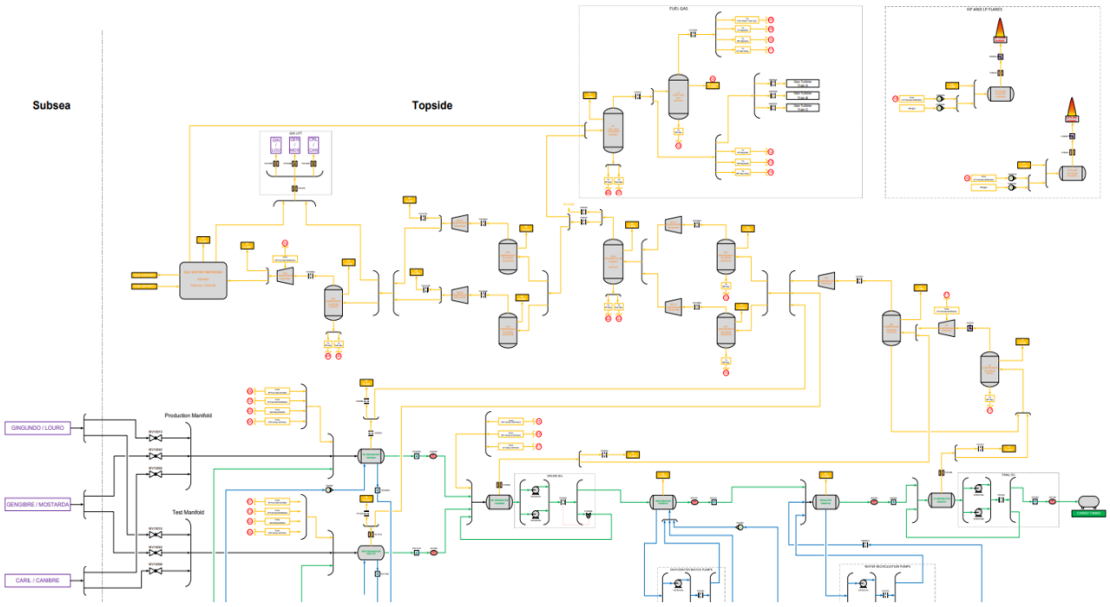

Figure 2- Example of Process flow meter monitoring

6. FLARE PROCESS' METERING MONITORING

In early 2019, TotalEnergies made public its aim to reduce its net Scope 1 & 2 emissions from our operated activities by at least 40% in 2030 compared to 2015 levels and announced to reach net zero by 2050.
To live up its ambitions to which it is highly committed, TotalEnergies created in 2019 the so-called Carbon Footprint Reduction (CFR) entity. Five CFR roadmaps have been set up to meet the objectives by 2050. One of the various projects addresses the quality of the measurement of the Green Houses Gases (GHG) emission volume and its conversion into the mass of CO2 equivalent. This project is based on the following principle: If you can't measure it, you can't fix it.

Consequently, a more recent application was dedicated on both fuel gas and flare network.
Looking at flare, being able to estimate the molecular weight on Low-pressure and High-pressure streams flare according to the well routing as well as the process upsets (compressors...), allows to refine the confidence in

- the meter configuration,
- the GHG volume precision in standard conditions,
- The definition of specific emission factors.

New functionalities are developed on regular basis via Python language by Widetech or by TotalEnergies's metering specialist.
Combining digital tools with thermodynamic equations and metering specialist know-hows leads

- to sustain improvement,
- to get more reliable & accurate meter outputs.

In flare measurement, the uncertainty depends mainly on fluid properties. With this overall monitoring, composition of gas to flare is estimated and recorded according to actual contributors (test separator, compressor outlet, inert gas …).

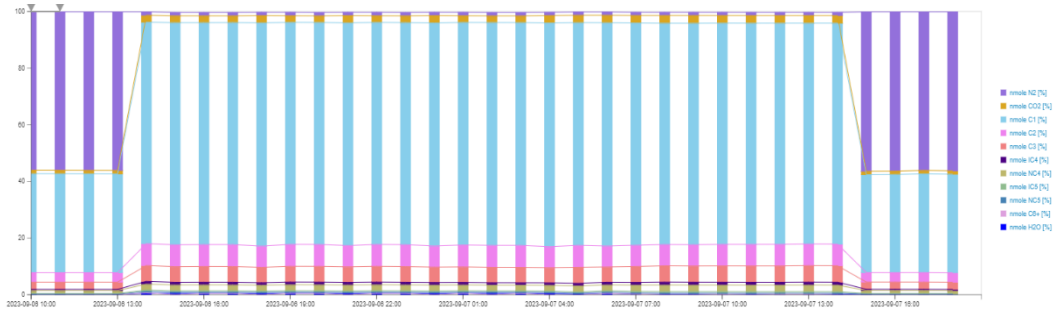

Figure 3- Flare gas composition variation

7. BENEFITS

The Digitalization of metering monitoring generated significant numbers of benefits on many aspects.

One of the key achievements is dealing with data quality in term of

- Availability with the Real time monitoring
- Reliability with the Mass balance' gaps reduction and the well back allocation improvement

Remote metering monitoring induces Safety benefits such as

- The reduction of site intervention by manufacturers (in addition to the monitoring, updated configurations are released to take into consideration the modification of the fluids properties)
- The well's events early detection

Remote metering monitoring leads to cost reduction as well:

- No need of specific shut down to monitor the MPFM (the system is able to detect any former opportunity- shut- down to carry out the analysis)
- Suppliers troubleshooting's visit almost eliminated (except for the annual calibration)

Last but not least, the TotalEnergies entity in charge has developed a tool in line with operations' key expectations, meaning reactivity & easy-to-access in all places:

- Periodic meeting are organized with affiliates, however data are available on real time
- The Web base solution allows an easy-to-access tool and a monitoring available for all
- The data are recorded into the application leading to any simulation on past data
- Simulated rates provided prior any modification of MPFM configuration

CONCLUSIONS

Global metering surveillance is successfully implemented in Totalenergies on many sites and this assistance keeps increasing.
The centralized organization ensure a sustainable high level of expertise and reactivity to assets.
This solution has improved multiphase flow meter monitoring but also all the flow meters all along the process, including flares.
It definitively increases the confidence on critical data and facilitates analysis for numerous end users (including reservoir, well perf, metering, process, mass balance teams).

Innovation is part of TotalEnergies DNA and the furthermore functionalities' improvement are kept tested / implemented.

Return of Experience on technologies and operational communication means with suppliers has improved. Sharing and transparency may continue in the right direction so that metering will never be a black box anymore.

4 ABREVIATIONS

MPFM Multiphase Flow Meter
RMM Remote Metering Monitoring
REX Retour of Operating Experience
R&D Research & development

4 AKNOWLEDGMENT

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