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Technical Paper

REMOTE METERING MONITORING AND SMART METERING ROOM FOR COST EFFECTIVE OPERATION OF MULTIPHASE METERS

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1 INTRODUCTION

Since 15 years, multiphase and wet gas metering techniques have been largely deployed by industry for well testing and well metering especially for subsea and unmanned development. The main reasons for that were to avoid expensive test separator solutions associated with test lines requirements mainly for CAPEX reduction.

TOTAL for instance is operating more than 150 multiphase flow meters (MPFM) worldwide from several suppliers with a majority located subsea (one meter per well) with minimum access due to high water depths.

There have been a lot of feedbacks challenging accuracy & reliability of multiphase metering solutions which may be subject to drift, fluid property changes and also sensors failure.

Maintaining data customer confidence in flow measurements and required accuracy is essential both for

- Fiscal measurements
- And technical application like reservoir monitoring and well production optimization

For development using MPFM, decisions are dependent on information's provided by such meters and well allocation for reservoir monitoring as well as forecast and shortfall calculations are based on well flow data provided by MPFM.

This is more critical in applications cases in which either MPFM are directly used to calculate overall marginal field productions or sum of well measurements provided by MPFM allow to calculate field production for fiscal allocation purposes.

Conventional way of operating MPFM by using both maintenance and operation practices adapted for topside applications as well as relying on suppliers spot or periodic assistance has been found not efficient and costly. Mobilization of manufacturer's specialists with offshore visits is also quite expensive and not compatible with the current climate of cost reduction.

In order to improve data quality for technical and fiscal applications but also to reduce OPEX related to maintenance and validation, real-time Remote Metering Monitoring (RMM) as well as collaborative work in Smart Metering Room facilities have been developed and implemented within TOTAL affiliate and headquarters to follow and trouble shoot multiphase meters & wet gas meters as well

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2 MULTIPHASE METERING TECHNICAL & COST CHALLENGES [1]

MFFM & WGFM which are bringing clear advantages on traditional approaches based on separation are largely applied in Oil & Gas productions by Operators... Most of technology are based on known physical principles and are using static sensors which per definition should be quite reliable.

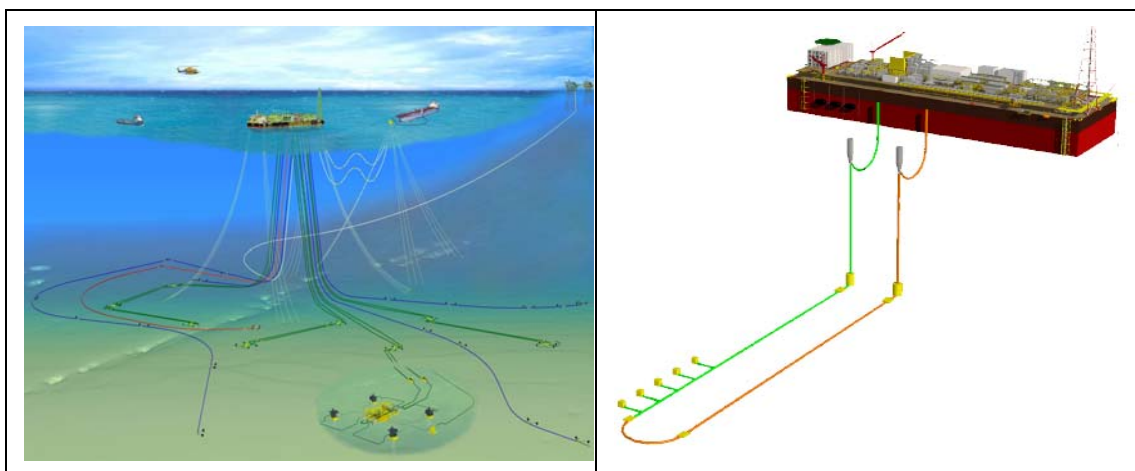
Nevertheless, maintaining accuracy of oil, water & gas phase flow rates determinations and confidence in information provided has been a challenge.

Most of technology is deriving phase fractions using on fluid property contrast measurements like density, gamma attenuation, and permittivity: this requires a reasonably good knowledge of individual phase fluid property and generates a rather high sensitivity to fluid property changes.

Partial failures have also been noticed due to problems on some sensors related to effect of severe process conditions able to generate conductive films with short circuits, deposits...

Taking samples and going to the laboratory or sending samples to specific labs for PVT analysis as recommended by some suppliers is rather difficult, costly and not suitable at all in subsea & unmanned situations.

In subsea environment where normal practice is to have one MPFM per well, removing and changing fully retrievable systems is also very costly. To reduce development costs of subsea fields, the tendency is to use non retrievable or partially retrievable systems: it is obvious in that case, meter cannot be retrieved and new operating approaches have to be implemented.



Flow calibration using a reference flow system like a test separator may be required in some circumstances to comply with regulations or agreements when MPFM measurement is used for fiscal allocation to determine ownership.

In addition to technical challenges, MPFM are associated with

- Complexity requiring specialists and experts
- Significant OPEX for configuration verification and reprogramming.

OPEX are due both to supplier mobilisation & trips (from 2 to 4 times a year) and also to in house time spent by metering specialists, operation people and data customers like Reservoir or Well performance to troubleshoot MPFM used at well level.

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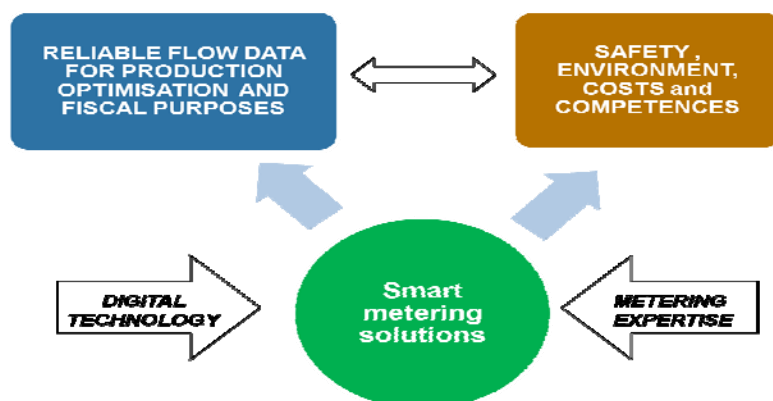
This may result on a significant time spent annually per multiphase metering systems. Time may exceed one week or more per MPFM if no specific follow up is deployed.

3 SMART METERING SOLUTIONS FOR MPFM OPERATION [2]

To improve both data quality and also to reduce operating costs related to multiphase metering systems , so called "smart metering " solutions have been developed and implemented in Operating assets & in TOTAL headquarters in France .

Basically, such approaches may include

- Remote metering monitoring
- Remote operation
- Collaborative work in Smart Rooms
- Dedicated Smart Metering room



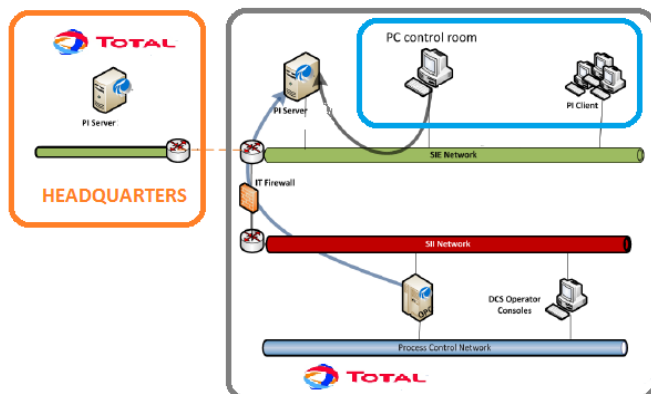
4 REMOTE METERING MONITORING (RMM) and OPERATION

Basically RMM consists of monitoring continuously flow data as well as raw data and all relevant sensor data to follow and trouble shoot metering. Data is acquired through real time field data made accessible in EIS environment through historical data base like PI systems.

Data is transferred from site and made available to Support entity of Operational Assets or to TOTAL headquarters.

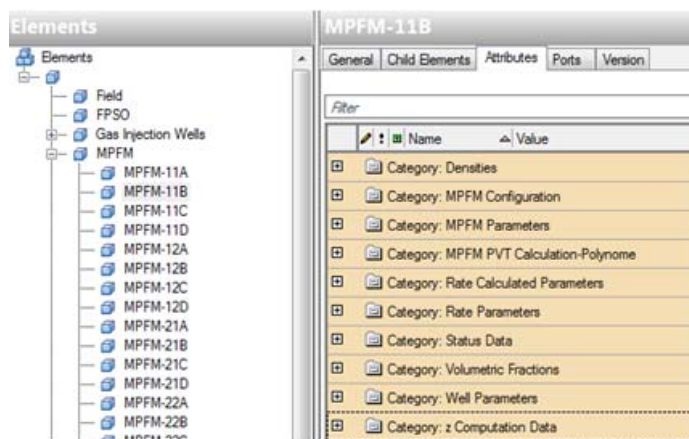
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In order to make approach clear and standard, data and information are structured and described through data asset models in PI-AF .

Following screens give examples of typical information category used for MPFM.



In house routine have been developed and implemented in PI – AF modules to run verification calculations or to check consistency.

Knowhow and in house expertise of users is implemented in RMM through choice of detection criteria or customized calculations.

Two main levels of RMM can be used : Standard Remote Metering Monitoring and Advanced Monitoring.

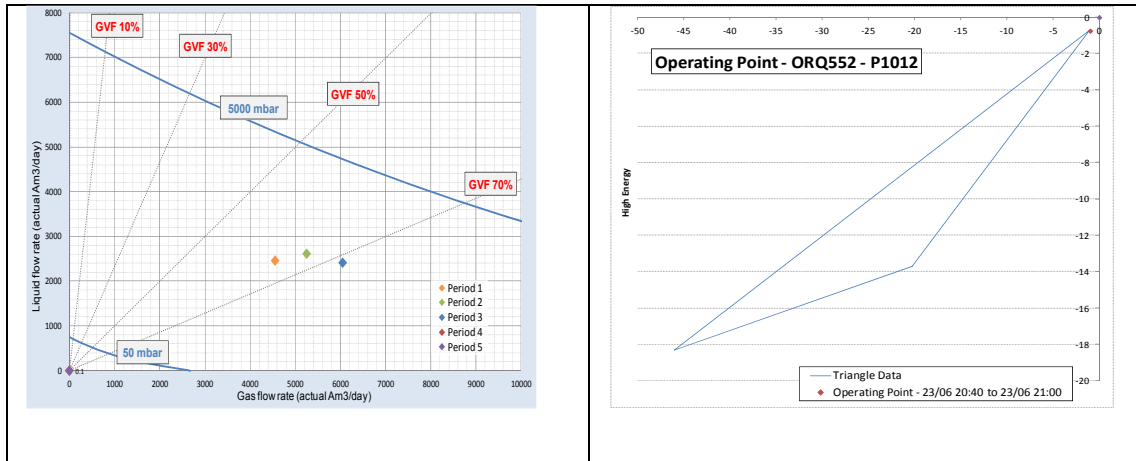
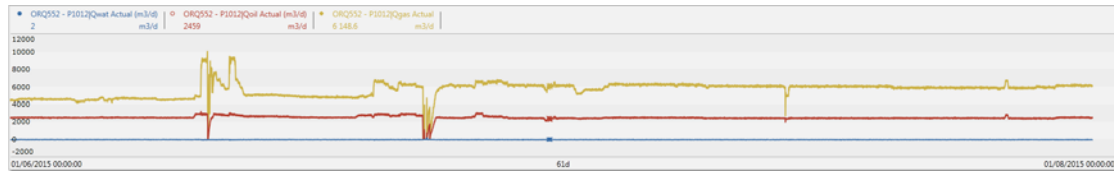
Standard RMM

Standard or routine RMM is applied to carry out continuous monitoring and to check operating performance of meters for instance MPFM operating points should remain within envelopes .

Static period are also analyzed remotely to verify fluid property like gas density or permittivity depending on MPFM technology .

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Thanks to continuous monitoring , normal production events like production shutdowns are used to make some simple calibration of permittivity or gas density without stopping productions



By facilitating failure detection on some electrical sensors , monitoring influence of chemical injection and identifying scale deposition on some meters , RMM allows to improve operation of MPFM and bring some added value to Operations for flow assurance and production optimisation.

Advanced RMM

In addition to routine tools and simple calculations, RMM may take advantage of advanced tools and software to calculate fluid property to validate data using & data reconciliation software (DVR).

Data validation & reconciliation approach is using information redundancy and input data uncertainty to

- Detect sensor & meter failure
- Calculate uncertainty
- To calculate back up data

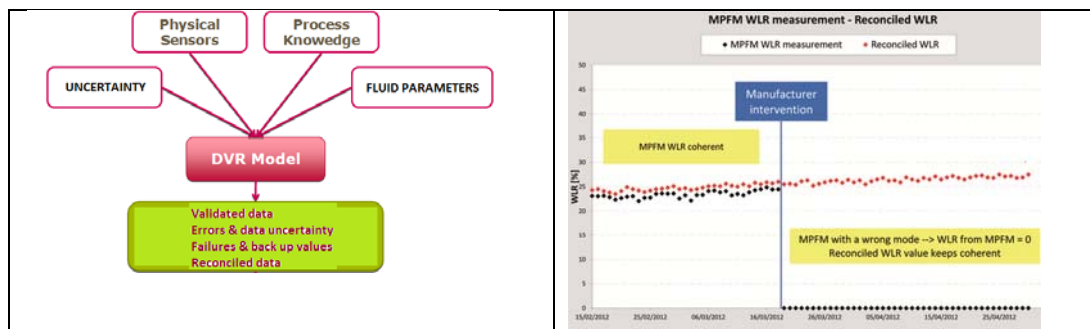
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DVR brings a back up for multiphase flow meters by using other sensors like choke valve opening, pressure and temperature combined with flow models.

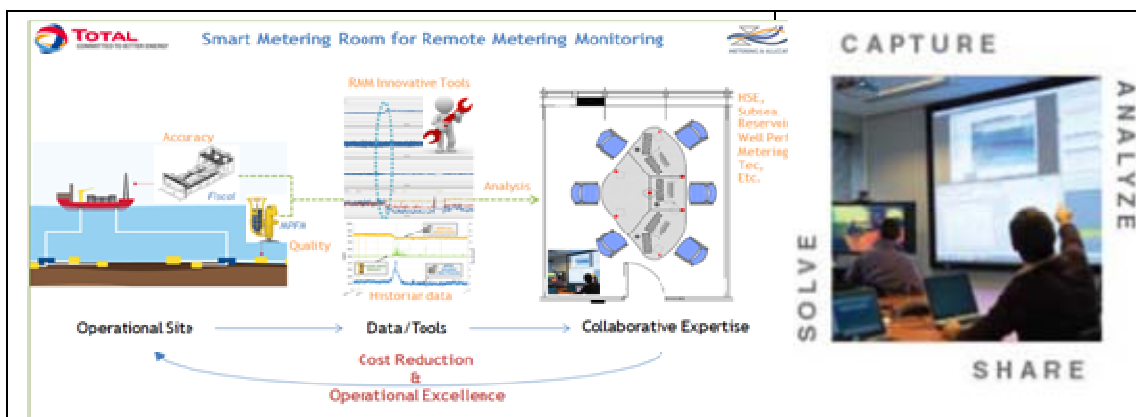
This is illustrated in the following recording in which there is a failure on water measurements given by a multiphase meter.

Thanks to redundancy, DVR calculated a back up value for Water Liquid Ratio.



5 SMART METERING ROOM

A Smart metering room putting together specialists and experts through communication and visualization tools is in operation within TOTAL technical center located in Pau, France.



The Smart Metering Room (SMR) is equipped with cutting-edge data analysis tools and modern technical devices and interactive system that enable several specialists to work on the same files and to interface with participants' computers. TOTAML smart bmetering room is currently use to monitor, validate and troubleshoot most of subsea multiphase meters (> 130 units) installed worldwide as well as topside flow meters.

After MPFM flow data is captured and analyzed, specialists, experts and data users are sharing information locally or remotely to make diagnostics and solve metering issues.

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For MPFM used for well metering & testing , Smart Metering Room allows to share data between HQ specialists , Site Operation and Well performance people as well as with Suppliers in order to trouble shoot systems in a quicker way .

This has also resulted in a significant cost reduction for MPFM operation : two times less visits for instance , no shutdown for calibration , less people on site .

6 BENEFITS

Optimal data quality

- Real time monitoring
- Imbalances reduction and better well allocation
- More confidence in MPFM data
- Ccorrect data to improve short- and long- term production forecasts and to adjust well performance models

Reactivity

- Remote monitoring and answers to affiliate queries in real time;
- Spot, periodic, or continuous assistance (from daily service to monthly reporting).

Organization and training

- MPFM Skills development in Operations " RMM and SMR are highly valuable for us to acquire and develop specific competencies and expertise"
- Experts available for the users
- Constant dialog between the specialists in headquarters and the Operations
- Standardized monitoring practices;

Safety and security

- Less site intervention
- Reduction of risks
- Less people on board

Economics & cost reductions

- Wells are no longer shut down for meter calibration
- Use of unplanned production shutdowns to check the systems
- Less costly interventions from specialists
- Suppliers visit divided by 2
- Intervention cost reduction through active preparation

7 CONCLUSIONS

Smart Metering solutions like remote metering monitoring or smart metering room have been successfully applied and implemented by TOTAL on several field locations in order to improve multiphase metering systems operations.

Thanks to them, the full added value of installed multiphase meters is used and confidence in data has increased.

Implementation of RMM has reduced cost of MPFM operation with better data quality for reservoir and well monitoring.

For full efficiency, we had to incorporate the business and metering metier know-how and to combine it with digital technology .This is particularly true for Remote Metering Monitoring and collaborative work carried out in Smart Metering room?

A lot of improvement may still be made through standardisation of required data and supplier cooperation to give access to raw data. For MPFM , black boxes should be prohibited for the benefits of everyone.

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It is also important to continue to develop associated monitoring tools and technology through RD initiatives.

RMM & Smart Metering Rooms are part of the digital solutions promoted within TOTAL operations to improve quality of MPFM metering data but also others systems like fiscal ones

8 REFERENCES

- [1] J.P. Couput , TOTAL ; Subsea multiphase measurements , 29th North Sea Flow Measurement workshop , 2011
- [2] J.P Couput, TOTAL, SPE Smart Metering Solutions: How to Combine Digital Technology with Business Expertise to Improve Metering Performance, 2015

Abbreviations

RMM: Remote Metering Monitoring
SMR: Smart Metering Room
DVR: Data Validation and Reconciliation
MPFM: Multiphase Flow Meter
WGFM: Wet Gas Flow Meter

Acknowledgement

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