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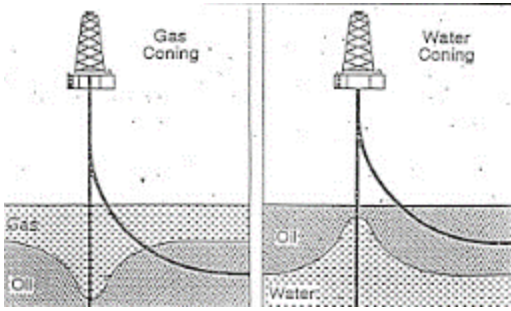
High Gas Multiphase Flow Meter (MPFM) ABB VIS

Introduction

- Oil and gas wells produce a mixture of liquid hydrocarbon, gas hydrocarbon and water in highly variable proportions depending on location, reservoir age, production type (**Multiphase Streams**)
- Multiphase streams with GVF (Gas Volume Fraction)>90% are commonly known as **Wet Gas Streams**
- Knowledge of the individual fluid flow rates of a producing oil/gas well is required to optimize the field production, reservoir management, the field development, and production allocation
- Conventionally the three phases are measured after separation, by single phase meters (i.e. Coriolis, orifice, turbine..)
- Traditional metering philosophy:
  - At well head using mobile test separators
  - At the oil center delivered by test lines

Testing a well – Why?

- Optimize the artificial lift process
  - Using too much or too little gas/water for lifting is not economical. There is an optimum for the amount of lift gas to be used to maximize the oil production
  - Optimize pump frequency

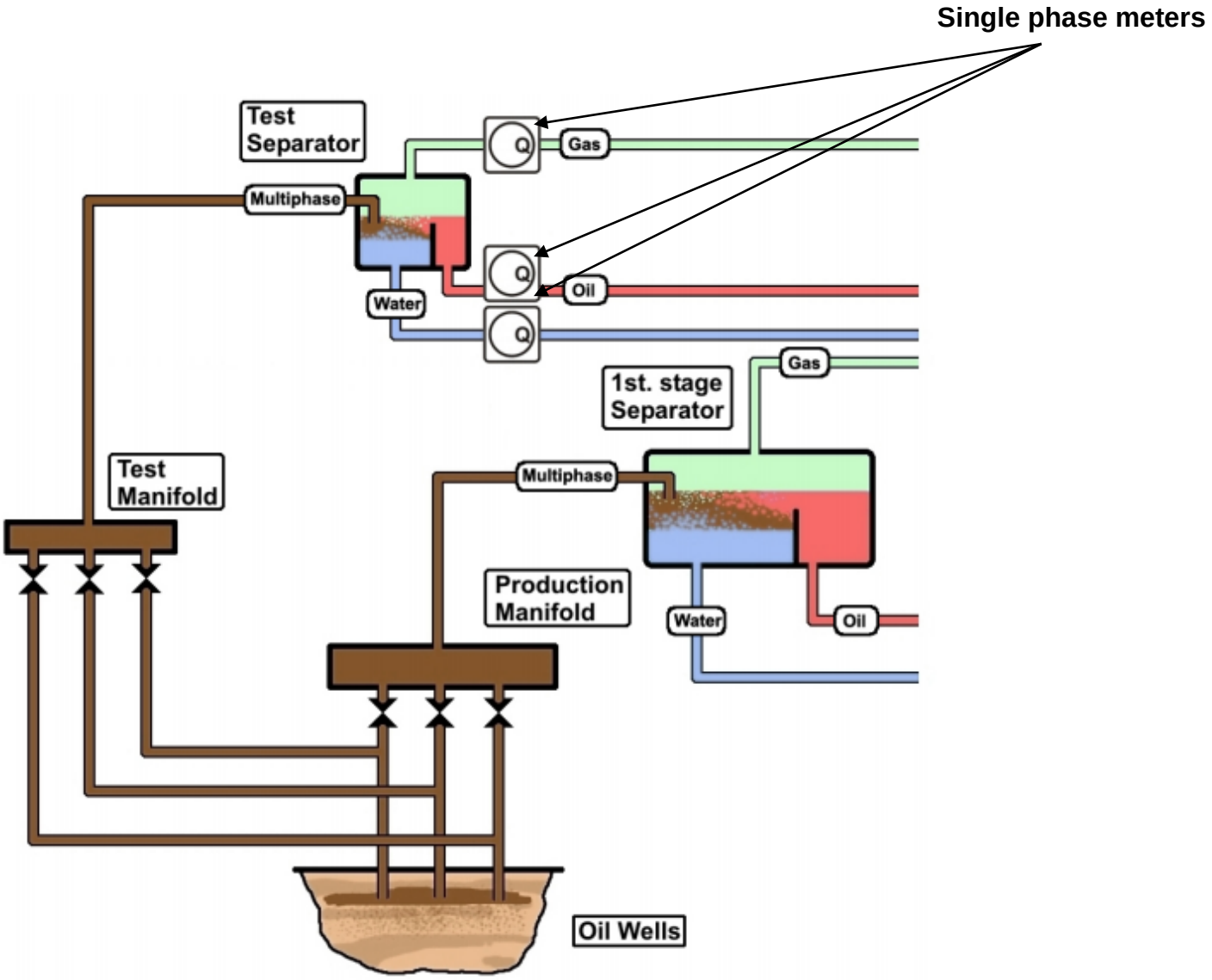


- Identify water coning, gas break through or other reservoir issues
- Identify potential blockages in the production system (e.g. hydrates, asphaltenes, wax, sand, scale)
- Production allocation (stronger requirements in terms of accuracy)
- Increase the life time of the field by better knowing the reservoir

Well testing – Conventional solution: Test separator

- Conventional well testing is usually performed by means of an extra separator dedicated for well test or special purposes
- The well streams are measured by directing one well stream at the time through the test separator
- Conventional metering systems require the phases of the well streams to be fully separated upstream of the point of measurement
- Single-phase metering systems providing high-performance measurements of hydrocarbon production are used
- Issues may arise with phase separation quality
- It may be difficult to detect variations in flow rates from instable wells (e.g. gas lifted wells)

Conventional metering



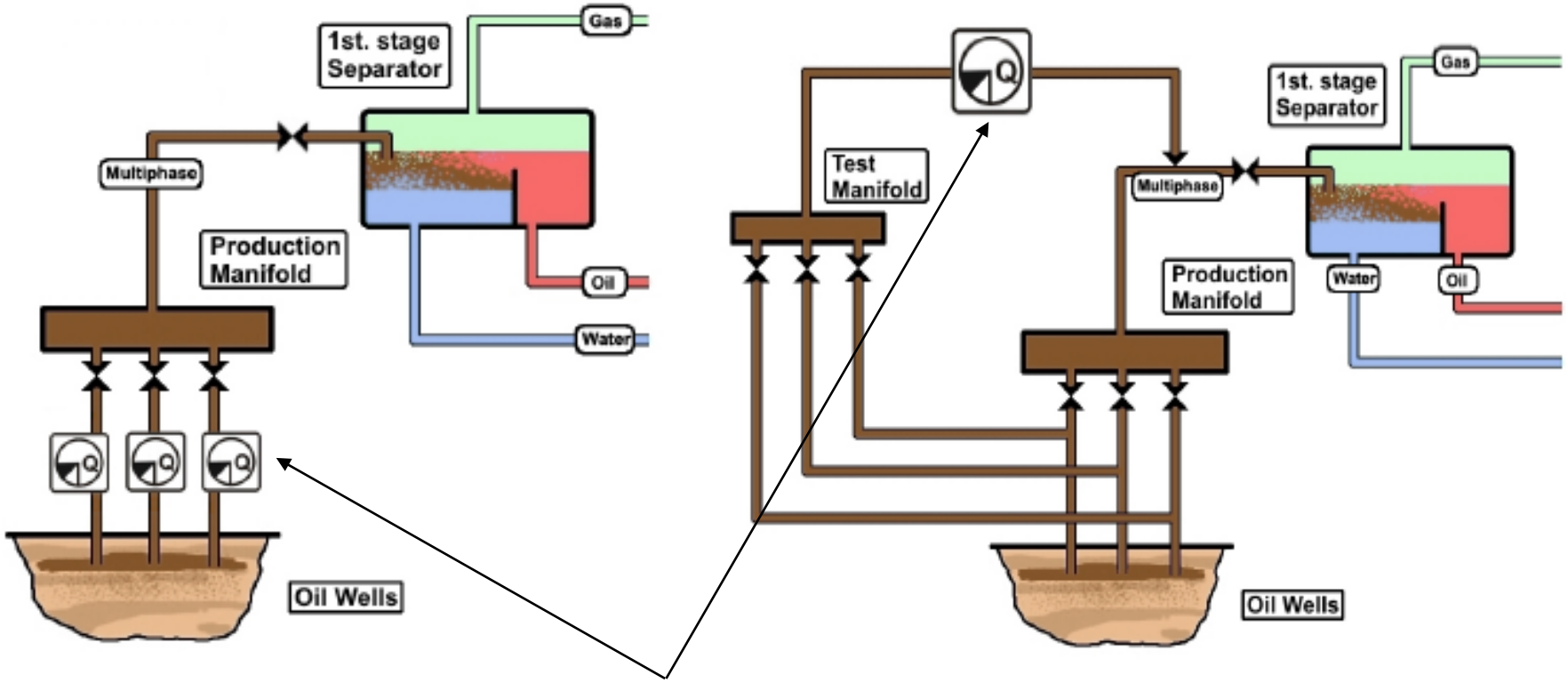
Multi-Phase Metering Concept

- **Multiphase flow meters** (MPFM) are devices used to measure the individual oil, water and gas flow rates without separation
- **Wet gas meters** (WGM) is sub category of MPFM used when GVF exceeds 90%. There are biphasic systems only measuring liquid and gas flow rates only and tri-phase systems measuring oil, water and gas flow rates
- Conventional measurement systems are test separators, which can be very expensive, massive and subject to frequent maintenance and field personnel intervention. They cannot provide continuous monitoring or metering.
- Multiphase metering installation philosophy:
  - On the well head on single well using fixed/mobile meters
  - On the test manifold using fixed/mobile meters
  - At the oil center/GOSP prior to phase separation

Multiphase flow metering

One meter per well philosophy

Meter on manifold test line



Multiphase/wet gas meters

Advantages vs. Conventional technologies

- **Operational advantages**
  - Real time measurement provided
  - Faster well testing operation
  - Easily transportable mobile units with quicker rig-up and rig-down times
  - Reduce man presence in hazardous areas
  - Reduced environmental impact (flares, waste management)

- **Flow assurance improvements**
  - Visualize flow regimes and behavior that would be invisible to separators
  - Promptly identify potential problems in the production system (e.g. hydrates, asphaltenes, wax, sand)
  - Early water detection and accurate water measurement at low levels

Advantages vs. Conventional technologies

- **Production optimization**
  - Better reservoir understanding leads to higher ultimate recovery
  - Optimization of gas/water injection
  - Optimization of pump rate

- **Cost**
  - Reduced cost
  - Reduced operating and maintenance expenses
  - In new field installation of test manifolds, lines and valves can be avoided resulting in a great saving

A new, high-performing yet compact meter

Technology Background …

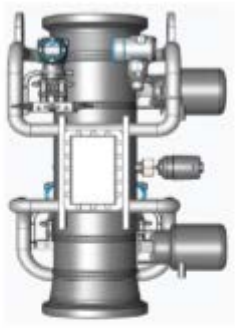
- VIS is the result of a partnership between ABB and TEA Sistemi, a University of Pisa spin-off, committed to R&D in the Oil & Gas sector and it is a direct descendent of TEA Sistemi's VEGA meter developed since 1998
  - TEA Sistemi brings its knowledge and world-class experience in multiphase systems and flow assurance
  - ABB makes available its global presence, its sales and service network, the engineering competence and a full portfolio of measurement products and systems for the Upstream industry.
- Initial field tests of this meter were carried out in the Trecate field in 2000-2001
- The conventional instrumentation installed in the VEGA & the VIS meter are designed and produced by ABB.

Technology Evolution

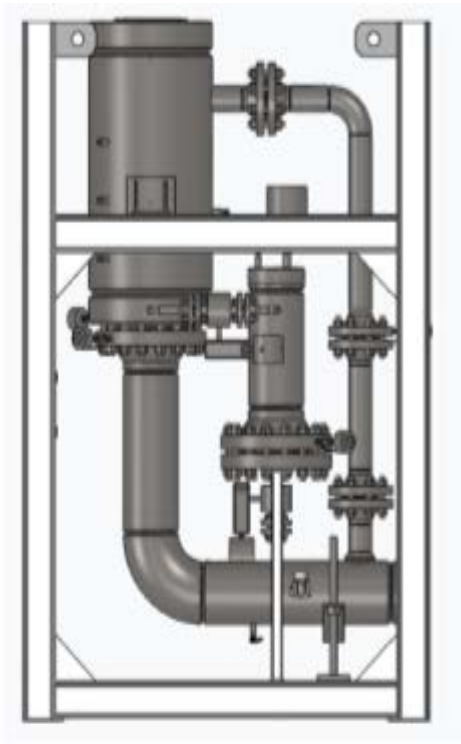
- The Meter was re-designed and its size optimized.

- The mechanical construction has been deeply changed, with a substantial weight reduction.
- The final result is a smaller and lighter MPFM

10” ANSI 900



H: 1800mm; W: 1000mm; L: 1000mm
Weight: 1300kg

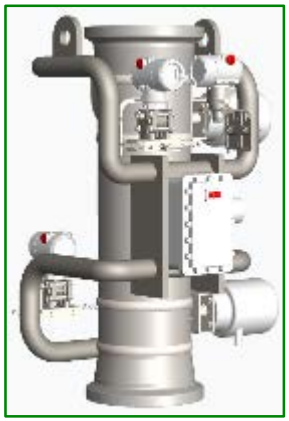


H: 3000mm; W: 1000mm; L: 2000mm
Weight: 2700kg

VEGA Installation

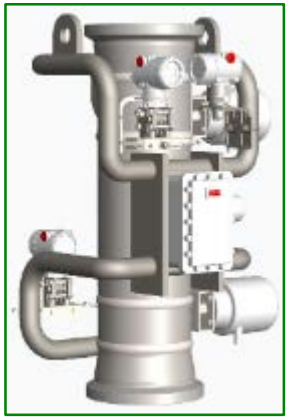
Offshore platform (Gulf of Mexico)

VIS Technology



- VIS is a compact meter which to be directly inserted on pipelines for topside onshore and offshore applications
- It is based on a unique and patented technology: the **isokinetic sampling**
- A small portion of the multiphase stream is sampled and separated into liquid and gas phase by means of patented high efficiency axial separators
- The liquid and gas are then measured separately as single phases with high accuracy
  - Gas phase is measured by a traditional single phase meter (Venturi)
  - Liquid phase is measured through the filling time of known volume of the main vessel (level by DP transmitters)
  - Oil/condensate and water density variations are directly accounted for thanks to additional DP measurements
- Overall flowrates are calculated through the sampling ratio (i.e. the ratio between probe and pipe areas)

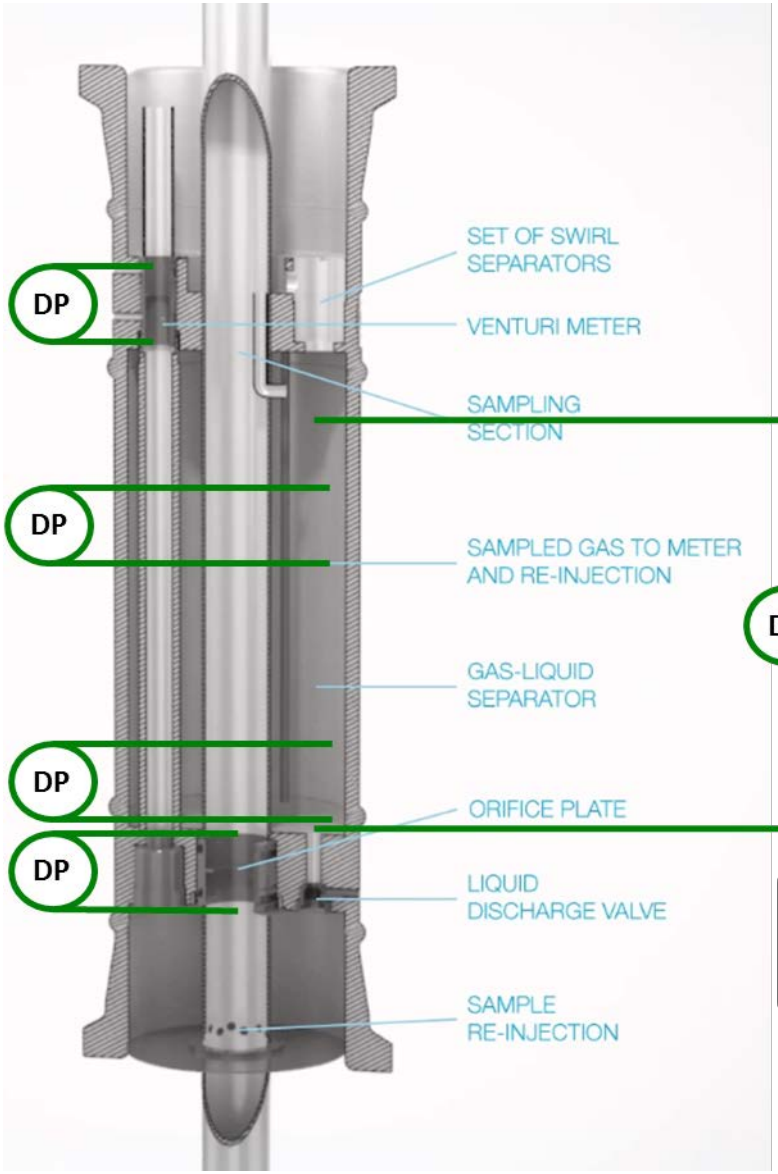
VIS Technology



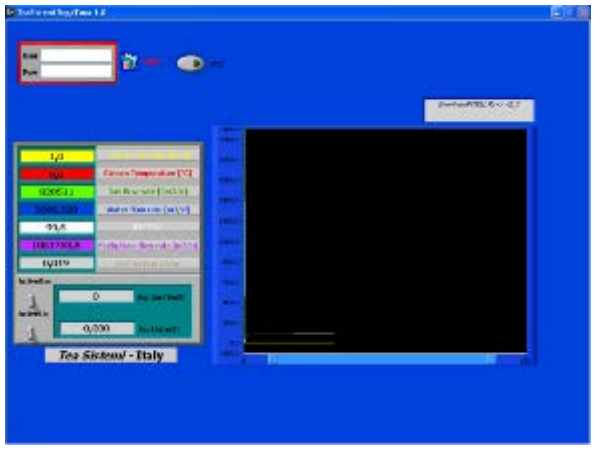
Isokinetic Sampling

- Sampling is performed in a section of the pipe where the two phases (gas and liquid) are well mixed (velocity profiles are uniform)
- The liquid volume fraction in the sample is the same as in the main stream
- Isokinetic sampling requires that the ratio between the sampling flowrate and the overall flowrate be the same as the ratio between the sampling probe cross section and the pipe cross section (at the sampling location)
- No use of empirical correlations or field calibration

VIS Technology



PC Station



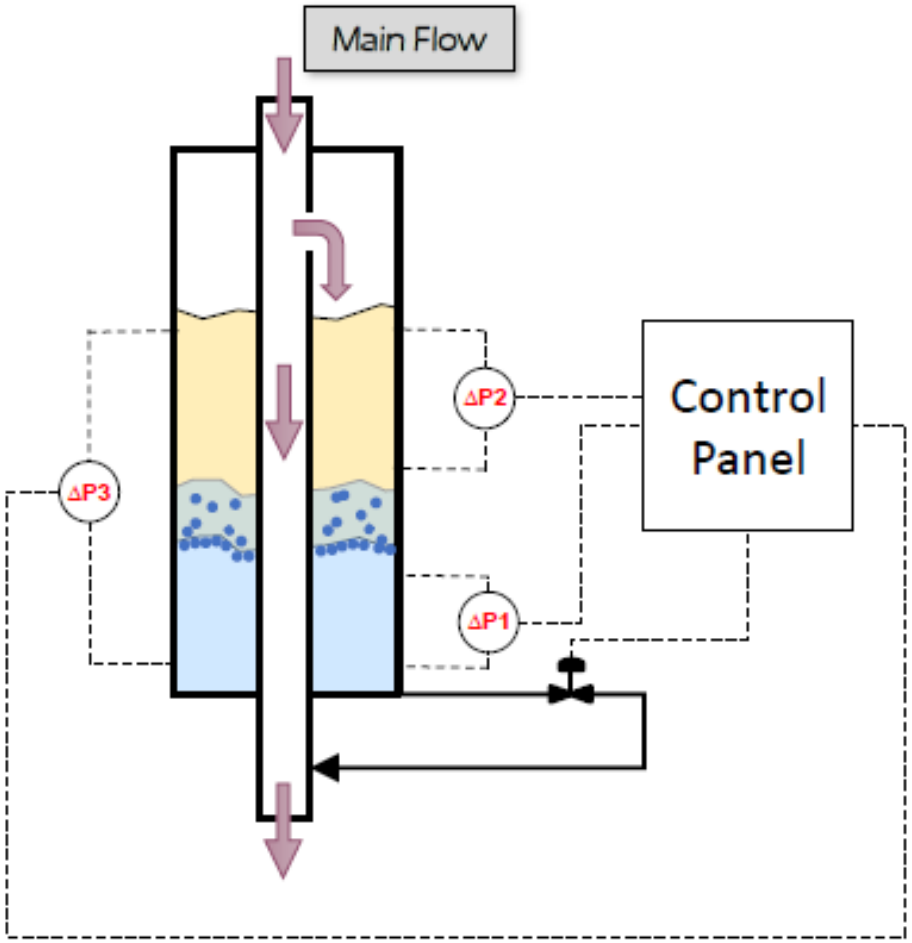
Field junction box

Digital outputs (Modbus. Profibus, Canbus …)

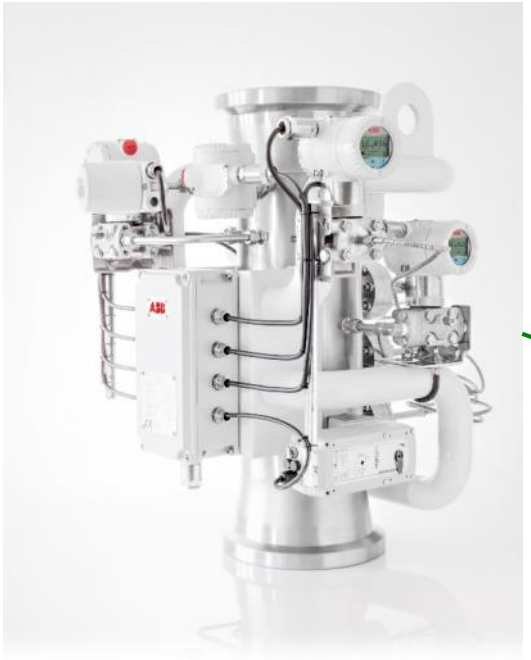
Analog outputs

Animation

Liquid measurement

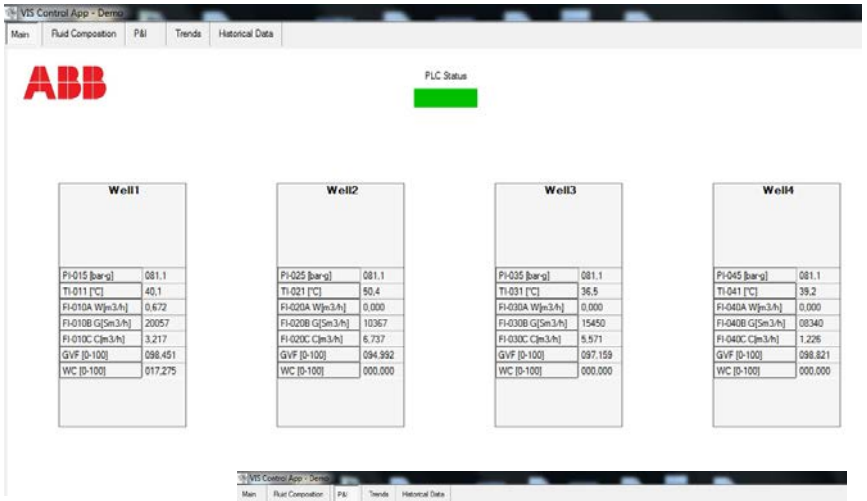


HMI Data reporting



VIS Proprietary SW Package

Overview



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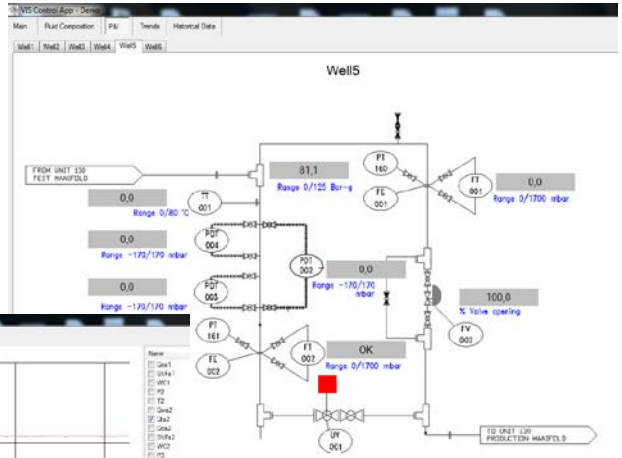
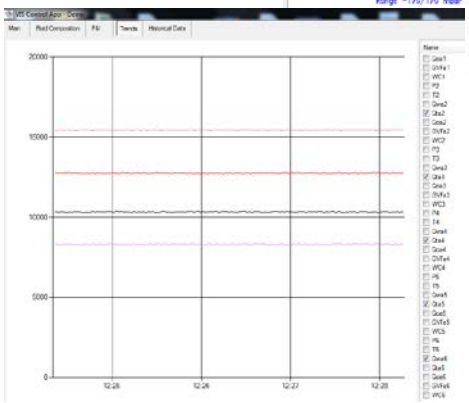


RT and Historical Trends



VIS main features

- VIS employs a proven and exclusive **gamma-free** technology:
  - Radioactive sources represent an issue for HSE, import, transport and maintenance activities
  - Customers often experience long delays (up to 12 months) just for Custom Clearance
  - Gamma sources often represent big operational costs

- VIS only utilizes **conventional instrumentation**:
  - VIS only uses rugged ABB field devices (DPT, PT and TT)
  - Maintenance and troubleshooting can be directly done by end user without involving manufacturer
  - Downtime greatly reduced
  - No replacement of expensive parts is needed

- VIS was specifically developed for the most demanding **high GVF applications**:
  - Very high accuracy in the most challenging conditions for MPFMs (GVF>95%) where most MPFMs are severely affected in terms of performance
  - Field references of meter successfully measuring liquid flow rates as low as 10^{-4}% of the total flow rate

VIS Most Suitable Applications

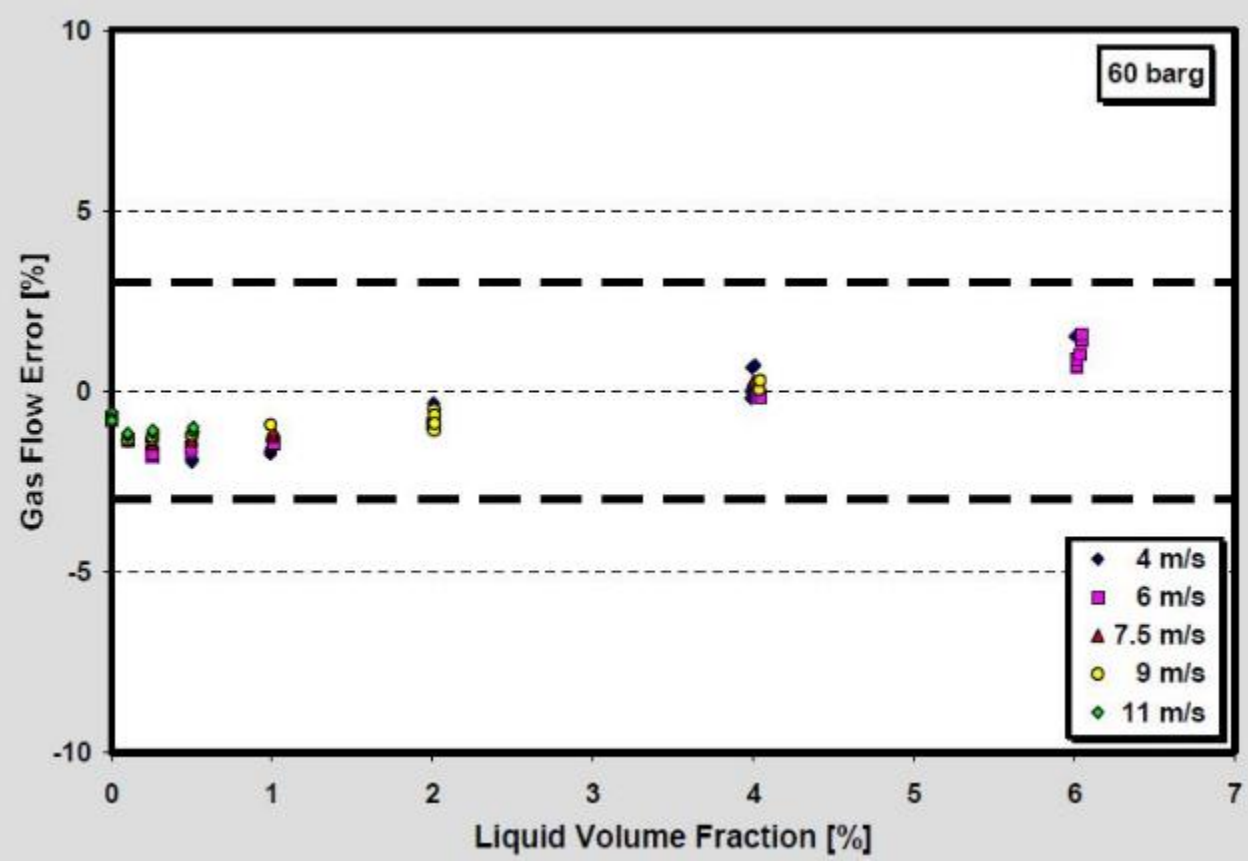
- **Conventional wells**
- **Wet gas wells measurement**
  - Tight gas wells
  - Old oil reservoirs with increased gas production
- **Gas lifted wells**
  - Gas injection process optimized in terms of resulting production
- **Underground storage**
  - VIS is bidirectional
  - Measures dry gas entering the UGS and the humid gas being extracted
  - Allows optimization of the dehydration process.
- **Mobile well testing**
  - Easy to transport
  - Fast rig up and down

General information

Important information at a glance	
Operating envelope	80-100% Gas volume fraction
Accuracy for liquid flow rate	±3% of reading
Accuracy for gas flow rate	±3% of reading
Accuracy for water flow rate	±5% of reading
Process connections	ANSI, API, UNI or according to project specifications
Nominal diameter	DN 50 (2") – DN 300 (12"), larger sizes available on Customer request
Material	Carbon steel, Duplex steel or according to Customer specification and process requirements
Design pressure	100 bar (1450psi) and 230 bar (3300psi) in standard configurations. Special configurations available according to process requirements
Process temperature	-40°C (-40F) - 300°C (572F)
Ex approvals	ATEX CE Ex II 1 G Ex, US Class1 Division1&2, IEC Zones 1&2 Exd Other approvals available on request
Communication	Analog (4-20mA), Modbus (Ethernet or serial) Other standards available on request
Pressure drop	0.3 – 1 bar
Size and weight	Footprint 0.5 x 0.8 mt, height 1.2 mt, 390 kg (for a standard 4" ANSI 1500 meter)
Flow direction	Vertical downwards

VIS performance – Gas flow rate accuracy

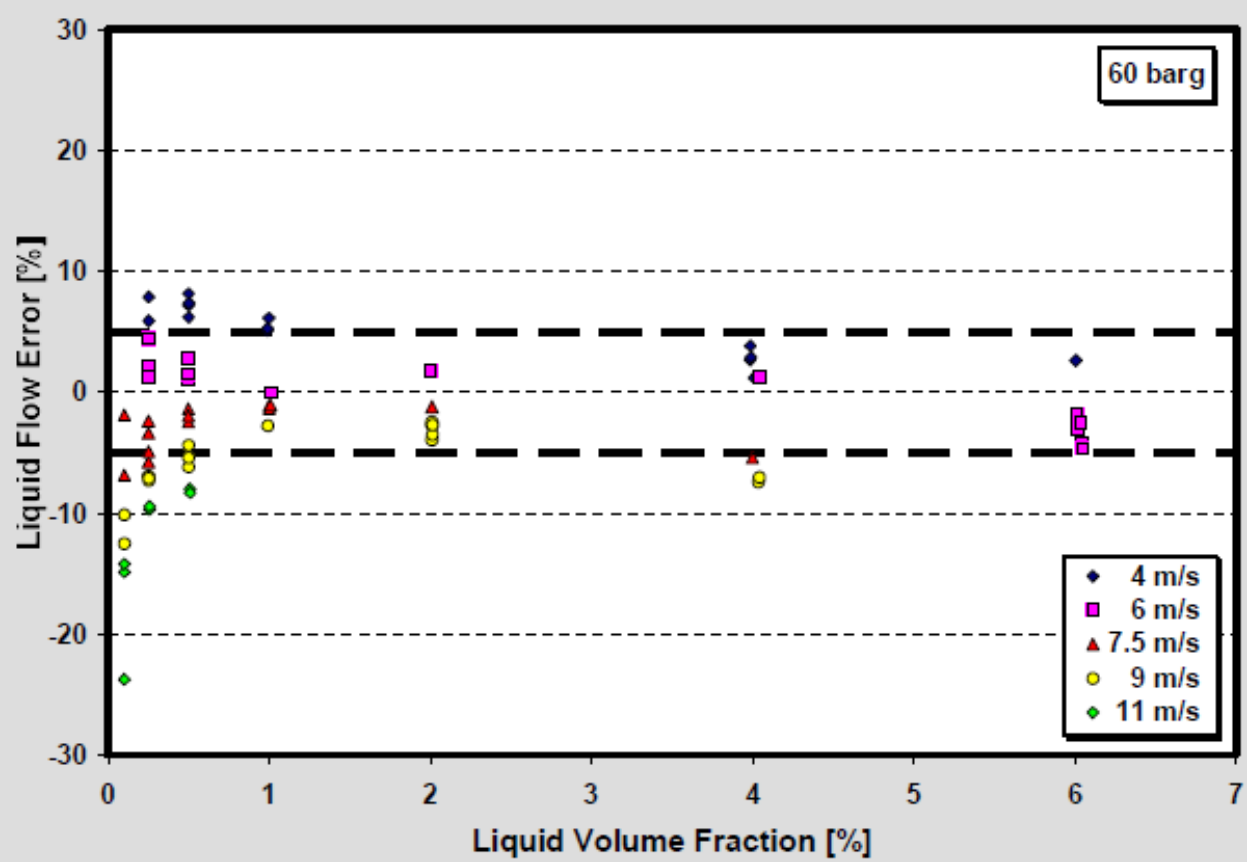
Tests at TUV NEL



- 98,7% of the total test points (including 30 barg points) fall within the ±3% uncertainty range
- 100% of the test points at 60 barg and 60% of the test points at 30 barg fall within the ±2% uncertainty range

VIS performance – Liquid flow rate accuracy

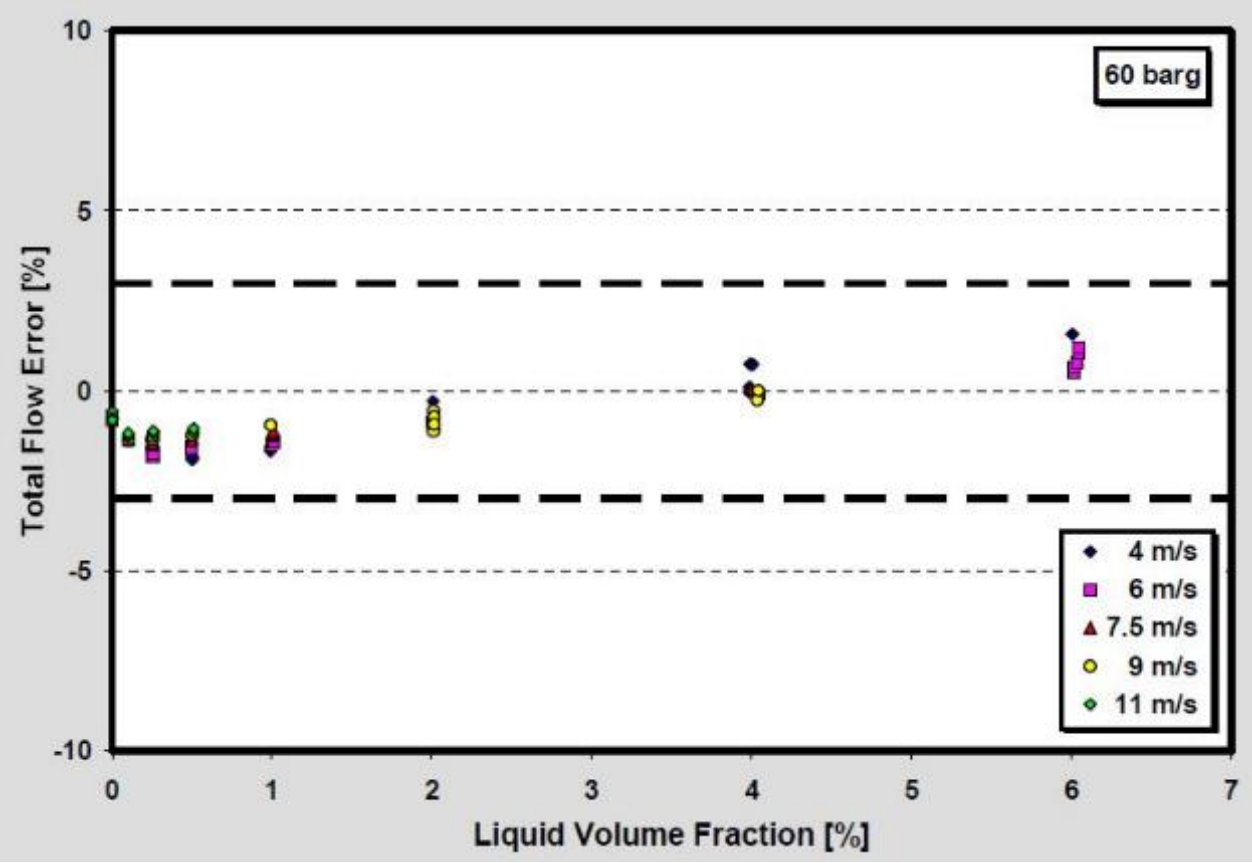
Tests at TUV NEL



- 97,5% of the total points fall within the ±5% of reading or ±0.1 m3/h uncertainty range

VIS performance – Total flow rate accuracy

Tests at TUV NEL

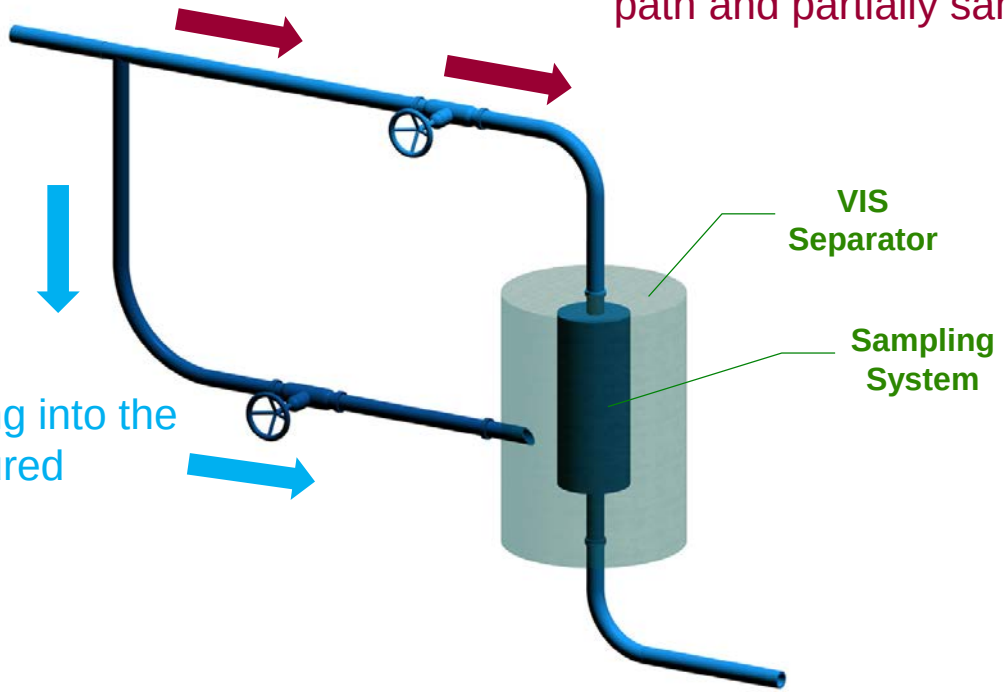


- 98,5% of the total points fall within the ±3% uncertainty range

VIS Advantages: an additional, unique feature

- **Turndown expanded up to 100:1 with the same accuracy**
  - With the “Dual Inlet” option a meter designed to operate at a given flowrate (say X m^3/h) can be easily used also at 1/10 of the design flowrate (X/10 m^3/h) with the same accuracy and no component replacement

Big well going through regular path and partially sampled



Small well directly going into the vessel and fully measured

VIS/VEGA Install Base

Client	Site	Country	Qty	Size	Rating
ENI Petroleum	Allegheny TLP, Gulf of Mexico	USA	1	2"	ANSI 900
Stogit	Fiume-Treste	Italy	21	6"	ANSI 900
Petrobel	TUNA platform	Egypt	1	8"	ANSI 900
Stogit	Fiume -Treste	Italy	2	6"	ANSI 900
CMTI	Fiume -Treste	Italy	2	6"	ANSI 900
CMTI	Fiume -Treste	Italy	2	6"	ANSI 900
ENI E&P	Trecate	Italy	1	2"	ANSI 600
ENI E&P	Ripalta	Italy	1	12"	ANSI 600
ENI E&P	Sergnano	Italy	1	12"	ANSI 600
ENImed	Tresauro	Italy	1	3"	ANSI 600
NAOC	Obi-Obi Field	Nigeria	1	4"	ANSI 2500
Navalmare	Lkitchndjili platform	Congo	6	3"	ANSI 2500
Stogit	Ripalta	Italy	1	6"	ANSI 1500
Petrobel	Seth Platform	Egypt	1	10"	ANSI 1500
Petrobel	Seth Platform	Egypt	1	16"	ANSI 1500

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