Non-intrusive wellhead surveillance to support brownfield production optimisation – recent case studies

Society of Petroleum Engineers

Aberdeen Section

Agenda

Introduction

Produce the Technical Limit

Typical Sonar Applications

Sonar Technology

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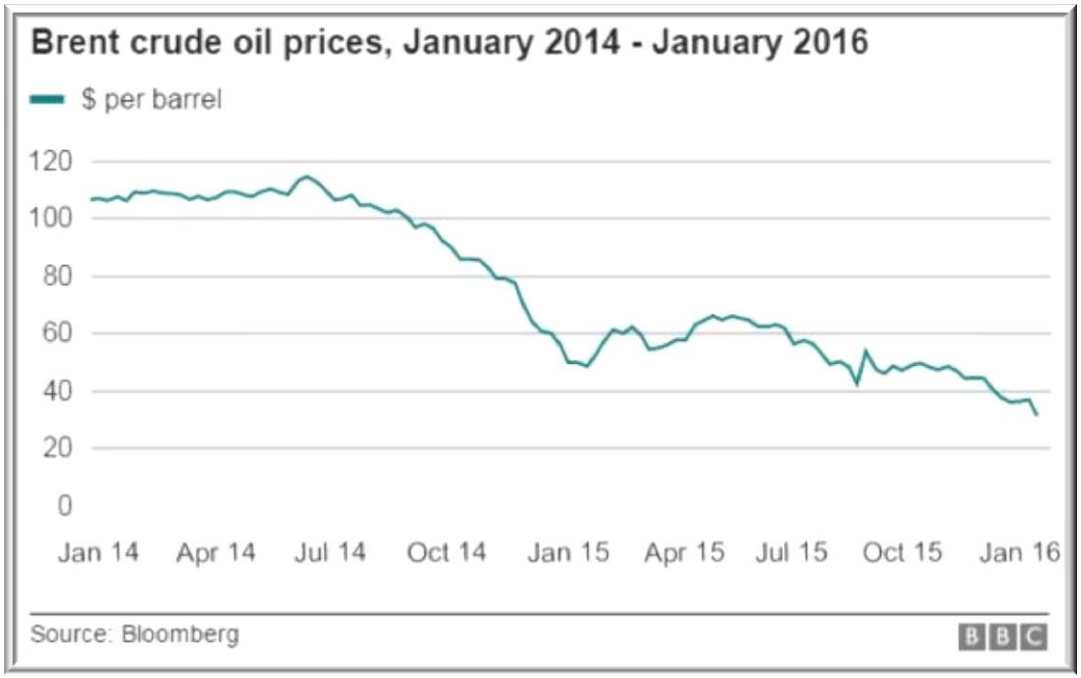
Conclusion

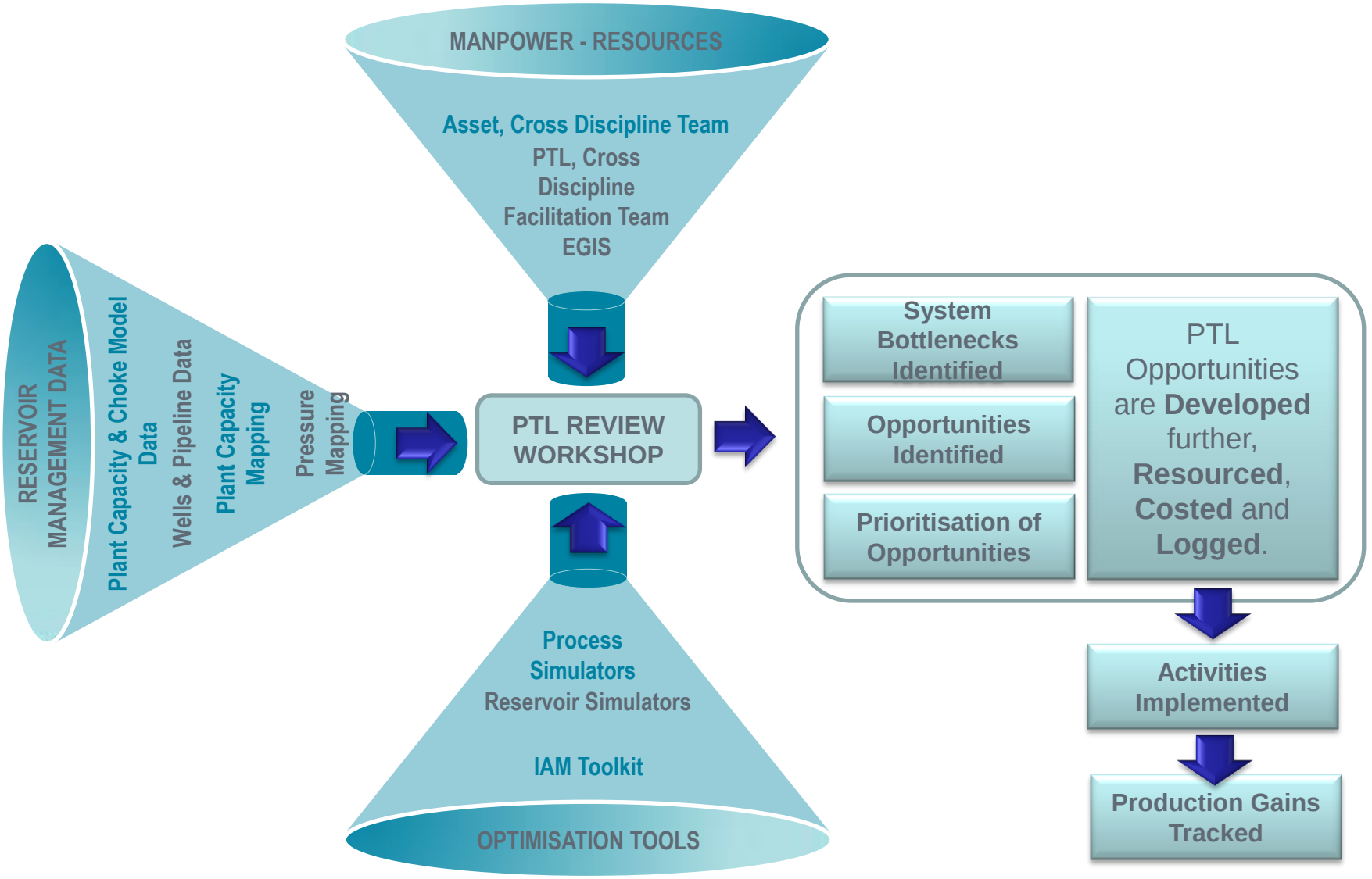
Introduction

Production optimisation of mature fields plays a significant role in todays market conditions where cost is at the top of the priority list and operators need to find suitable technologies to support daily operations while keeping costs down **without jeopardizing or shutting down production**.

Low oil price brings Optimization into sharp relief



Produce the Technical Limit



Typical SONAR Applications

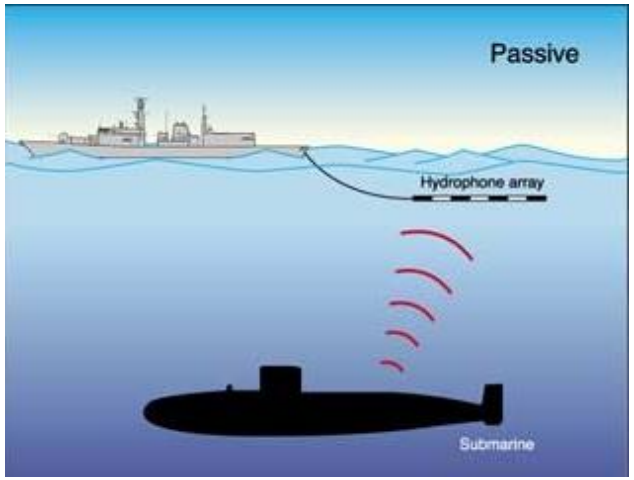
Sonar*Test*™
Temporary

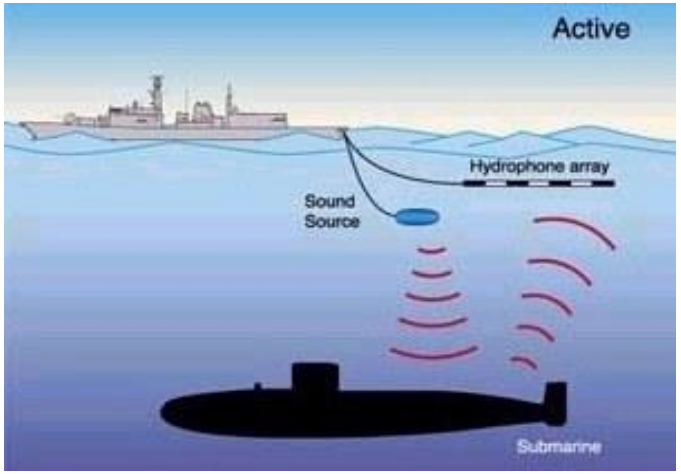
Sonar*Monitor*™
Permanent

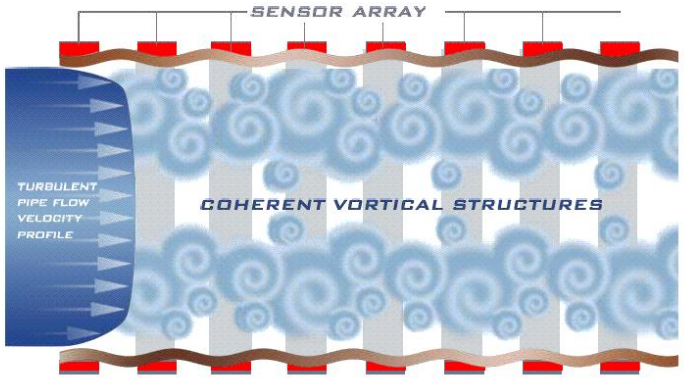
- Wellhead Production Surveillance
- ESP Optimisation
- Gas lift Optimisation
- Pressure Support (water Injection)
- Post and pre intervention

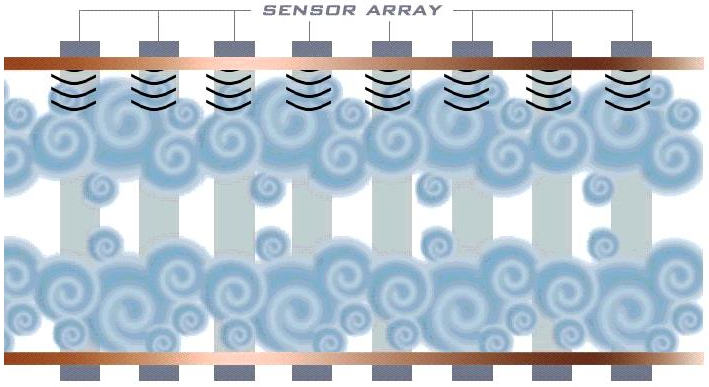
- Augment well testing regime
- New meter verification during start up
- Legacy metering verification
- Legacy metering replacement

SONAR Technology









SONAR Technology Specifications

PassiveSONAR™ Meter

- ATEX Zone 2,
- 2” to 30”,
- Liquid Flow Velocity Range (application dependant) =
  1 to 10 m/s (3 to 30 f/s)
- Gas Flow Velocity Range (application dependant) =
  6 to 50 m/s (20 to 150 f/s)
- Well-suited for high flow rates, large diameter pipes and high liquid loadings.

ActiveSONAR™ Meter

- ATEX/IECEX Zone 1,
- 2” to 32”,
- Liquid Flow Velocity Range (application dependant) =
  0.5 to 50 m/s (1.5 to 150 f/s)
- Gas Flow Velocity Range (application dependant) =
  0.5 to 50 m/s (1.5 to 150 f/s)
- Well-suited for dry and wet gas surveillance in heavy schedule piping.

Case Studies

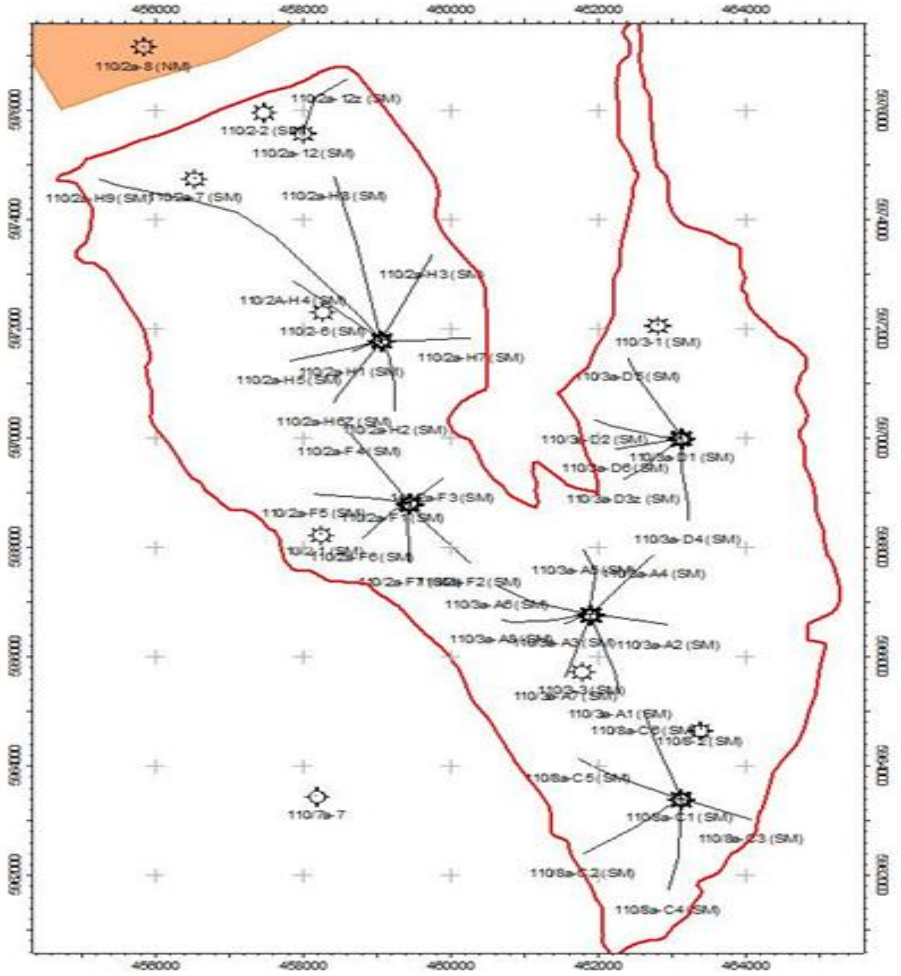
Centrica SNS: Mature Dry Gas (SPE171712)

Marathon NS : Liquid Loading Prone Gas (SPE166652-MS)

Algeria: Mature Oil Field

Centrica Case Study: Mature Dry Gas (SPE171712)

- Centrica operates South And North Morecambe Gas Fields
- Production commenced in 1985
- S. Morecambe – 34 active wells, N. Morecambe – 10 active wells
- Produced via volumetric depletion
- Wells gathered to drilling platforms – Normally Unmanned Installations



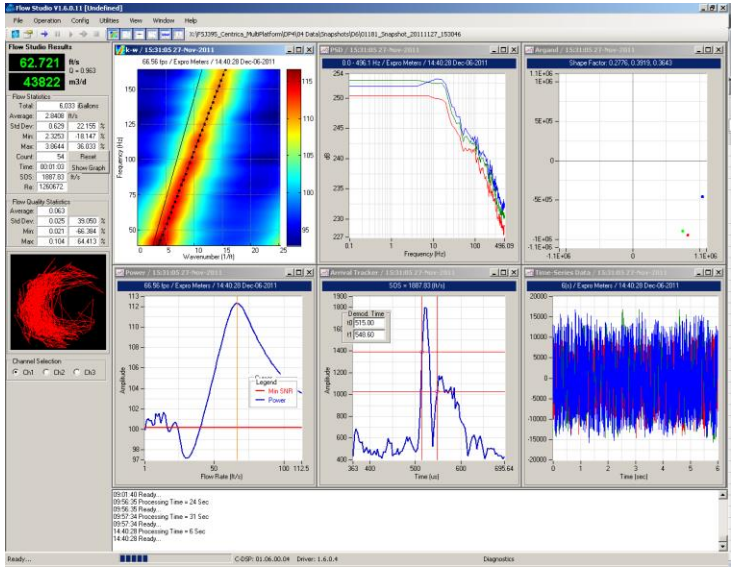
Well Allocation and Metering Background

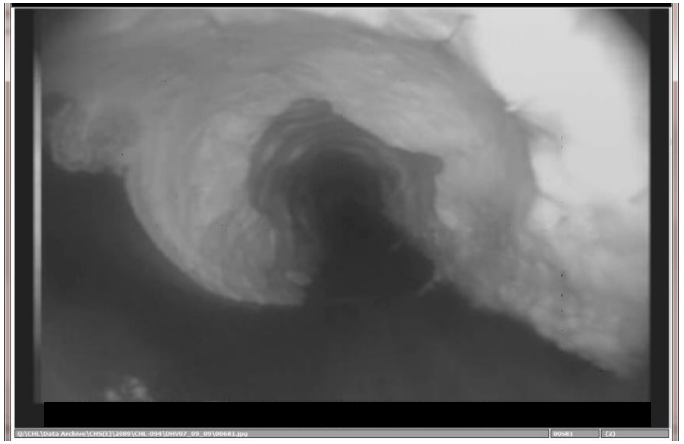
- Venturi meters originally installed for both fields (1985 and 1994 respectively)
- Meters sized for peak production, outside measurement range as field production declined.
- Production separators installed and subsequently removed.
- Rough well allocation performed by analyzing P & T trends.
- Different technologies evaluated before Sonar technology selected after an initial trial campaign.

Initial Meter Validation

Charlie Facility , Gross 14 MMscf/day,

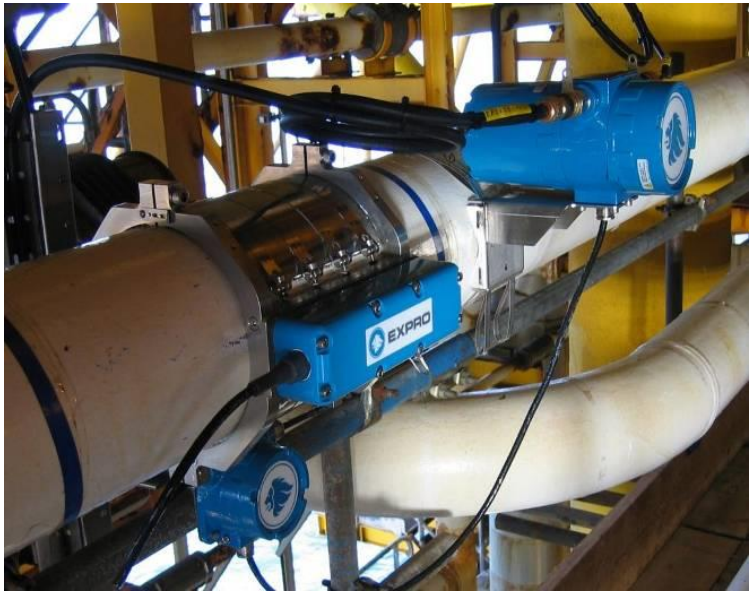
- 5 wells
- Individual wells ~ 3 MMscf/day
- SONAR Meter diagnostics gave overwhelming evidence that only 1 out of 5 wells were flowing,
- Flowing well was > 14 MMscf/day
- Production from only 1 well
- Customer made decision to shut in facility, one well at a time
- Well #4 shut in last, confirmed all production came from single well
- Wireline intervention downhole camera highlighted Halite
- Well work program –fresh water Halite wash and N2 Coil Tubing Lift
- Additional 4 wells were taken back onto production,
- Overall Field production up.



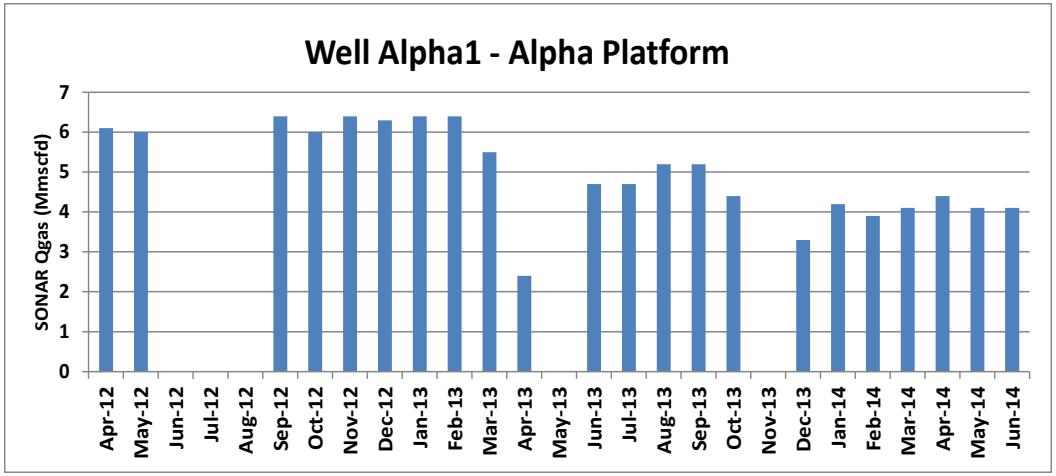


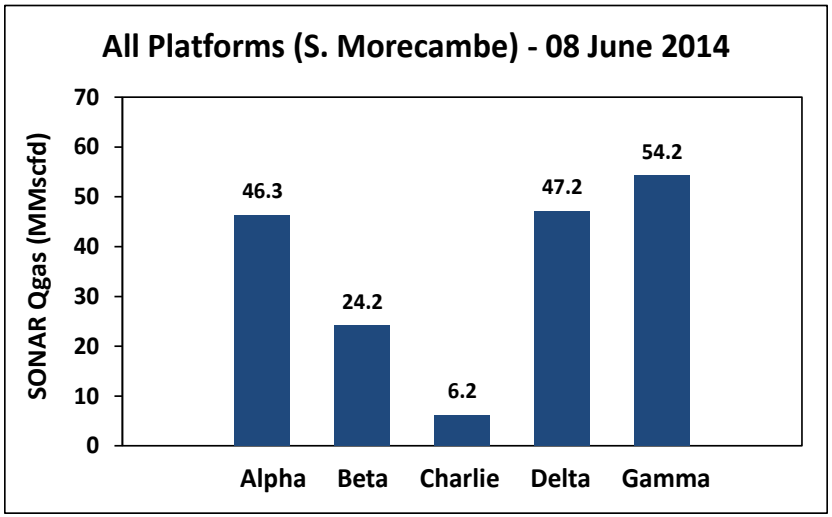
SONAR Well Surveillance

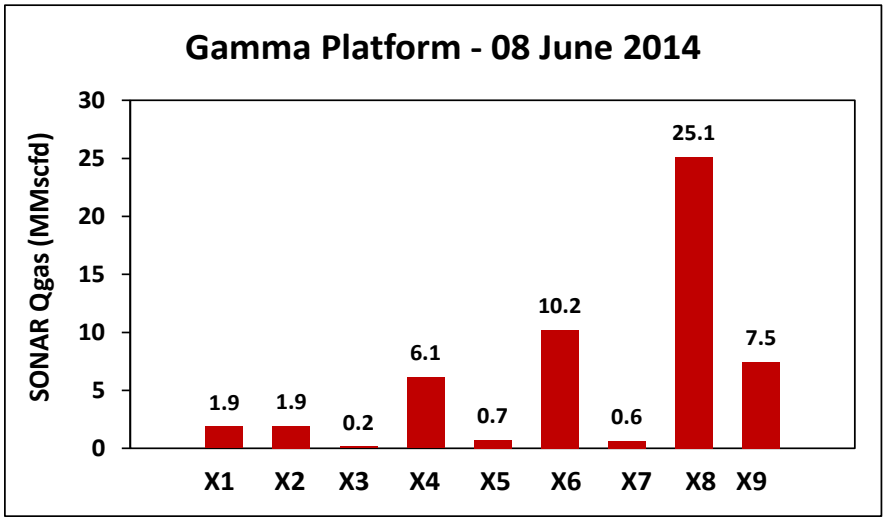
- 44 Sonar meters permanently installed across 6 platforms
- Meters directly clamped onto pipe, no flow interference or pressure loss
- Short rig-up time
- Significantly lower production losses as compared to individual well testing using test separators.
- Availability of real time flow information for each well.



SONAR Real Time Data



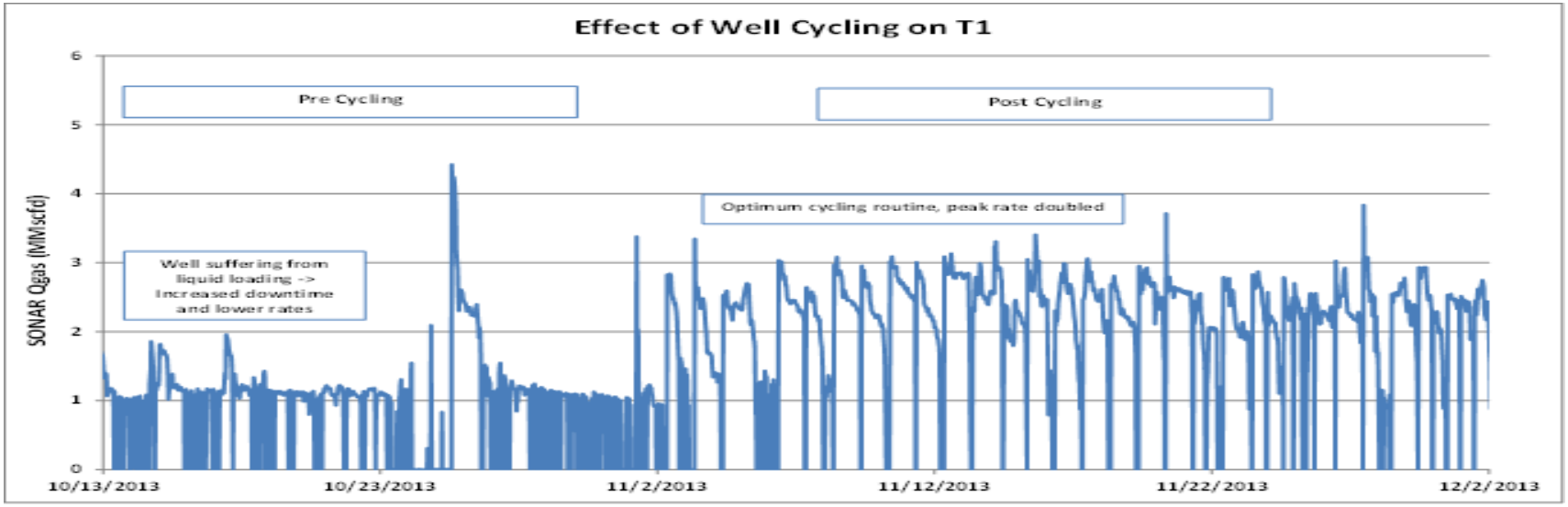




Well Production Optimization – Well Cycling

- Following the start up of a new, high pressure field, wells on DPPA platform dropped off in performance.

- Sonar meters used to establish worst affected wells and analyze response to cycling procedures.



- Determination of the optimum shut in period is a trail and error exercise until a suitable ratio is established

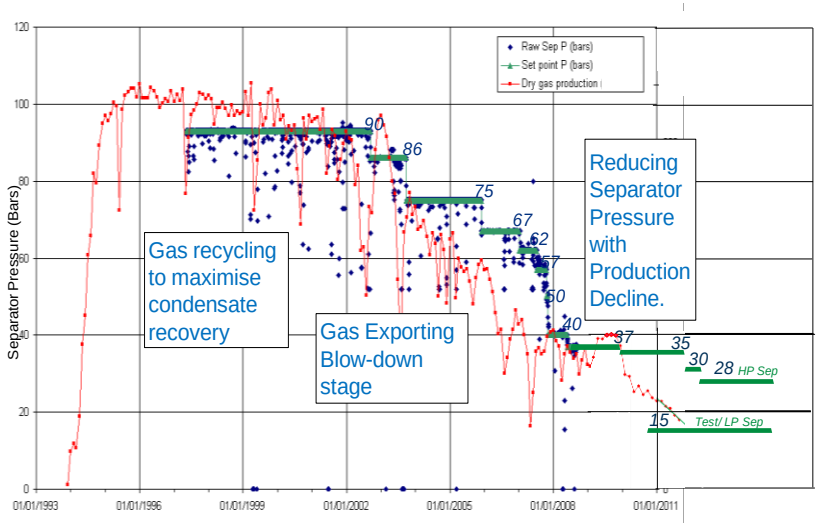
Well Production Optimization – Well Cycling

- Cycling program was then extended to other wells in the fields
- Wells responding to a cycling routine were subjected to batch foam treatment to help unload larger amounts of liquid
- Selected wells from the batch program put forward as candidates for permanent foam injection.
- Sonar test data used to diagnose unstable wells (due to liquid loading and/or other issues)
- After Sonar data evaluation, PLT (Production Logging Test) runs are scheduled for wells displaying unstable behavior due to liquid loading

Marathon Case Study: Liquid Loading Prone Gas (SPE166652-MS)

Marathon

- East Brae mature Gas Condensate Field
- Field in Production blow down
- Water Influx from active reservoir
- Mixture of core and lazy wells
- Well allocation using individual well testing

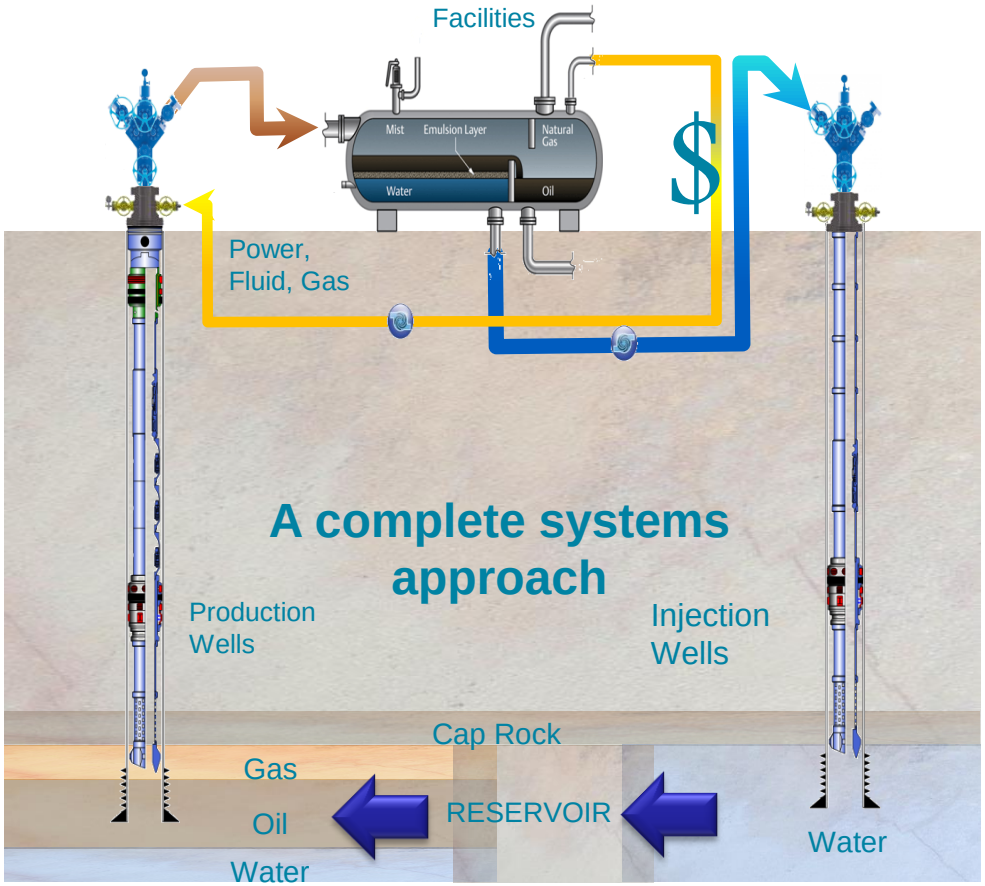


Case Study: Liquid Loading Prone Gas (SPE166652-MS)

- Flow assurance
  - Shell deliquifaction modelling tool
- Marathon Oil's gas modelling
  - Vertical lift performance
  - In-flow performance
  - Critical rate at HP & LP Separator Pressures
- Production constraints
  - Process modelling

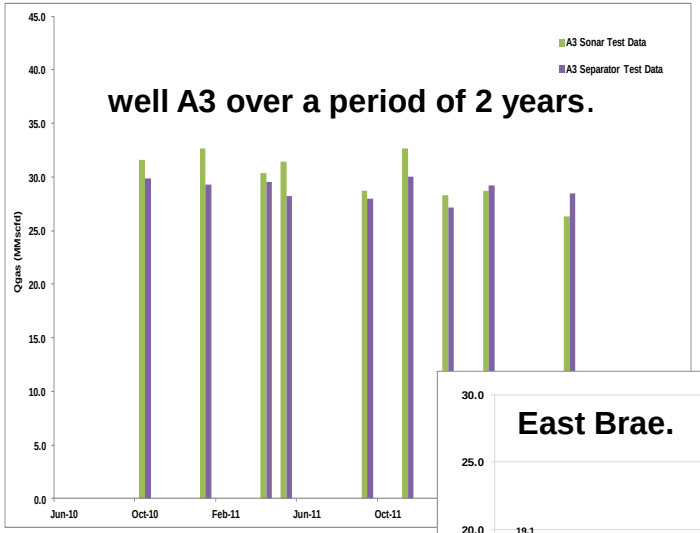
Actions

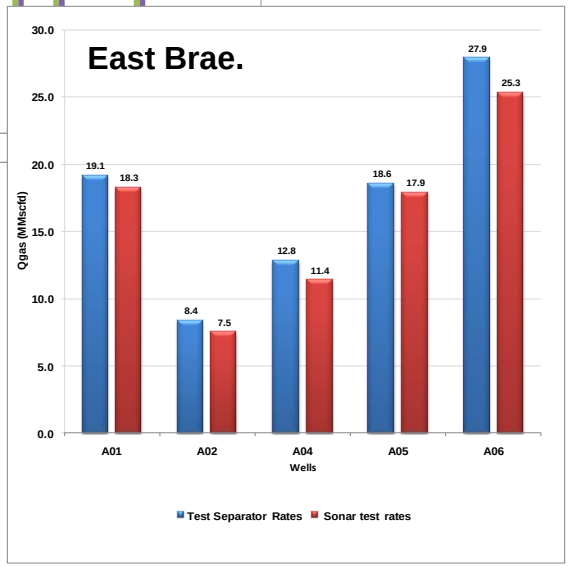
  - Convert test separator to LP Production
- Maximise production at or below critical gas rate
  - Intensive well manipulation with focused surveillance
    - Pro longed Sonar well tests
    - Temperature monitoring
    - Production logging interventions



Data Comparison

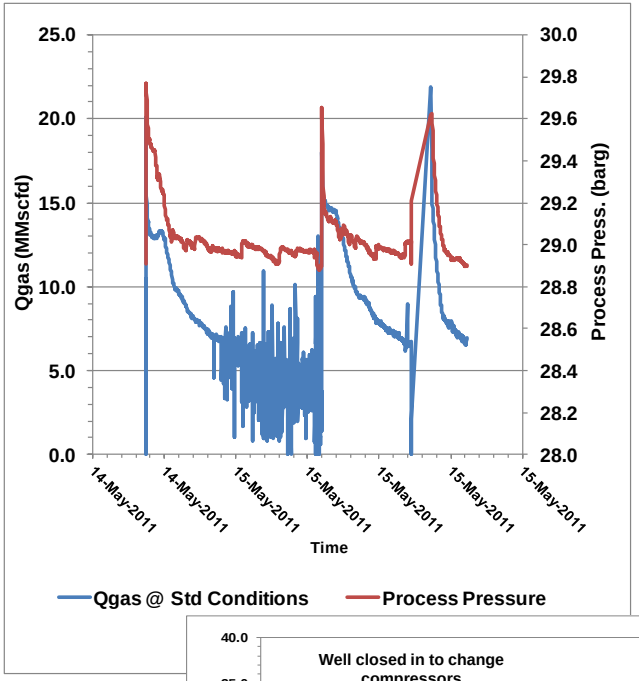
- Bi-monthly Surveillance clamp-on well testing
- Clamp-on hardware is permanently mounted to wellhead piping for consistency of measurement and well site efficiency
- Comparison of data from the test separator gas meter and the sonar meters was carried out.
- The percentage difference in measured Qgas (volumetric gas flow rate at standard conditions) varies between 0% and 10%.
- Work with regulatory authorities to have SONAR Meter accepted as alternative to conventional Test Separator based well tests

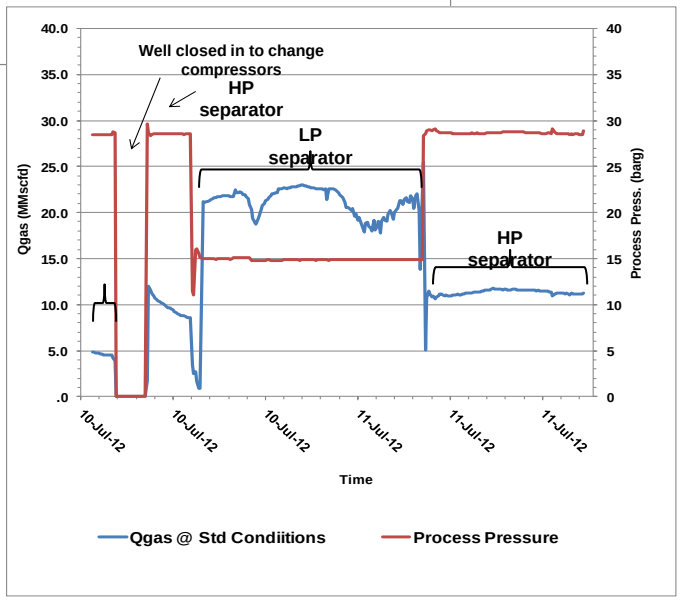




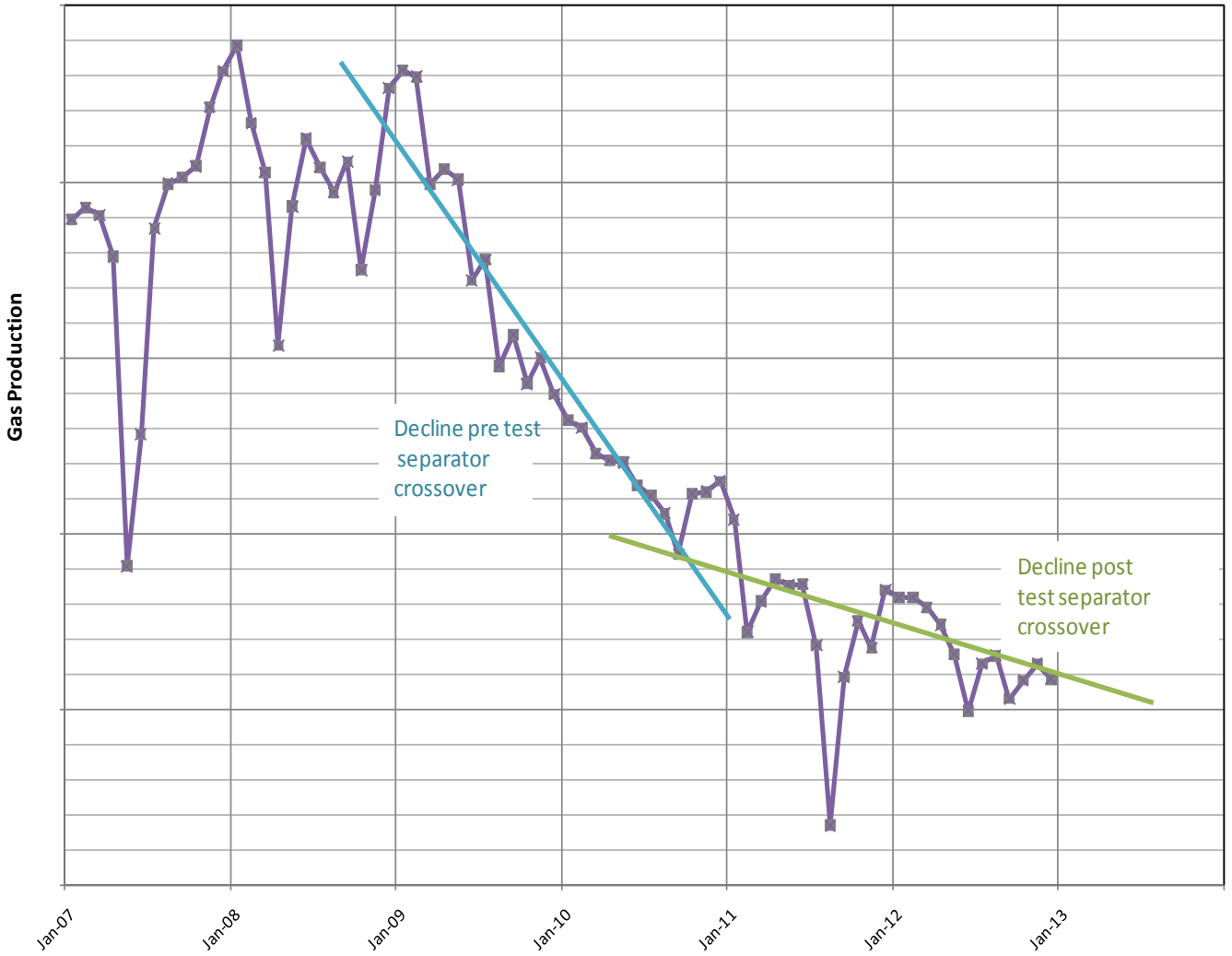
Huff & Puff plus HP to LP Swing

- Use SONAR Meters to test core wells when Test Separator is not available.
- Use of SONAR Meters to investigate individual well performance in LP Separator
- Identify performance based criteria for well swinging operations
- 12 wells on 4hr swing cycle
- LP separator can accommodate Maximum 3-5 wells
- Lazy wells on Huff and Puff
- Achieve 90% utilization of LP Separator for well unloading,





Arrested Decline

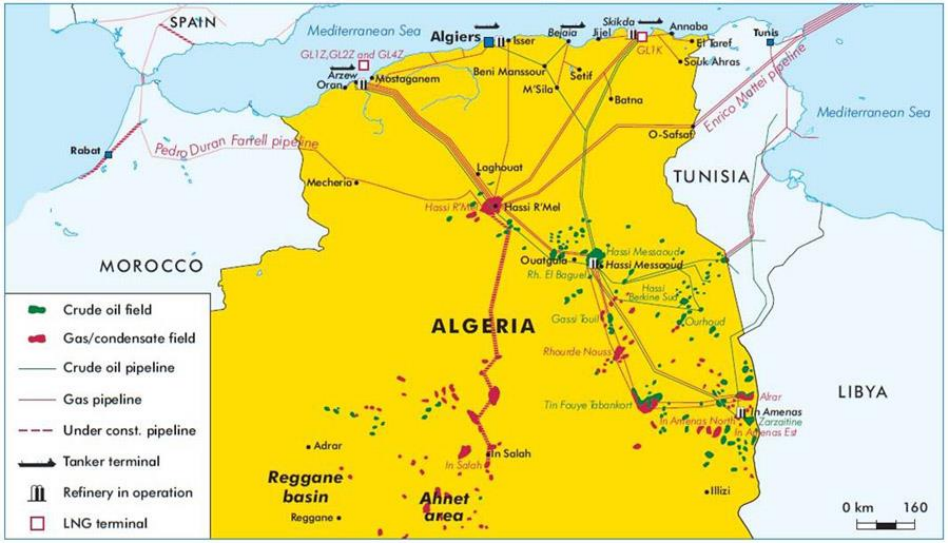


Algeria Water / Gas injection Case Study

Hassi Messaoud Mature Oil field 1956.

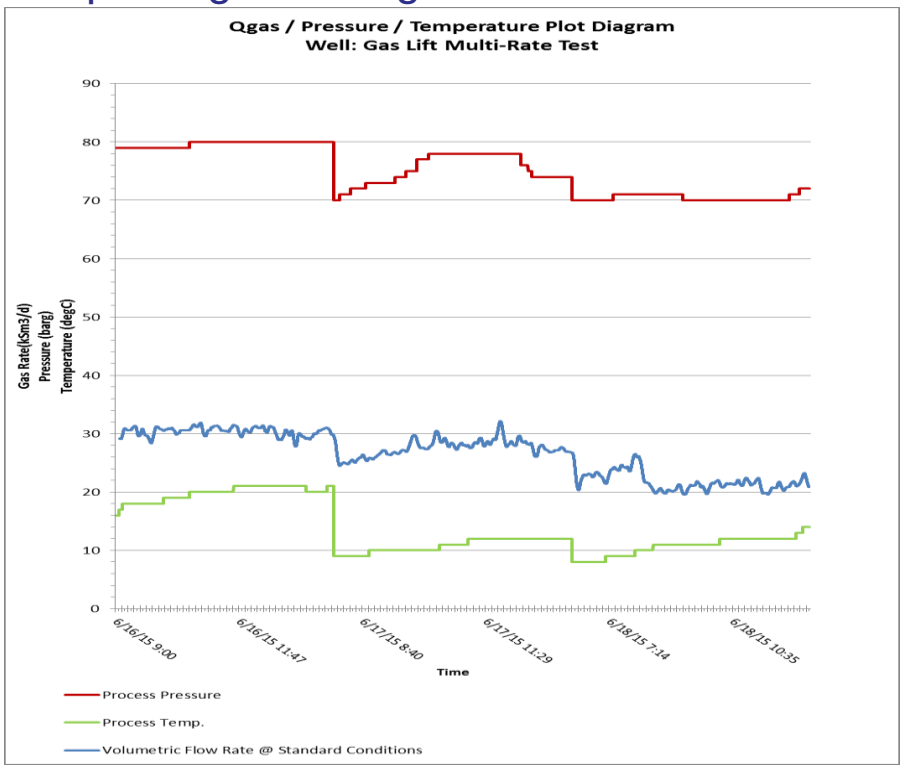
Super Giant reservoir with total proven reserves of 6.4+ billion barrels of oil.

- Large scale water and gas injection network
- Need for understanding and optimising injection of increased importance in current environment
- Identifying and trouble shooting gaps in existing data
- Gas lift Optimisation
- Reservoir Pressure Support
    - Gas Injection rates
    - Water injection rates
    - Multirate tests



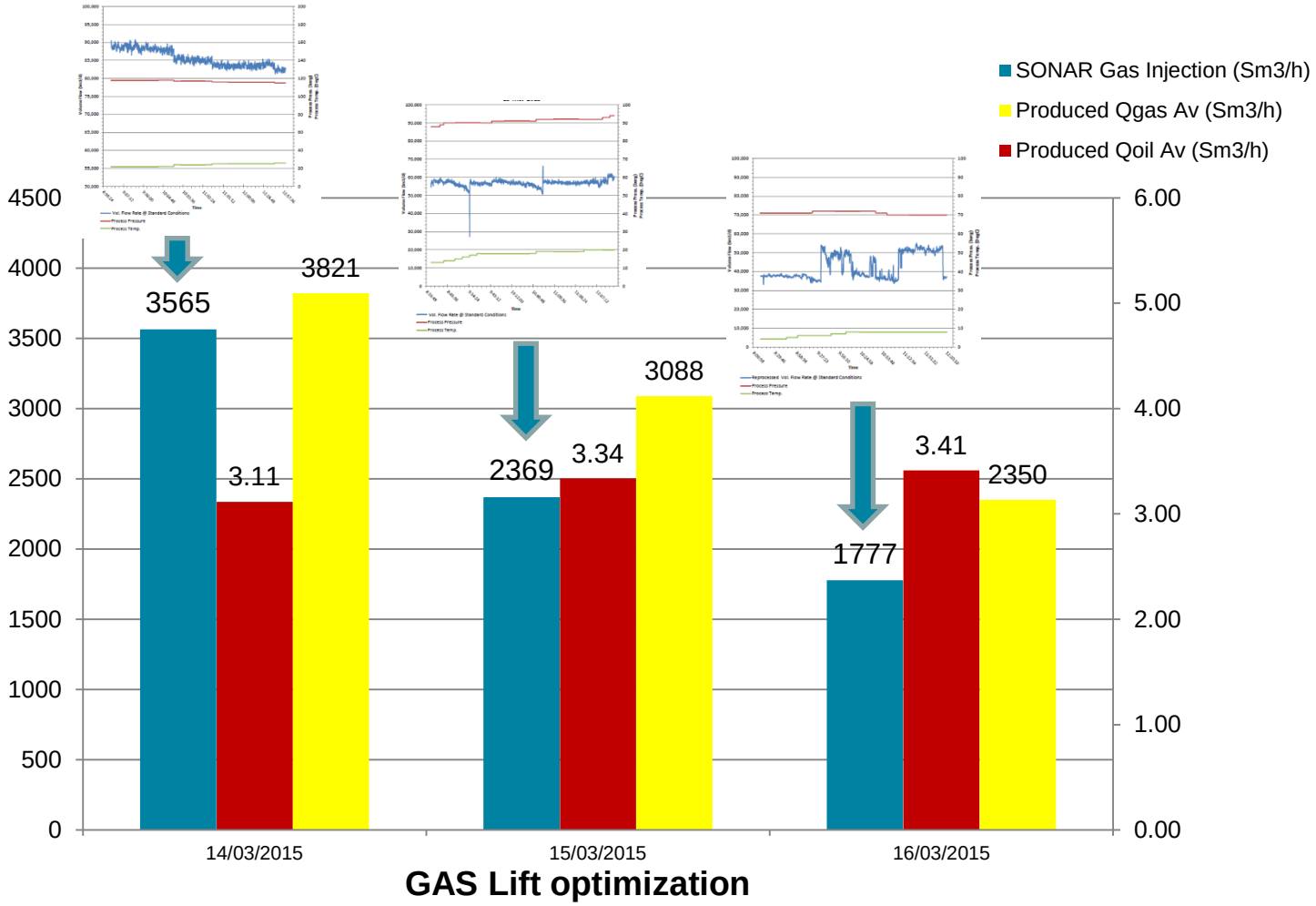
Gas Lift Measurement -Algeria

- ActiveSONAR used to measure gas lift rates during production testing
- Expro provides personnel and equipment data analysis and reporting
- One test per day
- Measure lift gas flow rate at wellheads and manifolds
- Enhance the value of the ongoing production testing TMU package offering



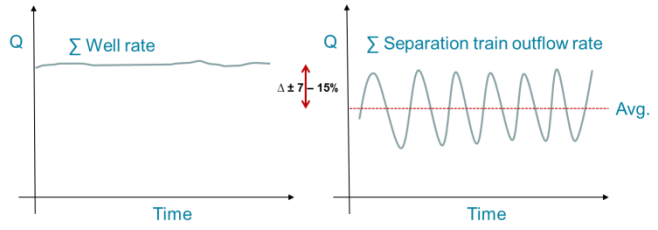
Gas Lift Optimisation -Algeria

- Hydrocarbon lifting optimisation is enabled by simultaneous measurement of lift gas and production rates.
- Couple Sonar with PassiveSONAR for production measurement



Algeria Production Plant

- Single phase injection and gas lift is on going
- SONAR now being deployed to monitor production separator outlets to identify and monitor cycling behaviours
- Next step is audits in the Production Plant where client is experiencing instabilities and uncertainties in the volumetric behaviour
- Client solution Multiple SONAR Packages run simultaneously
    - measure the production rates from the wells, manifolds, separators and export lines



Conclusions

Sonar Surveillance aids production Optimisation

Sonar Surveillance has had major impact in aiding production allocation from individual wells while minimizing separator well testing frequency and associated production loses

Sonar Surveillance, in conjunction with other methods such as temperature monitoring and PLTs, has helped to understand individual well performance and analyze the impact of liquid loading

Sonar Surveillance have enabled the production engineering team to identify underperforming wells and implement short-term de-liquification strategies such as well cycling

Sonar Surveillance is able to evaluate the effectiveness of interventions and select suitable candidates for further intervention work, helping to prolong the field life of the mature asset

Once adopted the scope of work and value information invariably increases

Conclusions

The use of non conventional technologies such **SONAR** allows for;

- Continuous Well and Reservoir Monitoring without process interruptions
- Understanding individual well behavior
- Real Time Data Collection
- Optimize and evaluate well intervention activities
- Access to Remote locations
- Minimize HSE risks
- Increase frequency of testing
- Cost reduction

More Quality Data = Better field management = Increased Production

Questions

Any Questions?