Integrated solution for Operational Metering, Surveillance and Condition Based Maintenance

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Agenda

- Introduction to Challenges
- Solution Requirements & Objectives
- Example Workflows
  - Virtual Flow Metering
  - Reservoir Monitoring, Management & Optimization
- Equipment Surveillance & Condition Based Maintenance
- Conclusion
Production Assurance from Pore to Process

- Concept Selection
- Design Verification
- Control System Checkout
- Operator Training
- Flawless Commissioning Startup
- Reservoir to Facility Optimization
- Condition Based Maintenance
- 24/7 Equipment Surveillance
- Production Optimization
- Operational Services
- Virtual / Combined Metering
Operational Challenges (example for gas condensate field)

**Reservoir Management**
- Well drawdown management
- Determine back allocation of flow
- Risk of water breakthrough/production

**Hydrate control**
- Hydrates can plug flowlines deferring or losing production
- Expensive chemical inhibition needed
- MEG Ops. based on predictions (affected by uncertainty)

**Liquid management**
- Liquid inventory (water/condensate/inhibitor) in long flow lines
- Rate changes (ramp-up surges)
- Flow instability (slugging)
- Onshore liquid handling

**Low temperature management**
- Wellhead and flowline shut-in pressure
- Temperature management during well restart

**High Pressure management**
- Packing / de-packing
- HIPPS activation and reset
- Shut-in pressure

**Erosion monitoring**

**Corrosion & Scale**

**Future Interventions / PLT**
Integrated Production Management Solution (IPMS)
Proposed Solution – Multi-Site Collaboration
Virtual Metering

Client Control Room

Client Support Centers

SLB Support Centers

Production engineers checks virtual metering is aligned with equipment

Reservoir Engineer

Operator identifies changes in well rates from Meters

Operator

Vendor ensure data reconciliation and virtual metering correctly history matched

Vendor Domain Experts
Proposed Solution – Multi-Site Collaboration
Reservoir Management

Client Control Room
Client Support Centers
SLB Support Centers

Operator identifies changes in well performance and must understand what is happening.

Res. Engineer uses downhole data to run different scenarios.

Vendor ensure model quality through calibration and Eng. assistance on demand.

Vendor Domain Experts

Operator
Integrated Production Management Solution (IPMS)
Virtual Flow Metering – Surveillance, Reconciliation and Calibration

- **Short loop – Data Surveillance**
  - Monitor Aqua Watcher, MPFMs and VFM values to detect changes/drift with alarms/warnings

- **Medium loop – Data Reconciliation**
  - VFM uncertainty calculation
  - Apply “correction” factors to the VFM flow rates as they are compared to inlet separator metered rates

- **Long loop – Solution Calibration**
  - VFM instrument failure detection / sensor drifting
  - Use of well test data and historic data analysis to identify changes / e.g. fluid property changes
  - VFM holistic flow rate reconciliation
  - Operational performance indicators (OPIs)
Virtual Flow Metering – Surveillance, Reconciliation and Calibration

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  - VFM instrument failure detection / sensor drifting
  - Use of well test data and historic data analysis to identify VFM quality, drift and calibration requirement
    - e.g. fluid property changes
  - VFM holistic flow rate reconciliation
  - Operational performance indicators (OPIs)
Hydrate Inhibitor Optimization Workflow

**Production Management Recommendations**

- **Real-time recommendations on optimum chemical injection rates**
  - Adjust dosage
  - Optimise utilities / energy consumption
  - Optimise future unit sizes or extend life
- **Inventory and consumption management**
- **Recommendation for proactive equipment maintenance**
Reservoir Monitoring, Management & Optimization - Workflow

Production Management Recommendations

- Real-time recommendations on optimum well drawdown / production rates
  - Risk of water breakthrough
  - Reduce risk of reservoir damage (avoid excessive drawdown / damage to skin)
  - Optimize production rates
- RT updates of reservoir models (perm/skin/water saturation)
- Recommendation for proactive intervention requirements
- Extend life of well / field

Reservoir Production Optimization Workflow

- Stabilized Flow Surveillance period
- Transient monophasic gas production monitoring
- P,T,Q transient gas & water zonal flow monitoring
- RT near-wellbore surveillance

- Refined flow profile
- Refined Perm/layer
- Parameter Constrains for further interpretation
- Water saturation per layer

- Zonal layer depletion tracking
- Drawdown monitoring

AquaWatcher
WellWatcher
Flux
- temp arrays

WellWatcher
Flux
- temp arrays

WellWatcher
Flux
PT gauges
Xmas Tree gauges

Formation water detection
Water production rate

Sandface DTS along flow zones
Stabilized flow:
• Perm per layer
• Prod flow profile

Annular PT
Tubing PT
WHFP & WHFT

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Water production rate

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Annular PT
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WHFP & WHFT
Real-time Interactive Monitoring

- Unified platform for flow assurance, reservoir and equipment condition monitoring
  - Intuitive and cross-discipline friendly GUIs
  - Data deployed back into the field’s operation system

- Know the health of hardware and logical components
  - Condition and performance based monitoring leads to predictive maintenance

- Warnings and alarms issued
Condition Based Maintenance

Reduce OPEX cost by optimizing maintenance planning based on actual condition of system – and not run to failure

Real time condition monitoring of system
- Understand health degradation function

Estimate Remaining Useful Life – RUL
- Predict future health condition
- Time to maintenance critical
- Time to end of life

Optimize maintenance schedule
- Spare parts
- Logistics
- Personnel

Instrument system for performance evaluation
- Pressure
- Temperature
- Vibration
- Load
- ....
Example portal: WGFM, VMS and PMS with quality indicators
Conclusion

- Everything start from the reservoir and well performance;
- Equipment and software is a continuum;
- Client knowledge and supplier knowledge are complimentary;
- Supplier can support the operator if
  - Has deep knowledge over the equipment;
  - Has deep knowledge over the production systems;
  - Can reconcile both.
- Virtual system allow inherent redundancy if properly matched with real systems.