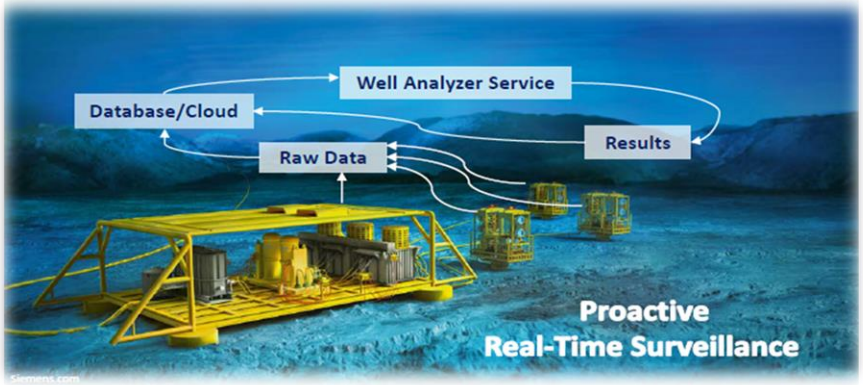
Well Analyzer

Pro-Active

*Automated Real-Time Surveillance **(ARTS)***

Well/Reservoir Evaluation Software Package



Scale Detection in North Sea Water Injector

Oilfield Data Services, Inc.

- ✓ Oil & Gas Reservoir Testing and Evaluation
- ✓ Real-Time Pressure Transient Analysis
- ✓ Hydrocarbon Volume Determination
- ✓ Well(s) Performance Tracking
- ✓ Multiphase Rate & BHP Calculations
- ✓ Optimize Gas Lift / Oil Production Rates
- ✓ Life Of Well Surveillance/Analysis
- ✓ Automated PVT Calibration

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ODSI Well Analyzer

Digital Operator Support Real-Time Automated System

Real-Time Reporting on Well/Field KPI's

The Well Analyzer RTS Concept:

Experienced Surveillance Engineers

+

Automation

VFM/PVT	Flow Assurance	Production & Reservoir Performance Optimization		Field Development & NPV Optimization
Virtual Metering	Wax, Hydrates, Asphaltenes, Scale, Corrosion, Emulsion Detection & Mitigation	Auto Real-Time PTA & Reporting	In-place and recoverable hydrocarbon volume monitoring	Short- and long-term asset and NPV Optimization
Auto Real-Time PVT Tuning & Calibration		Scale, Asphaltene detection in reservoir & wellbore	In-place and recoverable hydrocarbon volume monitoring	Drilling Decisions – Optimal Well Placement

Asset Modeling, Monitoring & Diagnostics

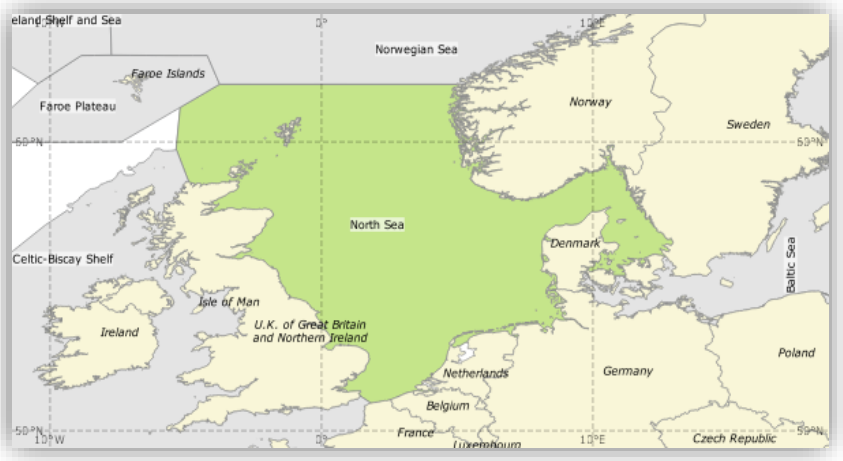
Raw sensor data → Data Communication → Intermediate Data Repository → Real-Time Data Management

Photo credit: www.energyglobalnews.com

Well Analyzer Automated Real-Time System (ARTS) Features

- Automated Rate Calculations and PVT Adjustments
- Conversion to BHP/Datum Depth
- Automated Pressure Transient Interpretation of Build-ups (PBUs) and Drawdowns (DDs)
- Time-Lapse Skin, Perm, Mobility-Thickness, P* and P.I. or I.I.
- Continuous calculations of observed in-place, hydraulically connected, mobile and recoverable HC Volumes
  - Static & Flowing MBAL, Decline Analysis

Background Water Injector- North Sea



- Equipped with
  - WHP and Downhole Gauges
  - Flowmeter
- **Objectives:**
  - Demonstrate WA's wellbore calculations
  - Perform diagnostic PTA on the historic data
  - Identify performance impairment cause, recommend remedial procedures; confirm the results of the stim job

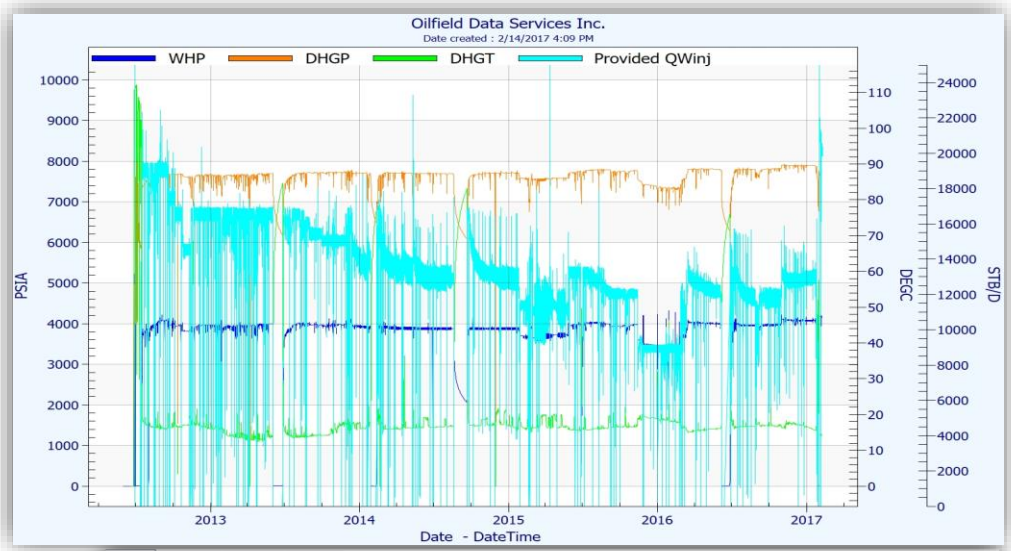
Automated Real-Time System (ARTS) Input Data

Input Data

- WHP/T
- DHGP/T

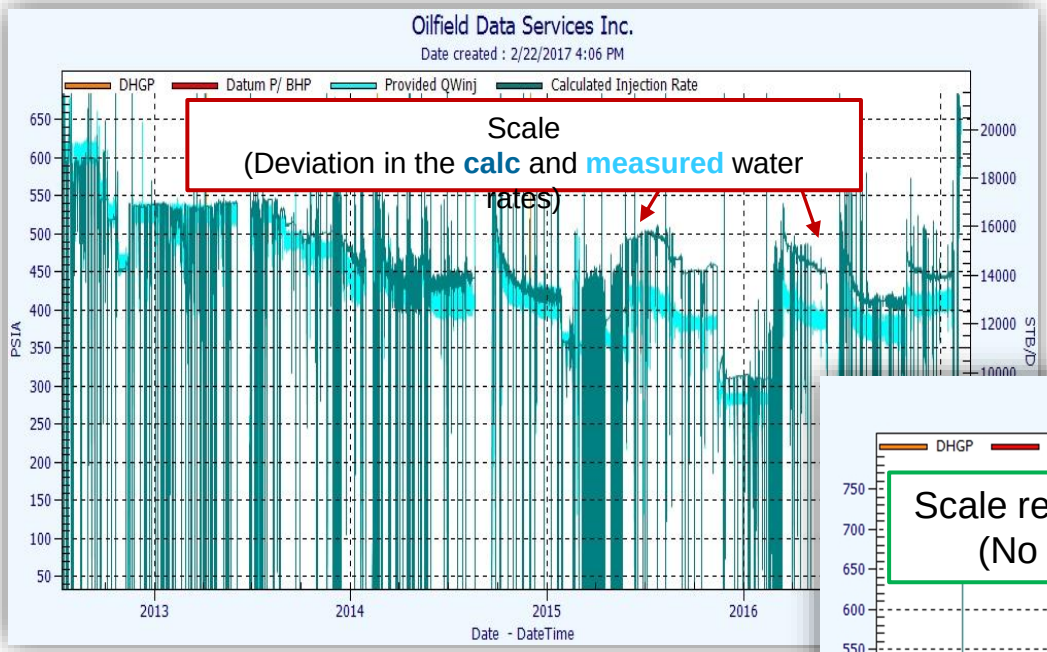
Outputs & Deliverables

- Water Rates
- Mid-completion BHP
- Diagnostic Auto-PTA
  - Permeability & KH
  - Skin & DP Skin
  - Injectivity Index
  - Reservoir Pressure

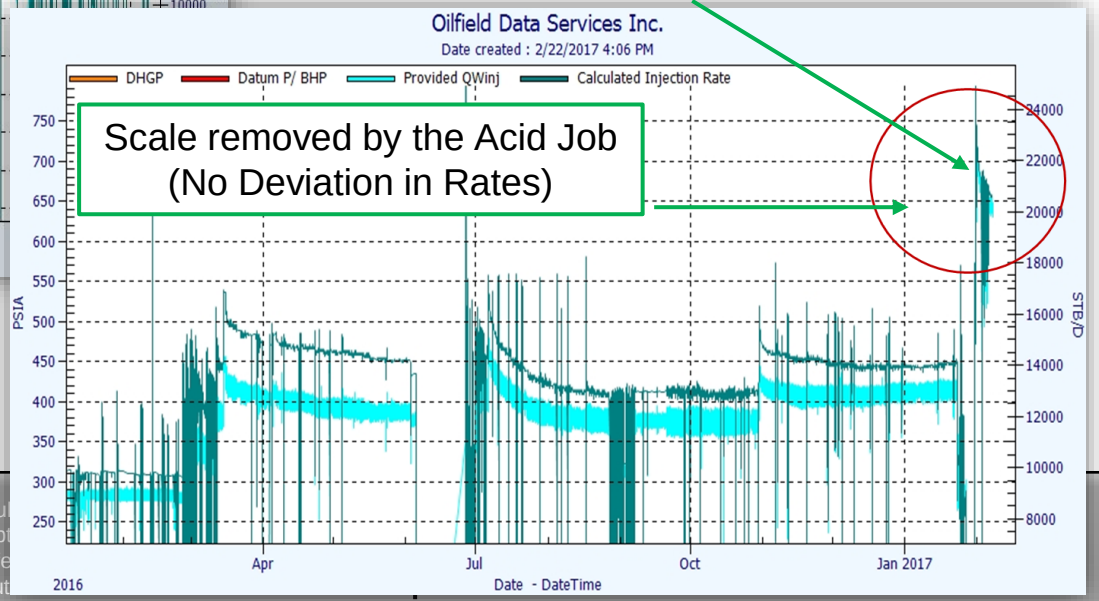


Measured vs Calc Water Rate Comparison & Wellbore Scale Detection

- Spot water rates were calculated from dP wellbore
- Deviation between the measurement and the calculation is indicative of **scale** (additional frictional pressure drop in the wellbore)

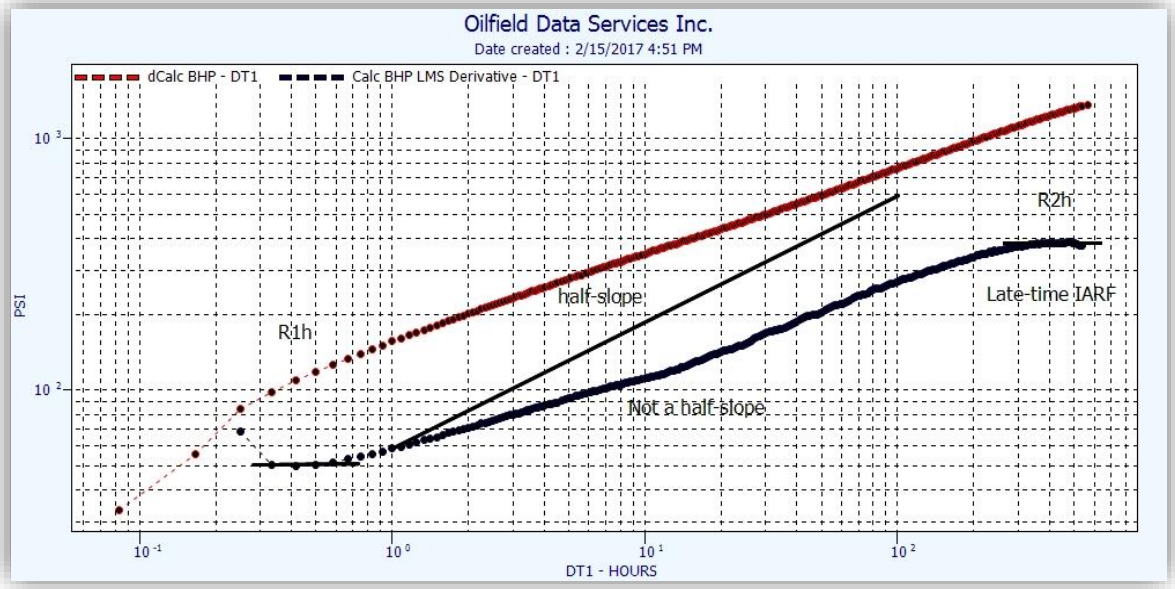


- Scale was removed by the acid job
- The measured and calculated rates matched again
- The method helped the operator to **recognize successful stim job**



Diagnostic Historic PTA

- Unusual flow regime based on the derivative response, therefore, PTA was performed for both early and late time radial flow
  - Early-time IARF: 0.2 ~ 0.9 hrs
  - Late-time IARF: 300 ~ 400 hrs



- Note: late-time PTA was not useful for well's performance evaluation due to lack and nature of the data

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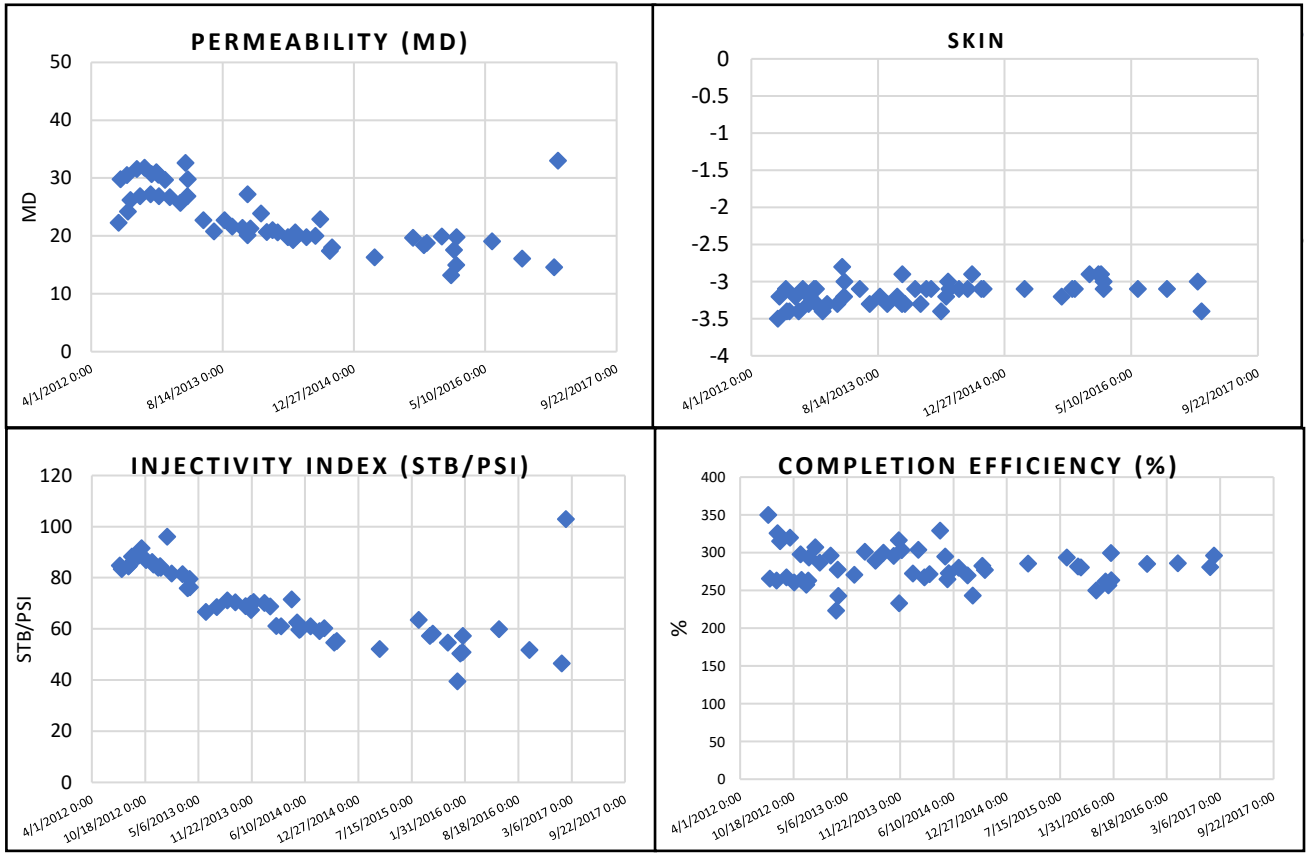
Historic Diagnostic PTA (Early-Time PTA)

Injectivity and Injection Fall-Off Tests



Each Fall off and Injection test are analyzed for diagnostic PTA parameters in real-time

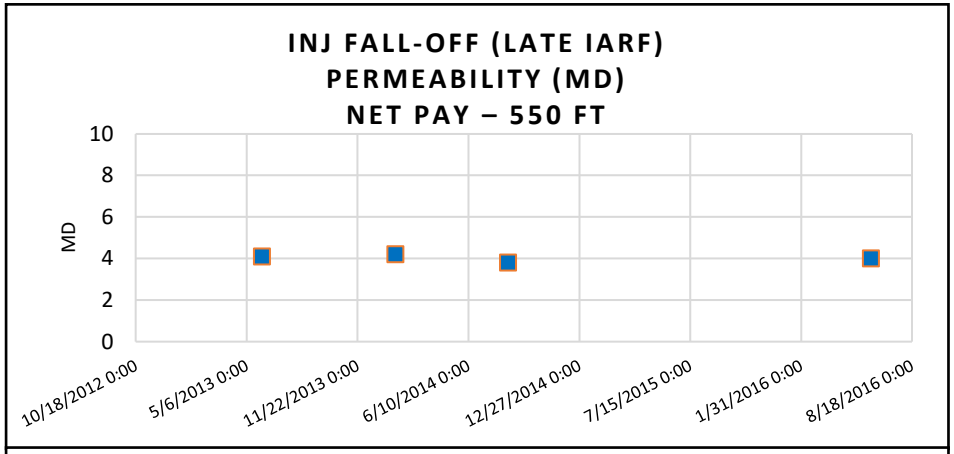
A **report** is generated for each test

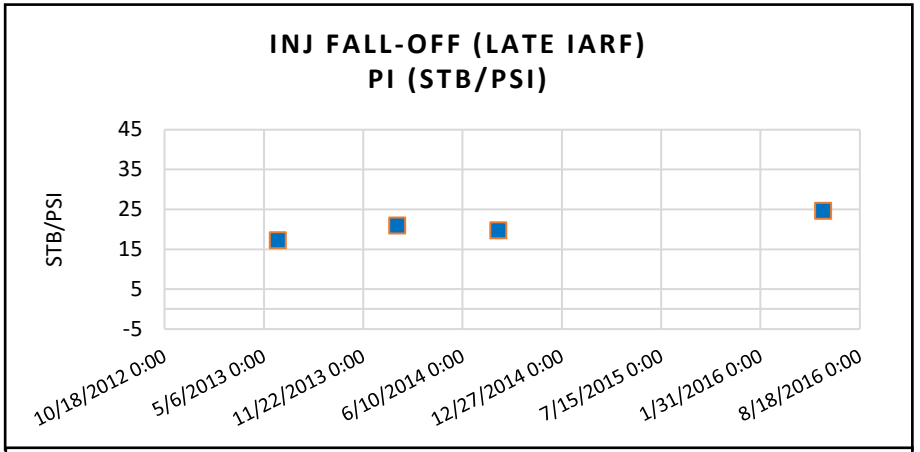
- Gradually decreasing injectivity index with time (scale buildup)
  - 120 % increase in the injectivity index after the stim job
- If the software was running in real-time on client's server, the Operator could have detected the scale immediately and performed the stim job 2 years earlier

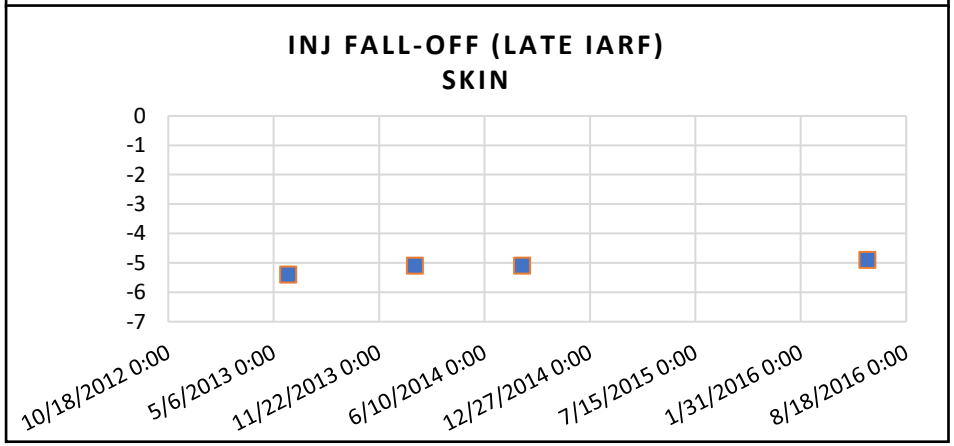
Historic Diagnostic PTA (Early-Time PTA)

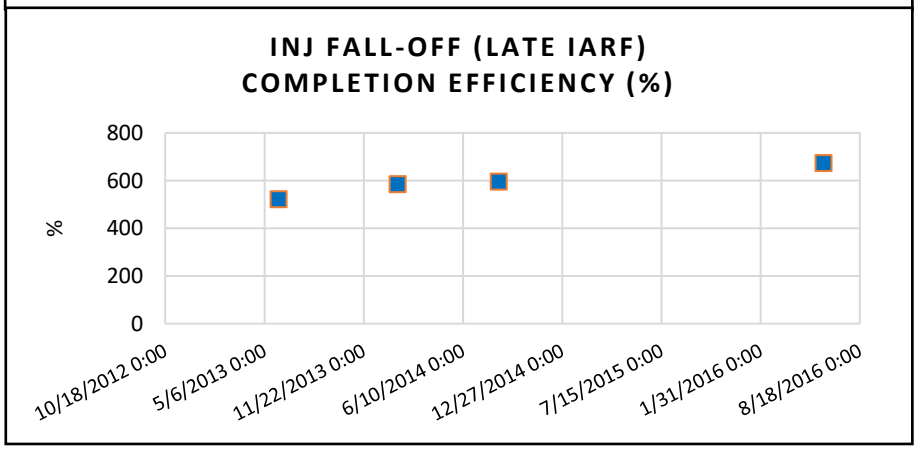
Injectivity and Injection Fall-Off Tests

- Late IARF was observed at around ~ 300 hrs
- During 4.5 years, there were only 4 PBUs of sufficient duration to 'see' late IARF









- **No indication of scale or performance degradation from the proper PTA interpretation**
  - **No changes in skin, perm, PI in the reservoir**
  - **No indications of scale implying the scale is near the wellbore or in the tubing**

Results & Conclusions

- ODSI calculated rates matched the measured rates accurately until the well started to scale in the well bore (and in the completion)
- The deviation between measured and the calculated rates was indicative of additional pressure drop in the wellbore - scale
- Scale build-up caused additional friction in the wellbore
- Diagnostic early-time (near-wellbore) PTA confirmed scale buildup in the tubing

- The tool helps to detect errors in Allocations and to diagnose changes in well's performance!

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