Well Analyzer

for

Producing Oil & Gas Wells

BHP Conversion/Failed DHGP Gauge Case Study

Pro-Active

Automated Real-Time Surveillance

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Automated Real-Time Surveillance (ARTS)

Real-Time Reporting on Wells / Field KPI's

The ARTS Concept: Physics + Automation + Experienced Surveillance Engineers

Rates & PVT

- 3-Phase Rate and BHP Calculations
- Flow meter Validations
- Automated PVT Tuning & Calibration
- Water Cut and GOR or Yield Calculations

Production & Reservoir Performance Optimization

- Auto Real-Time PTA & Reporting
- Scale and/or Asphaltene detection in reservoir, completion & well bore
- Recognize Wellbore Lift Issues & Gas Lift Optimization
- Recognize Completion & Reservoir Performance Issues (Skin, Scale, Compaction, Velocities)
- In-place, Connected and Recoverable Volumes
- Producer-Injector Interaction
- Tracking on Moving Oil-Water, Gas-Oil, Gas-Water Contacts with time
- Know the Maximum Safe Flow Potential of the Well (Spare Capacity)

Flow Assurance

- Wax, Hydrates, Asphaltenes, Scale, Corrosion, Emulsion Detection & Mitigation

Topsides/Facilities

- Automated Facilities Debottlenecking & Optimization
- Recognition of Inefficiently Operating Equipment

Asset Modeling, Monitoring & Diagnostics

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

Photo credit: www.energyglobalnews.com

Well Analyzer Wellbore Model

- The only existing software based on a direct numerical integration to the Mechanical Energy Balance (MEB) eq.
  - Does not rely on correlations
  - Provides **more accurate** and **reliable results**
- The wellbore model
  - Accounts for dynamic temperature behavior
  - Adjusts the fluid properties accordingly
  - Performs wellbore flash calculations to determine the composition of the fluid in the wellbore

"It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts."

Sir Arthur Conan Doyle, Author of Sherlock Holmes stories

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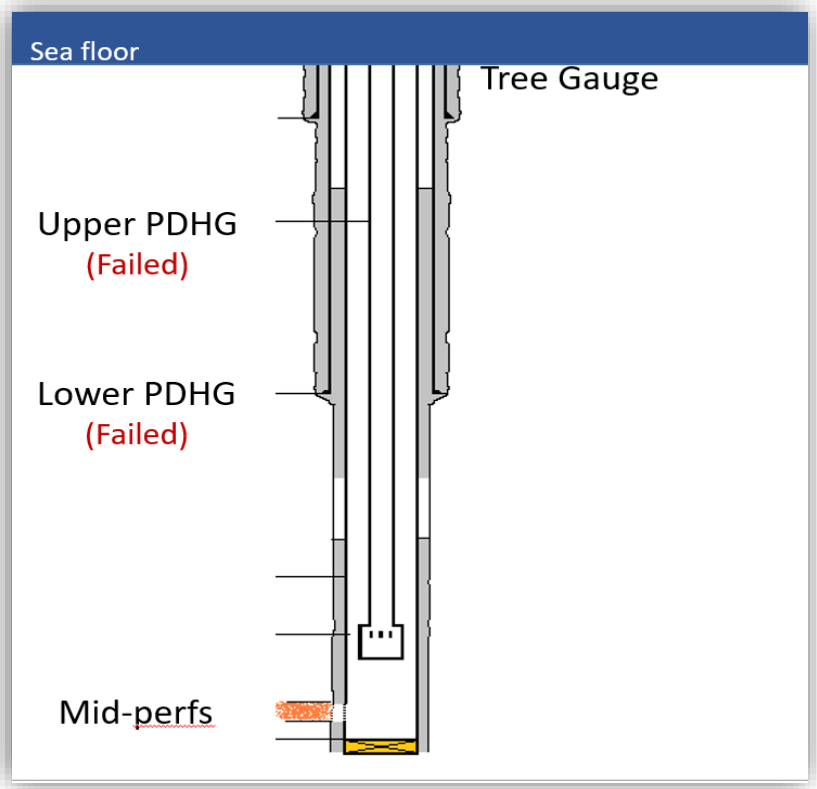
BHP Conversion Case Study
Subsea Gas Condensate Well – North Sea

- Multiple PDHGs and measured gas rate
- **Objectives:**
  - Calculate and validate the metered gas rate
  - Calculate BHP at mid-perf depth
  - Perform PTA and determine if the well is a stimulation candidate (?)



Is your well really a stimulation candidate?
High skin or bad BHP conversion?

All PDHGs failed. The interpretation was done on the historical data with functional gauges to demonstrate the accuracy of ODSI's BHP conversion and to demonstrate that the well was not a **stimulation candidate**

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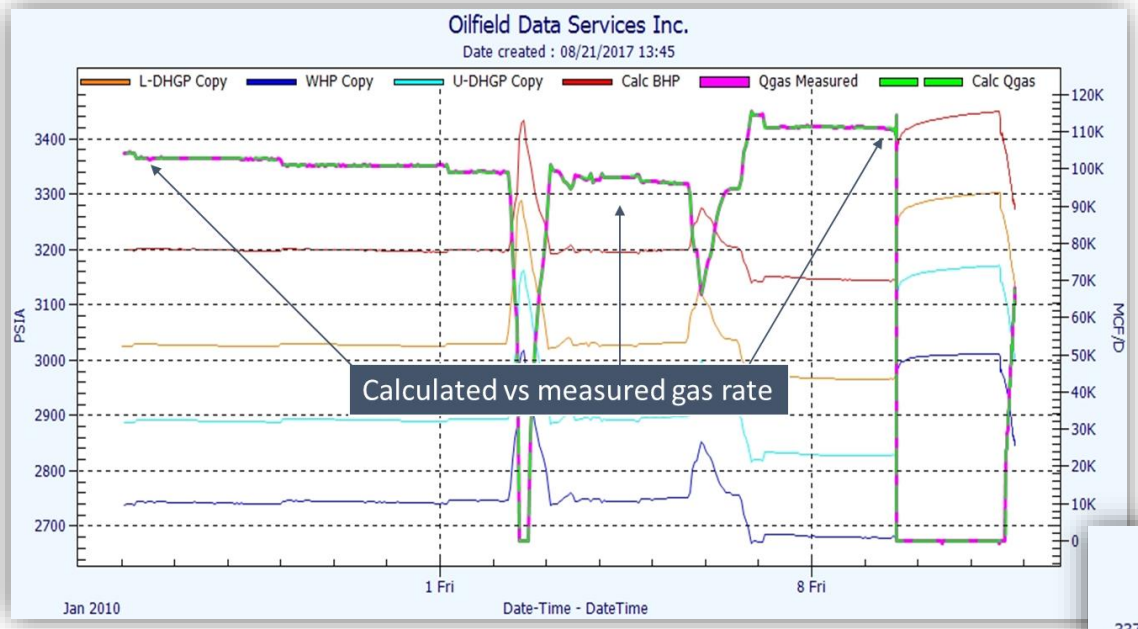
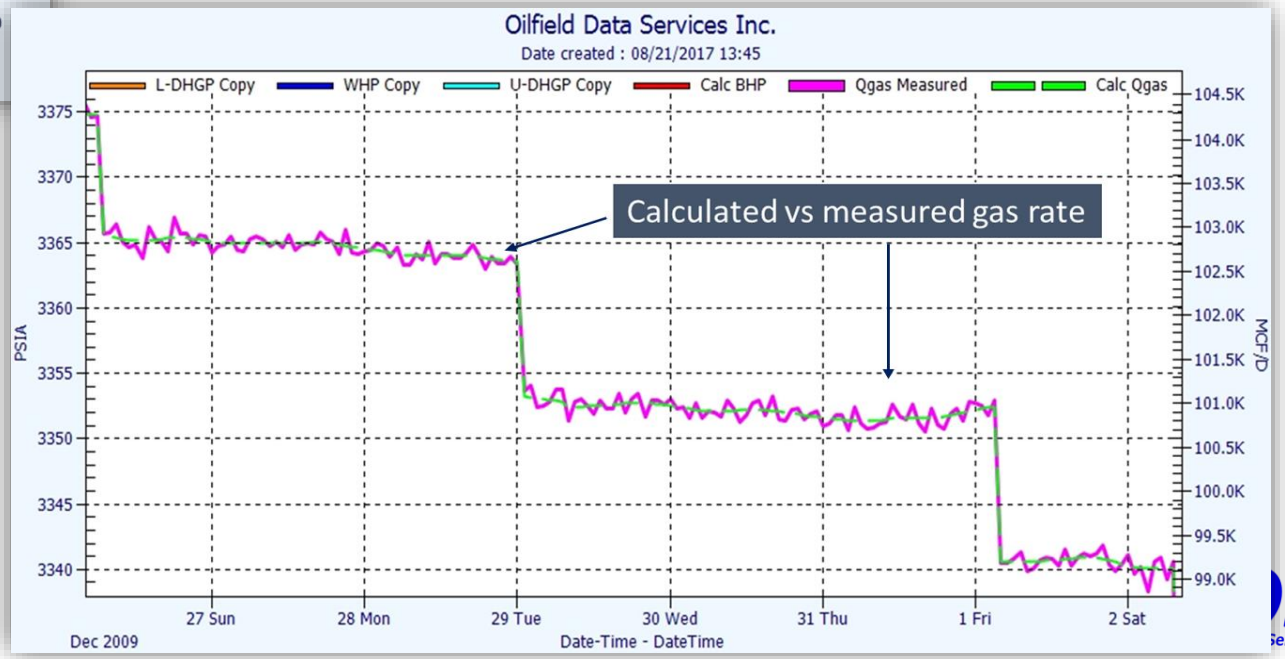
BHP Conversion Case Study
Subsea Gas Condensate Well – North Sea

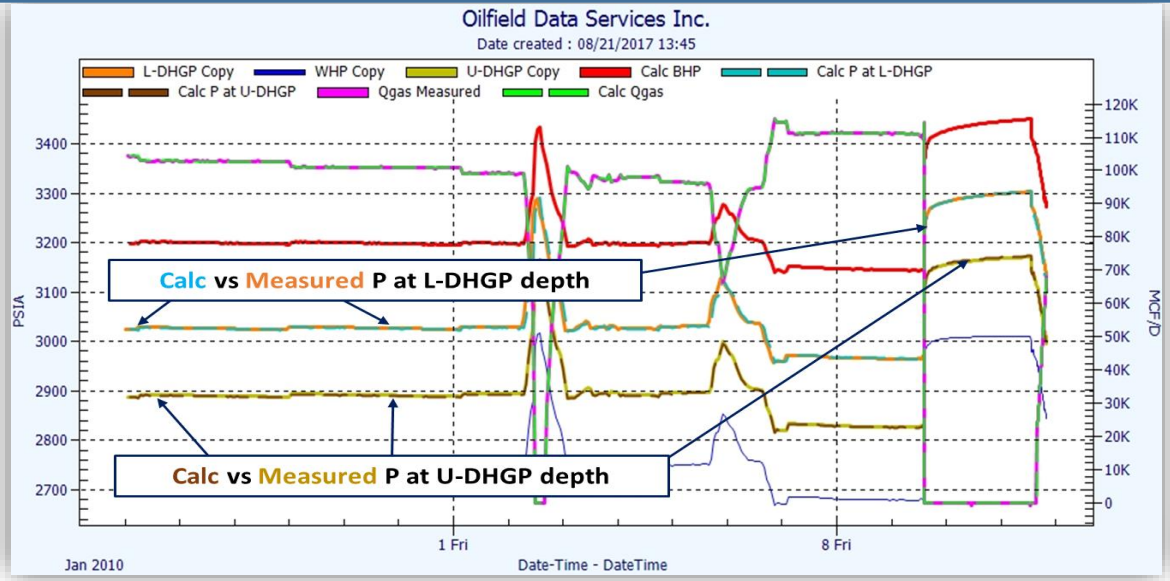


- Gas rate calculated using dP wellbore & compared to the metered gas rate
  - **Less than 1 % error** between the measured and the calculated gas rates



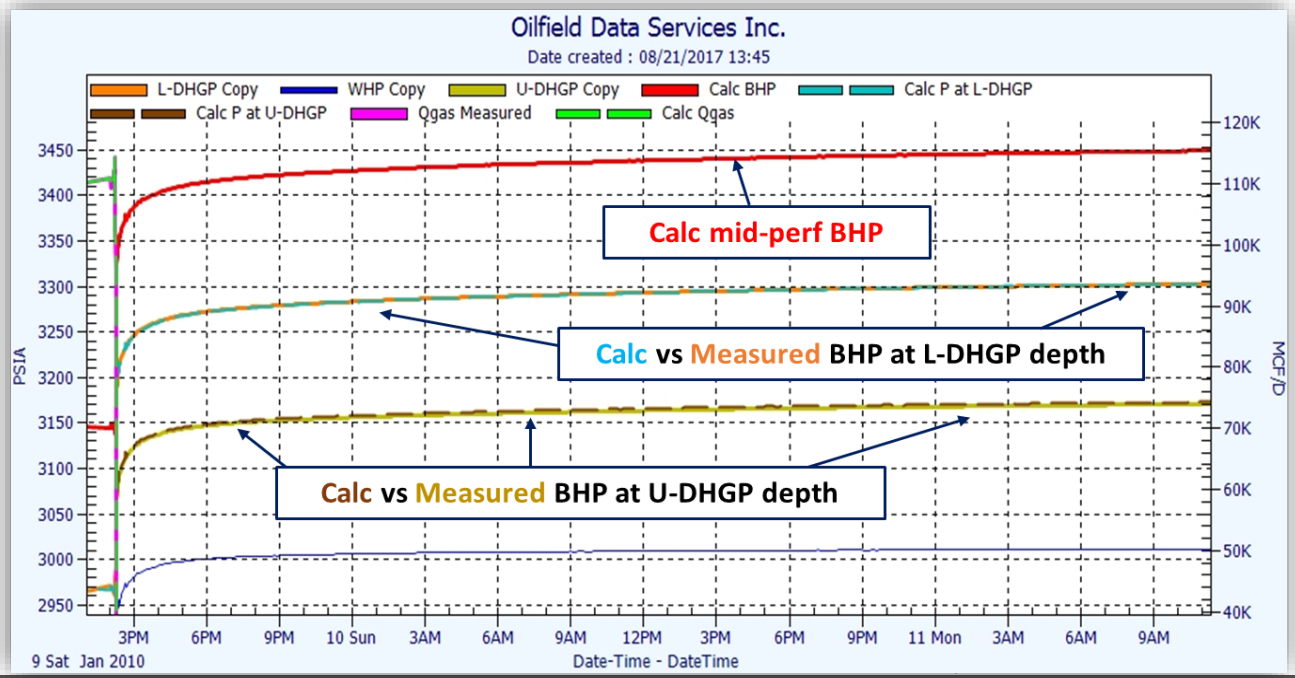
- Independent solution
- Backup if MPFM fails
- Detects errors in allocations

BHP Conversion Case Study
Subsea Gas Condensate Well – North Sea



- BHP was calculated at the Upper and Lower DHGP depths using the WHP and the calculated gas rate (proof of concept)
  - **Less than 2 psi error**

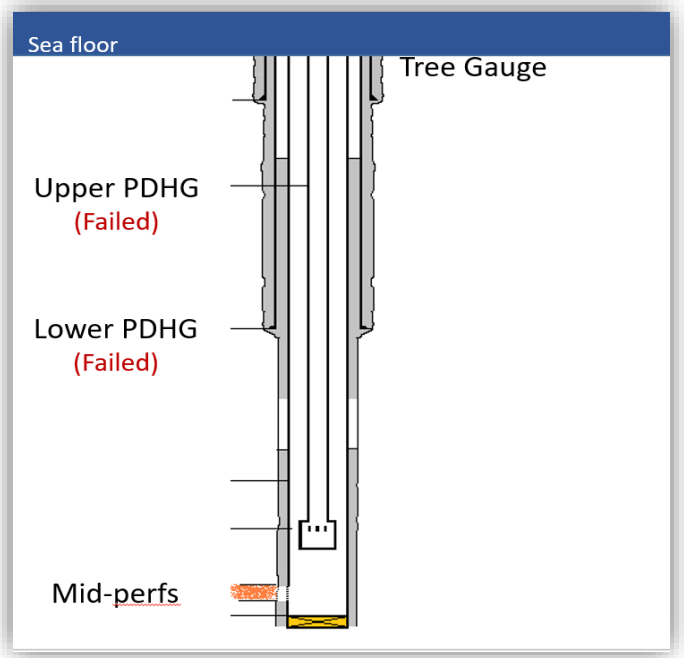
- Backup if PDHG fails



BHP Conversion Case Study – Importance of Valid mid-perf BHP
Subsea Gas Condensate Well – North Sea

Is your well really a stimulation candidate?

High skin or bad BHP conversion?



- **It is crucial to have a valid mid-perf BHP**
- Failure to perform PTA on mid-perf BHP leads to:
  - Overestimation of Permeability
  - Overestimation of Skin
  - Underestimation of P*/Reservoir Pressure

- The next slides show how this well could be **incorrectly considered to be a stimulation candidate**

ODSI's solution accounts for rigorous PVT and phase-thermal changes in the wellbore

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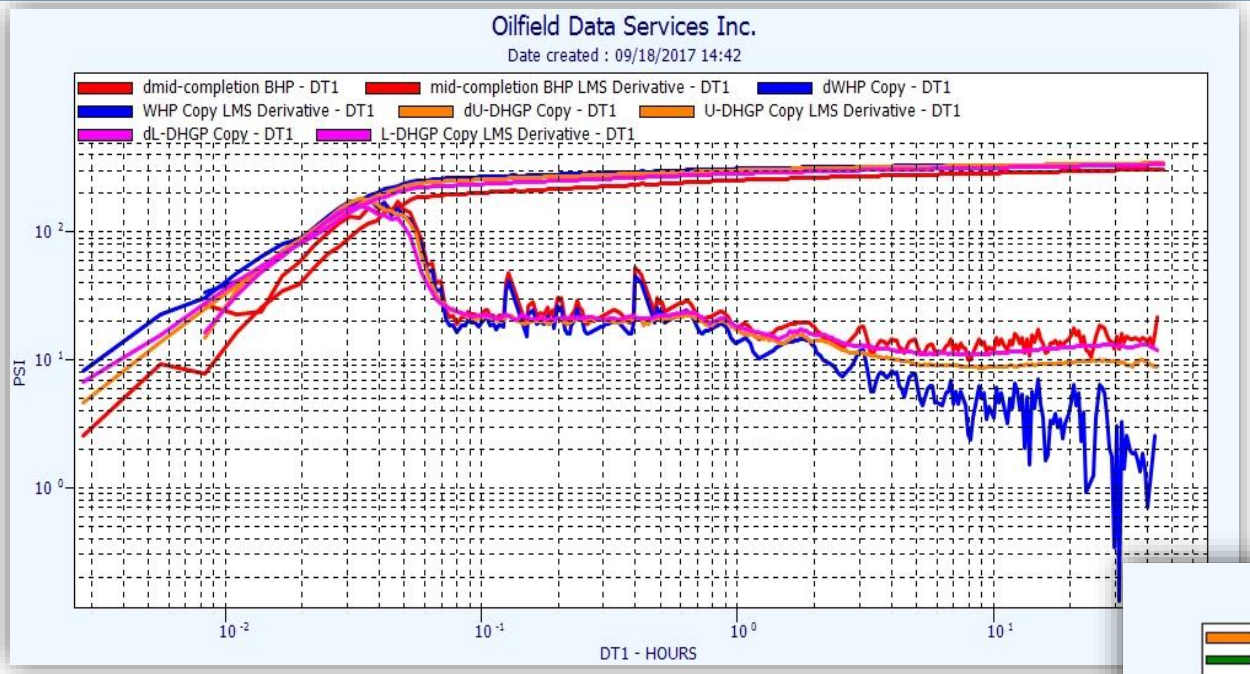
BHP Conversion Case Study – Importance of Valid mid-perf BHP

Subsea Gas Condensate Well – North Sea



Is your well really a stimulation candidate?

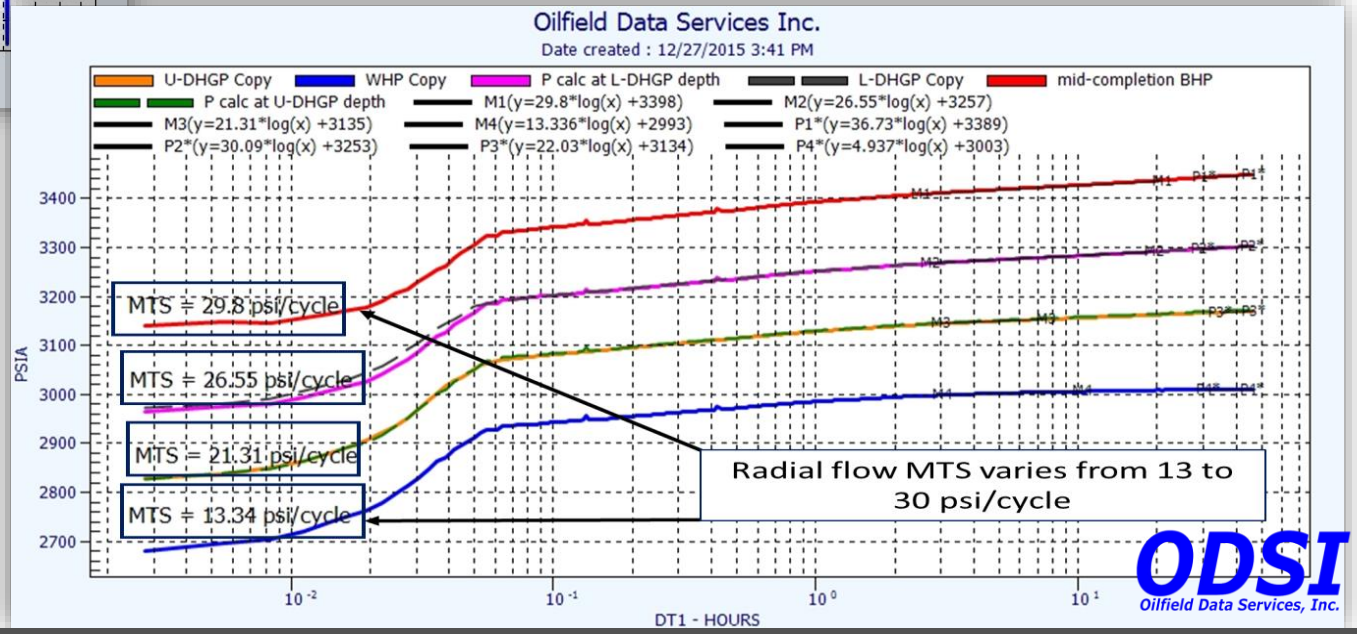
High skin or bad BHP conversion?

Calculated mid-perf BHP

Lower PDHG

Upper PDHG

WHP



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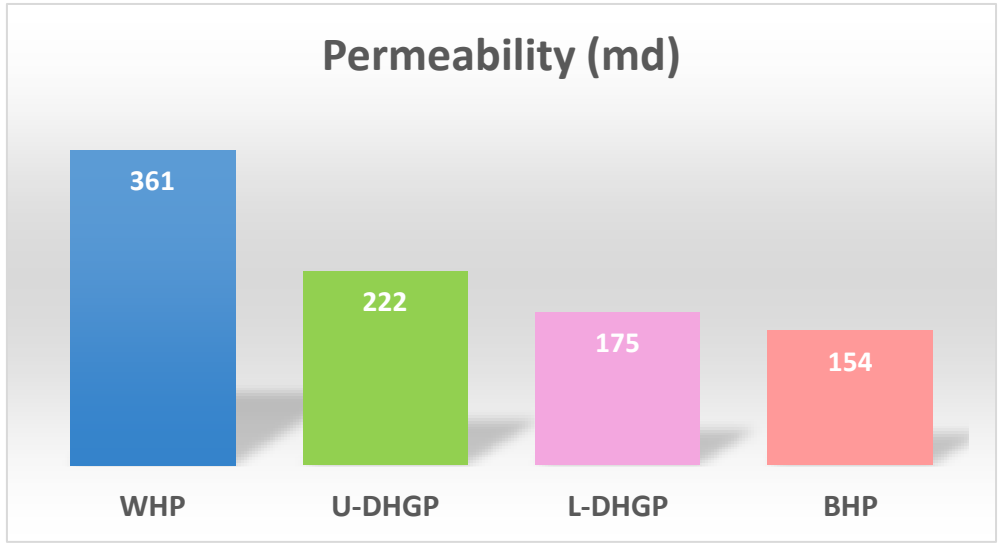
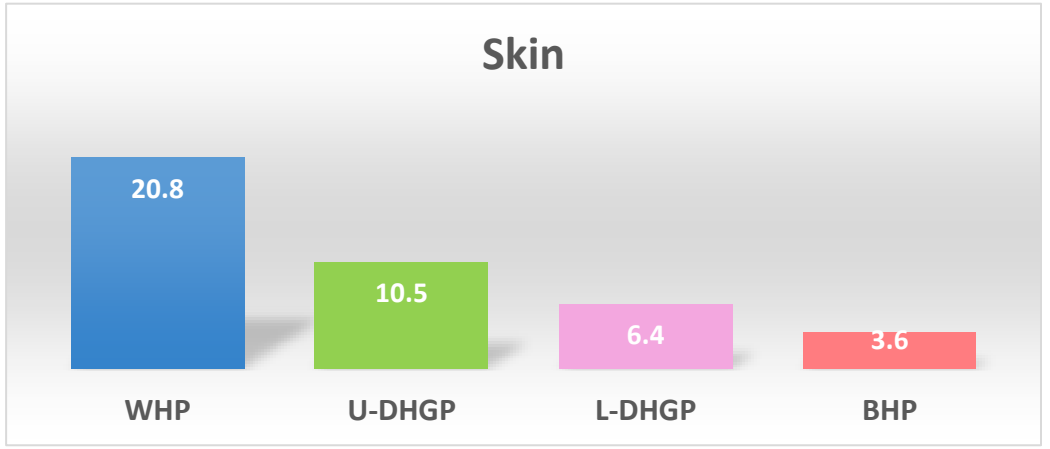
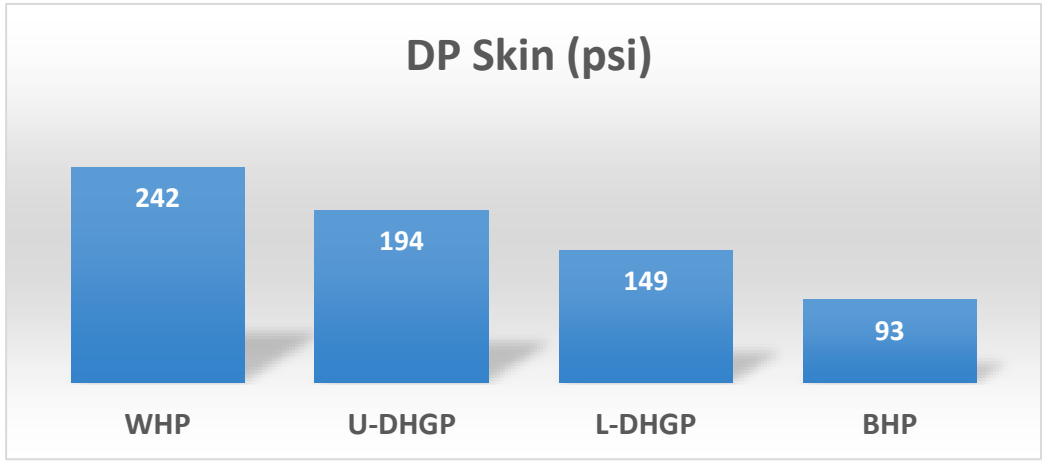
BHP Conversion Case Study – Importance of Valid mid-perf BHP Subsea Gas Condensate Well – North Sea

- To show the importance of valid mid-perf BHP, the PBU was analyzed using the following:
  - **WHP**
  - **Upper PDHG**
  - **Lower PDHG**
  - **Calculated mid-perf BHP**







Is the well really a stimulation candidate?

No! It's wellbore cooling

ODSI's solution accounts for rigorous PVT and phase-thermal changes in the wellbore

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BHP Conversion Case Study – Importance of Valid mid-perf BHP Subsea Gas Condensate Well – North Sea

- The difference in the mid-time slope values was caused by wellbore cooling
- **During a shut-in**, the head is **NOT CONSTANT**; wellbore cooling causes fluid density (head) to increase
- **BHP increases** as the reservoir pressure builds up
- However, if the RATE of an increase in the density term is significant, it can result in SLOPE SUPPRESSION on the WHP or even cause DECREASING WHP during a shut-in!

- **Artificially lower MTS would provide artificially higher skin & perm**
  - **ODSI's solution accounts for rigorous phase-thermal fluid behavior at every segment in the wellbore**

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BHP Conversion Case Study – Importance of Valid mid-perf BHP Subsea Gas Condensate Well – North Sea

- Direct numerical integration to the Mechanical Energy Balance accounting for rigorous PVT, thermal and frictional changes in the wellbore
  - Accurate Gas Rate calculation
    - Less than 1 % error between measured and the calculate gas rates
    - Backup if MPFM fails
  - Accurate BHP at any point along the wellbore
    - Within 2 psi error margin
    - Backup if PDHG fails
- Valid PTA Results
  - Failure to perform PTA on valid mid-perf BHP leads to overestimation of skin & permeability
    - Wellbore cooling and additional friction below the gauge
- The well was NOT a stimulation candidate
  - Treatment would not improve the well's performance

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