WA ARTS for

Producing Oil & Gas Wells

Pro-Active

Automated Real-Time Surveillance

Well/Reservoir Evaluation Software Package

Gas Condensate Well
Offshore Australia

USA | UK | AUSTRALIA
www.odsi-energy.com

- ✓ 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

Oilfield Data Services, Inc.
+1 (713) 521 - 4571 | info@oilfielddataservices.com
Visit: www.odsi-energy.com

Well Analyzer RTS – Introduction

The Well Analyzer ARTS Concept:

Experienced Surveillance Engineers

+

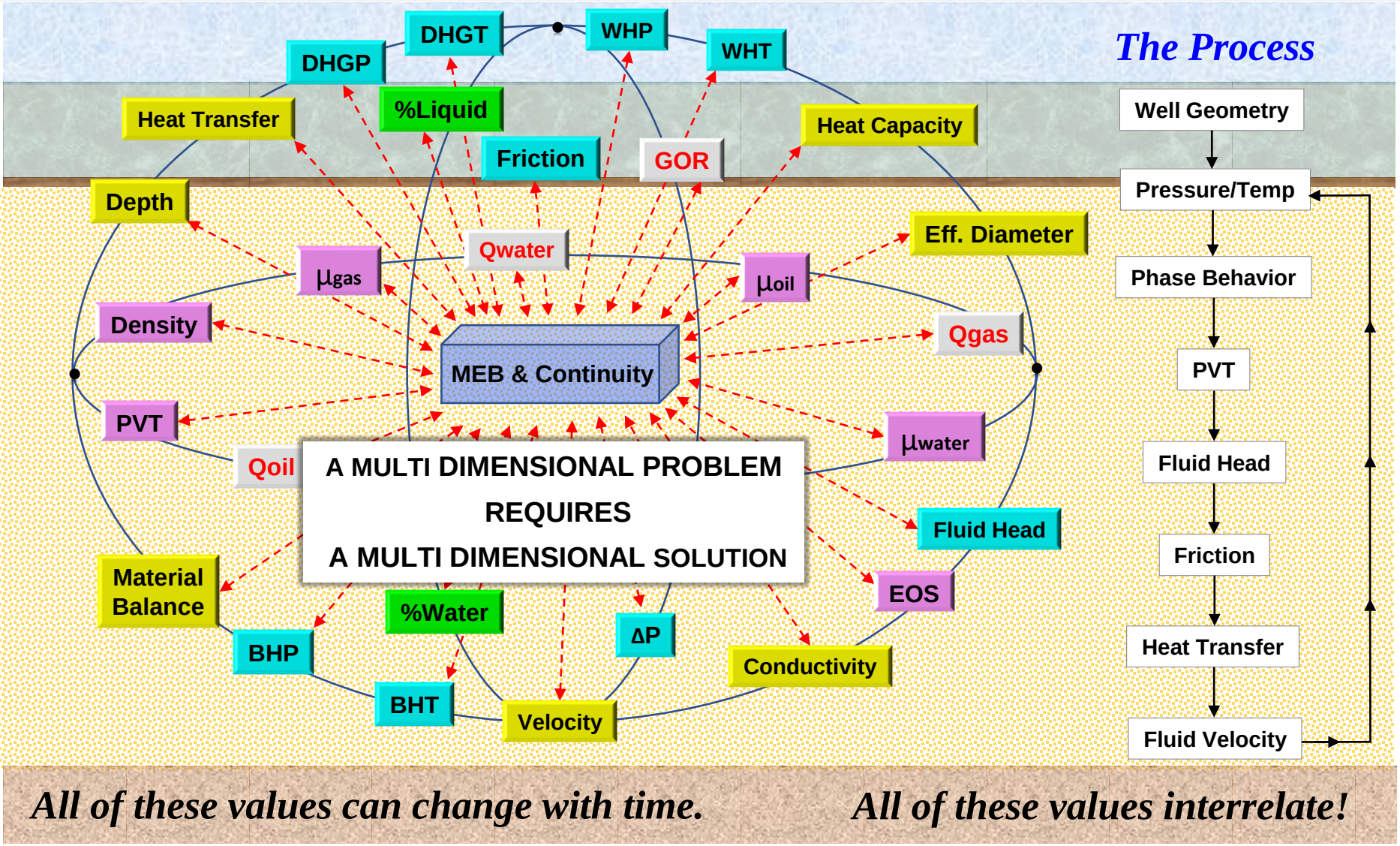
Automation

Spend your time thinking about what the results mean, not just digging for data!

The only existing software based on a direct numerical solution to the Mechanical Energy Balance (MEB) equation

- Does not rely on vertical lift correlations and, hence, it provides more accurate and reliable results (or fails when the well is loading)
- Accounts for dynamic temperature behavior
- Adjusts the fluid properties/PVT accordingly
- Performs wellbore flash calculations to determine the composition of the fluid in the wellbore

ODSI's Wellbore Solution, a Brief Overview



All of these values can change with time.

All of these values interrelate!

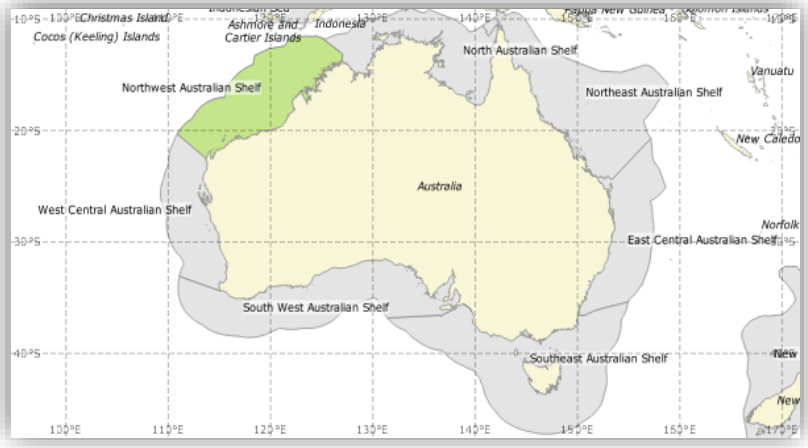
Well Analyzer Automated Real-Time System (ARTS) Features

- 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

Case Study Background

- **NWS Australia - Gas Condensate well (~ 70 bbl/mmcf)**
- Equipped with WHP & Downhole P/T Gauges
- Gas Rate was occasionally measured at a test separator
- Oil Rates @ the test separator were not considered accurate

- **Objectives:**
  - Continuous rate & BHP calculations
  - Demonstrate automated PVT tuning/liquid yield calibration during S/I's
  - Calculate oil rates (Stock Tank Conditions)
  - Demonstrate auto-PTA feature



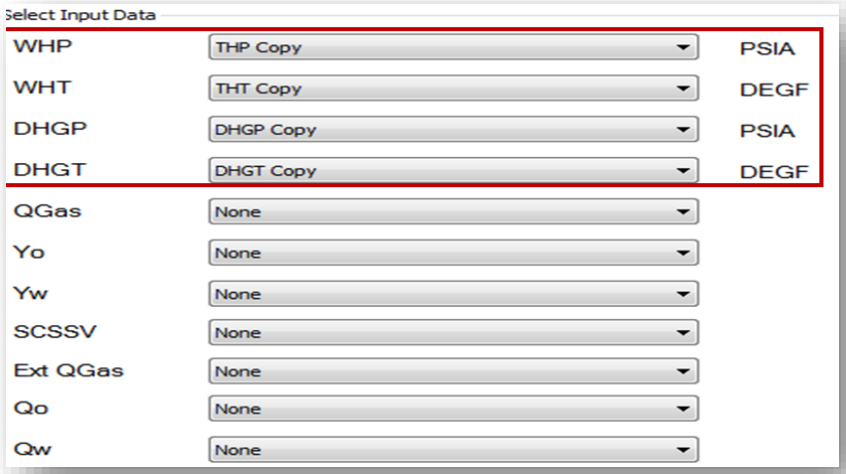
ARTS Input Data

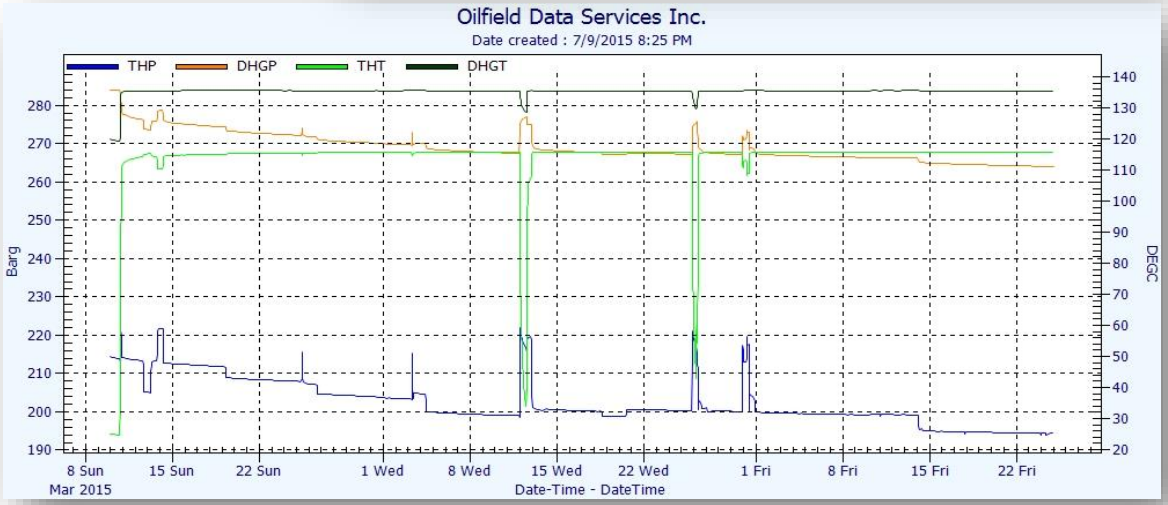
Input Data

- WHP/T
- DHGP/T

Real-Time Outputs/Deliverables

- Gas rate
- Condensate Yield/PVT recalibration
- Mid-completion BHP
- Auto-PTA & Reports



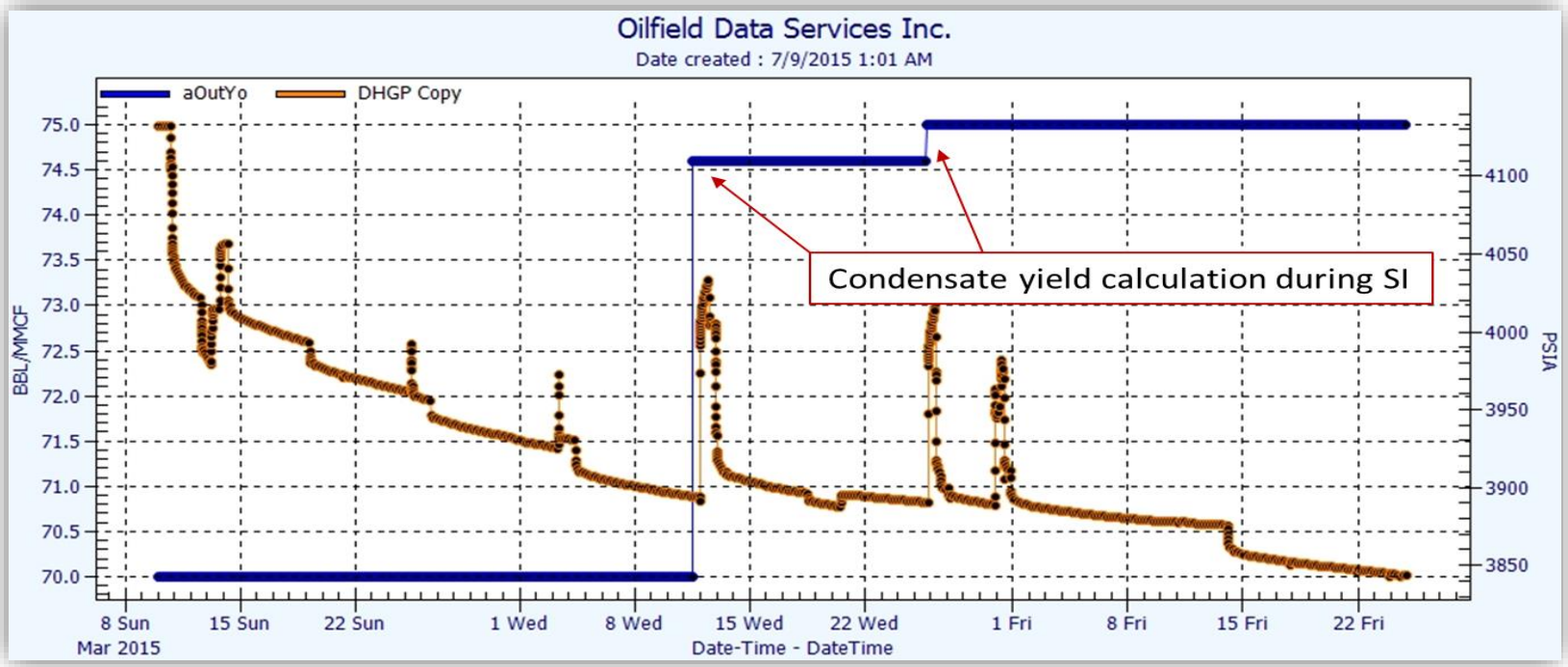


- ✓ Oil & Gas Reservoir Testing and Evaluation
- ✓ Real-Time Pressure Transient Analysis
- ✓ Hydrocarbon Volume Determination
- ✓ Well(s) Performance Tracking
- ✓ Multiphase Rate & BHP Calculations
- ✓ Optimize Gas Lift / Oil Production Rates
- ✓ Life Of Well Surveillance/Analysis
- ✓ Automated PVT Calibration

Oilfield Data Services, Inc.
+1 (713) 521 - 4571 | info@oilfielddataservices.com
Visit: www.odsi-energy.com

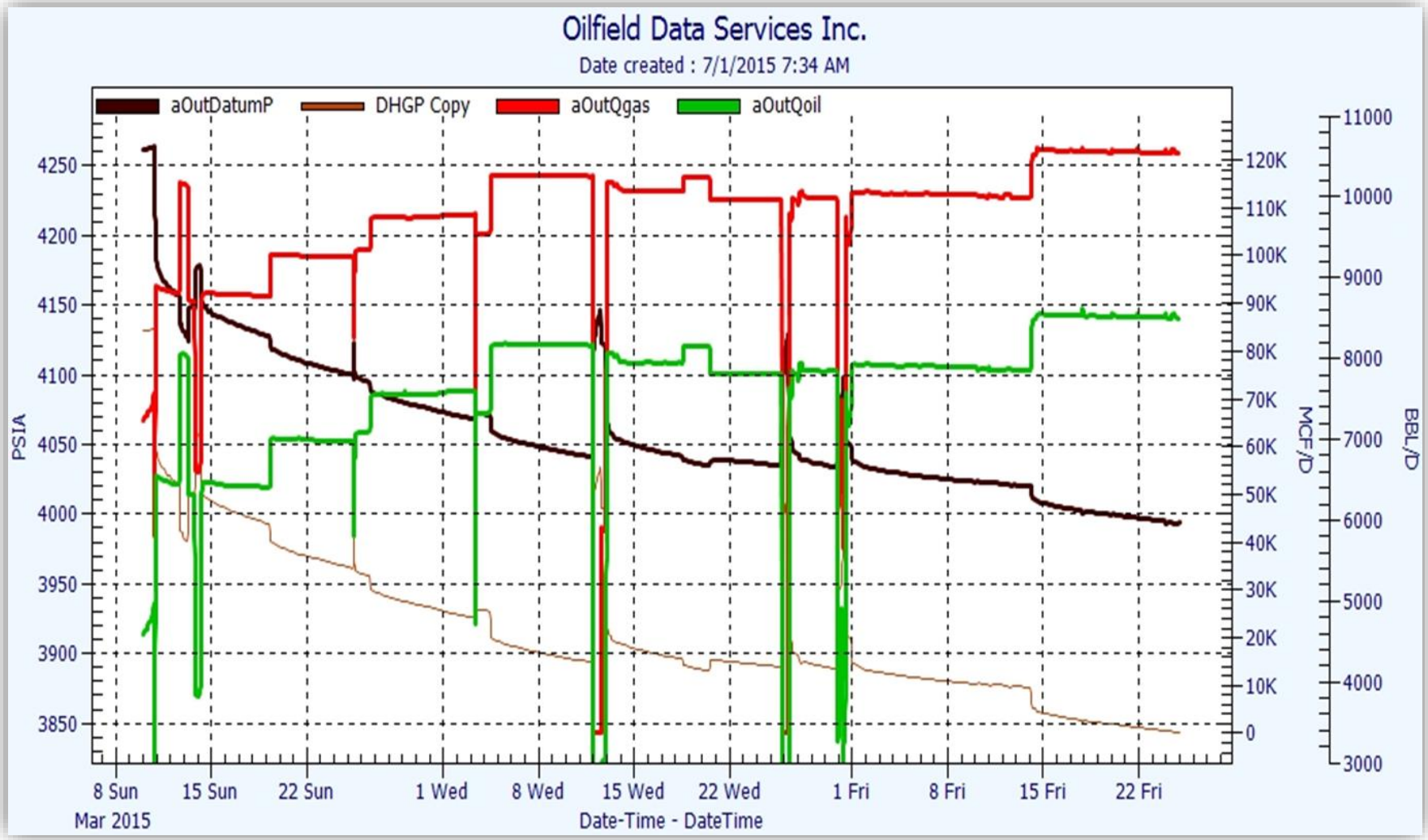
Real-Time Auto PVT Calibration during Shut-ins

- Condensate yield (water cut, gas gravity, oil density) is **recalibrated** during every S/I **automatically** & the rates/BHP are adjusted accordingly



- **Methodology:** Frictional component is zero during shut-in; DP in the wellbore corresponds to the head; That DP during the first 10-15 mins of shut-in (before fluid re-segregation) can be used for PVT/condensate yield/WC re-calibration

Calculated Multiphase Rates & Datum BHP



- ✓ 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

Oilfield Data Services, Inc.
+1 (713) 521 - 4571 | info@oilfielddataservices.com
Visit: www.odsi-energy.com

Gas Rate Comparison: Calculations vs Test Separator

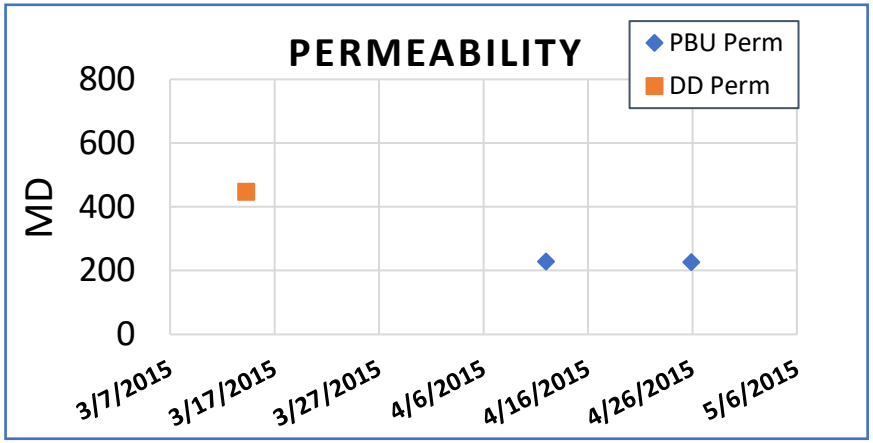
The calculated rates were compared to the sparsely measured separator rates

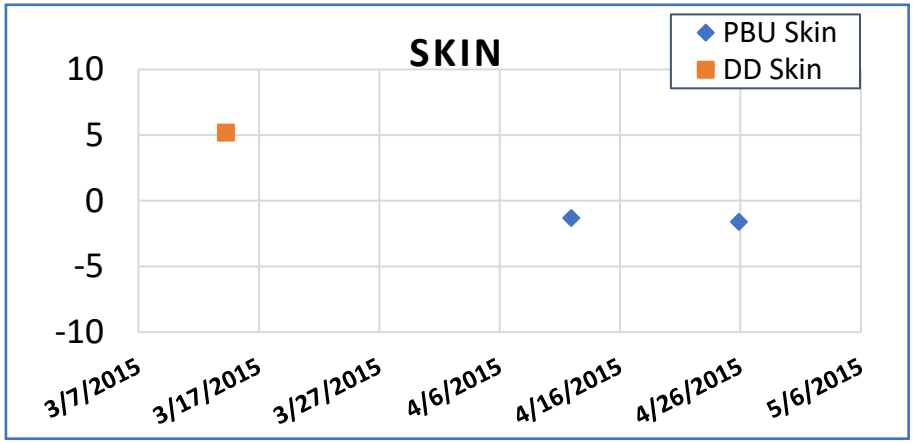
- Good match on the calculated and measured gas rates
- Some of the separator rates were recorded erroneously/changed during the well test

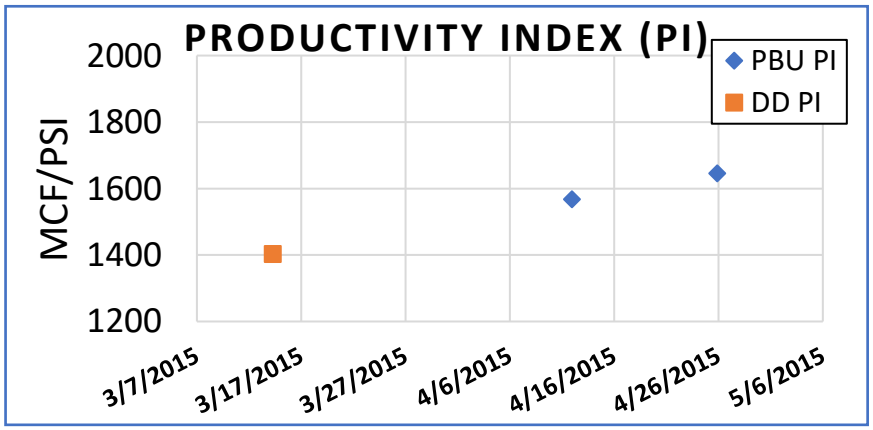
Date (dd/mmm/yy)	Separator Measured Qg (MMscf/D)	Well Analyzer RTS Calculated Qgas (MMscf/D)	Diff (%)
10-Mar-15	92	92.6	0.7
13-Mar-15	115.2	114.3	-0.8
13-Mar-15	90.4	89.5	-1.0
14-Mar-15	60.1	54.0	-10.1
14-Mar-15	93.8	91.5	-2.5
26-Mar-15	105	107.3	2.2
4-Apr-15	107	104.0	-2.8
30-Apr-15	67.1	64.9	-3.3
30-Apr-15	99.6	98.6	-1.0

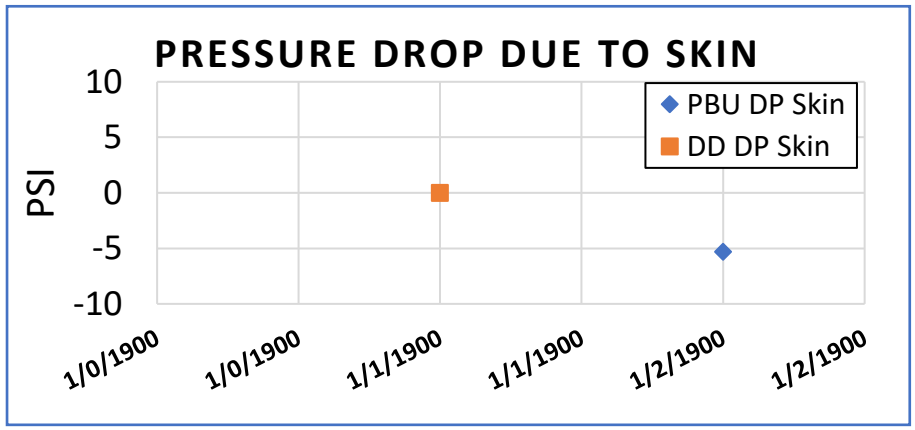
Auto Real-Time PTA & Reports

- WA recognizes new transients in real-time (buildups and drawdowns), analyzes them for skin, perm, Pres/P*, Productivity Index etc. and generates a report for each test and a historic PTA Summary Table & Plots









- ✓ 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

Oilfield Data Services, Inc.
+1 (713) 521 - 4571 | info@oilfielddataservices.com
Visit: www.odsi-energy.com

Real-Time Auto Well Test Example

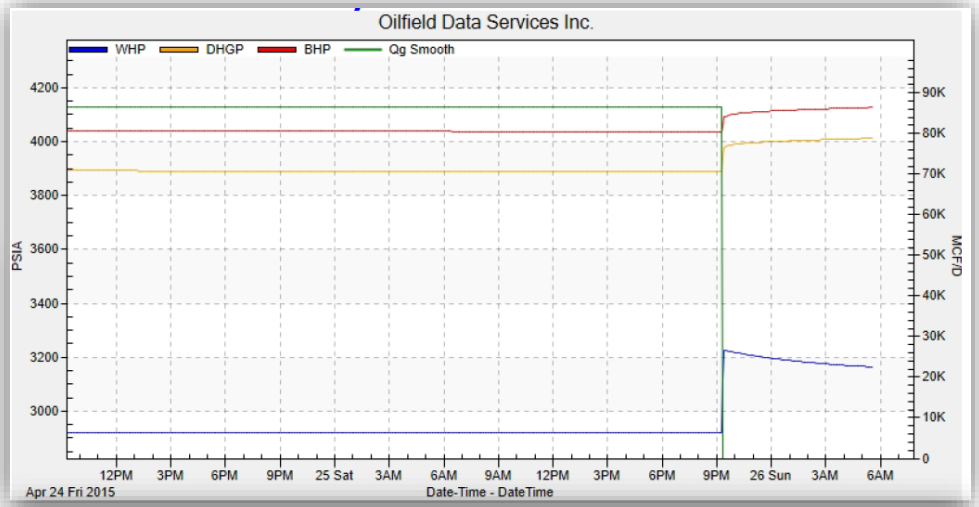
- PTA Summary Table as well as individual well test report is generated automatically for each test
- Note: ODSI's wellbore model is the only existing tool that accounts for phase-thermal effects in the wellbore

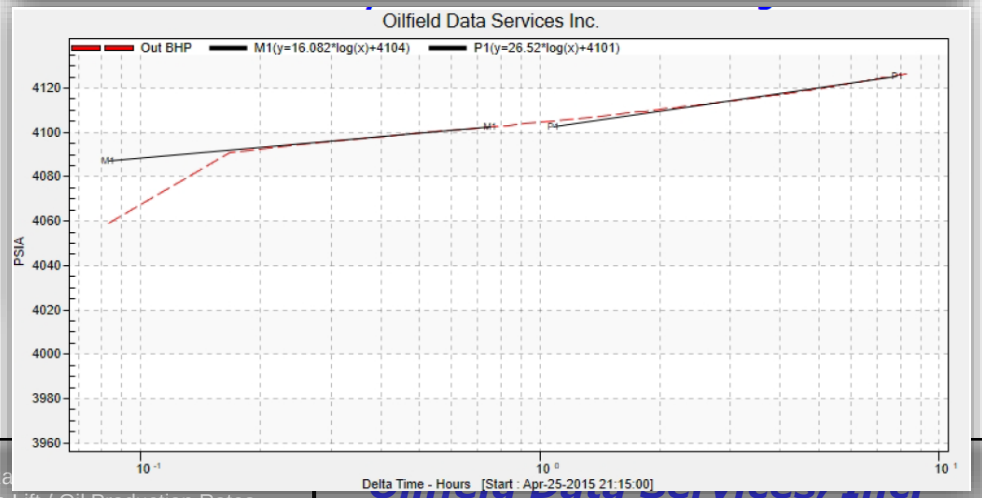
ANALYSIS RESULTS

PBU
Apr/25 - 26/2015

Calculated Reservoir & Completion Properties

SKIN	-2.1	
PRESSURE DROP DUE TO SKIN	-29	PSI
COMPLETION EFFICIENCY	143	%
PERMEABILITY	159	md
RADIAL FLOW PI	1,287.0	MCF/PSI
SKINLESS RADIAL FLOW PI	897.4	MCF/PSI
PERMEABILITY THICKNESS	20,866	md-ft
MOBILITY THICKNESS	766,794	md-ft/cp





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

+1 (713) 521 - 4571 | info@oilfielddataservices.com
Visit: www.odsi-energy.com

Case Study 1 Results & Summary

- **Gas rate** was calculated using pressure drop in the wellbore
  - Calculated gas rate matched measured separator test rates
- Condensate **yield** was **re-calibrated** during shut-ins, and oil rates were adjusted accordingly
  - Auto PVT calibration (density portion of EOS)

- **BHP** was calculated accurately at the mid-completion depth
  - ODSI's wellbore model is the only one accounting for phase-thermal effects in the wellbore
- **Auto transient** recognition in real-time, PBU and DD analysis and **PTA** reports
  - High perm: 200 md – 450 md
  - Low skin: 0 – 5
  - High productivity well: 1400 MCF/psi – 1650 MCF/psi

Case Study Summary

- ✓ Accurate Rate calculation using pressure drop in the wellbore
  - ✓ Gas rate
  - ✓ Oil Rate
  - ✓ Water Rate
  - ✓ Allocation error detection
- ✓ Continuous PVT calibration using shut-ins
  - ✓ Condensate yield
  - ✓ Water yield
  - ✓ Gas gravity

Well Analyzer's Rate and BHP calculations are **based on a direct solution** to the Mechanical Energy Balance and NOT VLP correlations; The solution provides accurate results as it simultaneously accounts for **frictional and PVT changes**

Well Analyzer Automated Real-Time System (ARTS) Features

- Virtual metering
  - **More accurate than MPFM** for 3-phase flow
  - Metered rate validation
  - Detects errors in allocation/meter calibration
  - **Backup** if MPFM fails
- **BHP** conversion (from surface data)
  - Solution for failed downhole pressure sensor
- Automated Pressure Transient Interpretation **(PTA)** of buildups and drawdowns
  - Skin
  - Permeability
  - Avg.Pres/P*
  - Productivity (PI)
- Continuous HC volumes and Mobile HC updates
  - Static and Flowing Material Balance calculations