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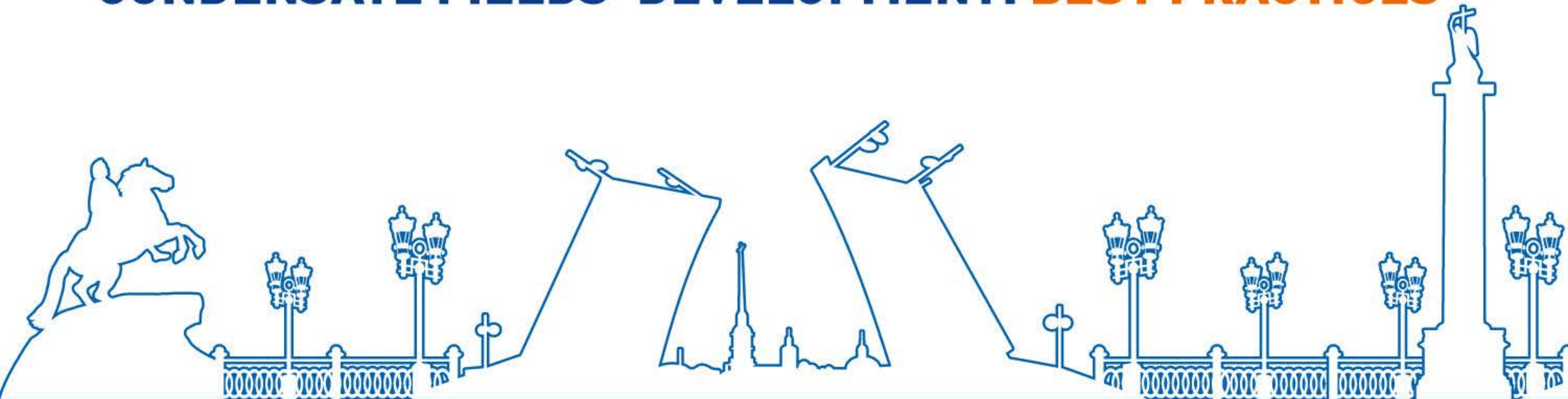
INTEGRATED MANAGEMENT OF OIL AND GAS CONDENSATE FIELDS' DEVELOPMENT: BEST PRACTICES



Integrated Approach To Development Of Low Permeability Reservoirs

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Integrated Approach To Development Of Low Permeability Reservoirs

Low Permeability Reservoirs Represent a Significant Percentage of the Worlds Remaining Reserves

Fluid State is a Critical Element to Well Productivity and Profitability

- Oil Reservoirs with low GOR have high in place reserves but lower productivity
- Dry Gas Reservoirs can have high productivity but lower profitability due to overall world gas pricing
- Condensate Reservoirs can provide an optimal balance of productivity and optimal economics returns

Low Permeability Condensate Reservoirs have traditionally been the most challenging to mange from an operational point of view.

- Condensate Banking
- Liquid Loading
- Low permeability limiting fluid properties equalization over any significant area

Best Practices Can Deliver Optimal Recovery

- Multiple Scenario Reservoir Simulation
- Integrated Planning and Operations asset Team

Topics

Best Practices
- Initialization, Data
- Model Building

Example 1, Identifying Key Governors of Production

Example 2; Impact of Production Procedures

Conclusions

Integrated Approach To Development Of Low Permeability Reservoirs

<u>Critical Best Practices That Can Lead to Optimal Recovery</u>

Capture of Rock and Fluid Data

- Core data, conventional and SCAL
- Fluid Composition and PVT; sampling in low per reservoirs is very challenging
    - Long post frac cleanup impact
    - Low K limits practicality of DSTs
    - Phase separation in wellbore with pressure drop
- Create Equation of State (EOS) Model
    - PVT analyses of components
    - Characterize C 7+
    - Re-combine gas and liquid surface samples either in lab or mathematically

Determine Natural Fracture Network and Representations

Determine Hydraulic Fracture Network and Representations

- Design, Model, Measure

Challenges to Reservoir Simulation

Adequately gridding horizontal wells with multiple fractures

Including natural fractures and discrete natural fracture systems in an already complex model

Availability of adequate PVT data for liquids-rich environments

Selection of optimum stimulation treatment design

Effective fracture length

Fracture conductivity

Effective drainage volume

Optimum fracture spacing

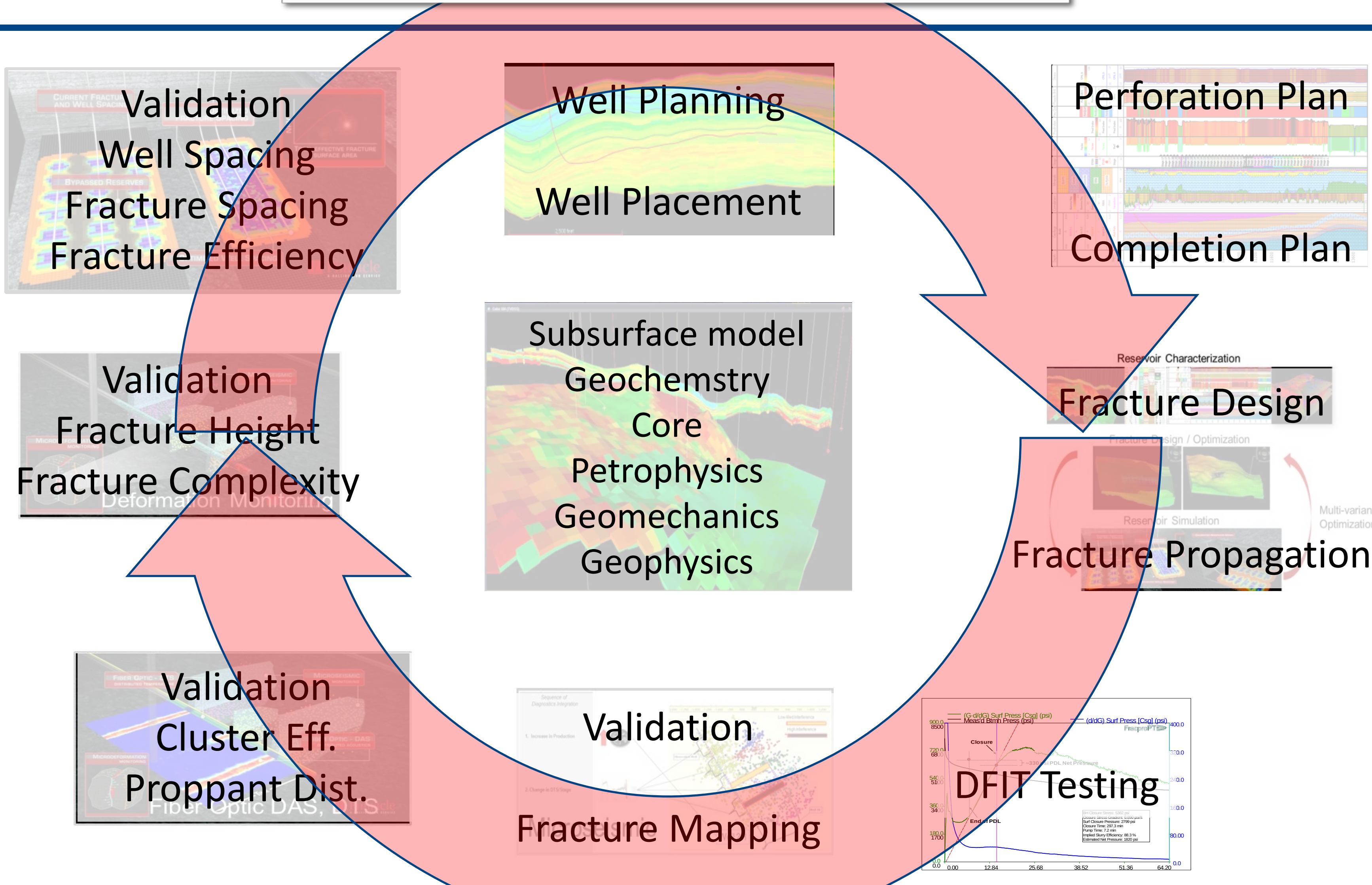
Very low effective reservoir permeability

Complex, multi component reservoir systems

Severe vertical heterogeneity

Significant lateral heterogeneity

Overall Process for Drilling and Completion Improvement



Full EOS workflow

SPE International Northwest Russia Section

SUPPORTED BY GAZPROM NEFT

Source Data

- Well Data
- Fluid Data includes composition, CCE data and seperator data

Lumping of components

- Before tuning EOS lumping was done to reduce the number of components in EOS tuning. The final lumping scheme was 7 components

Trend analysis and sample adjustment

- Generate basic trend lines
- Use production GOR to further tune

Setting up the EOS tuning

- Add the sample to the PVTP and try to fit EOS model to all data
- Each sample has a pseudo component with its own MW

EOS tuning

- Perform the EOS tuning using Tc, Pc and BIC of pseudo components
- Fit one EOS to all the data
- Try to preserve the phase envelope

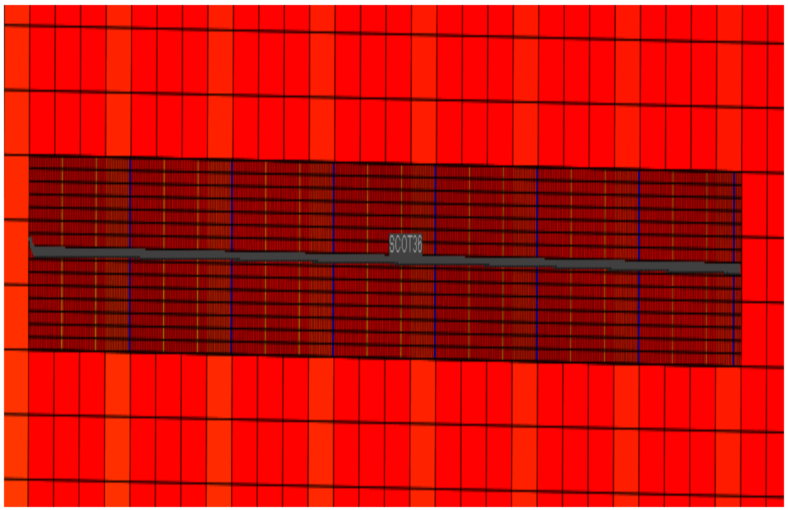
Validity Check

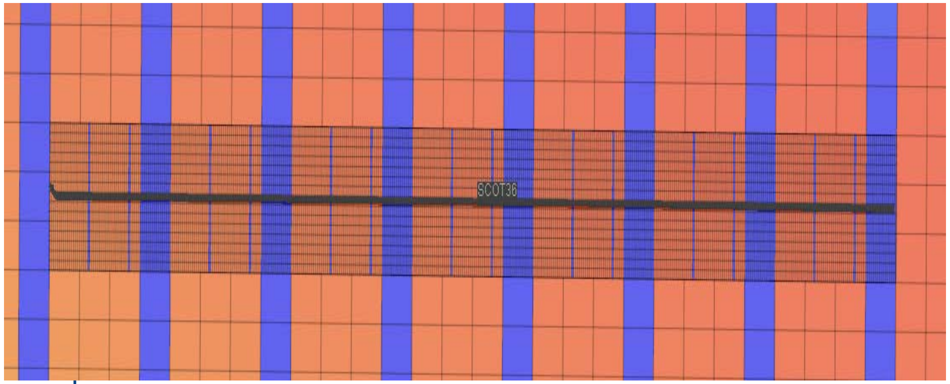
- Run separator tests and compare them with the available data

Well Model Workflow

Setting up the Well LGR

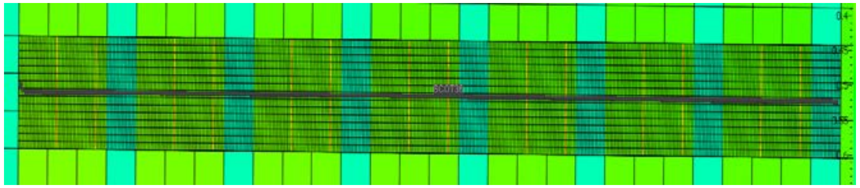
Add the fractures plus the high perm streak in the model and add K and PV mult.





Assign contrasting J Functions to set up the initial saturations

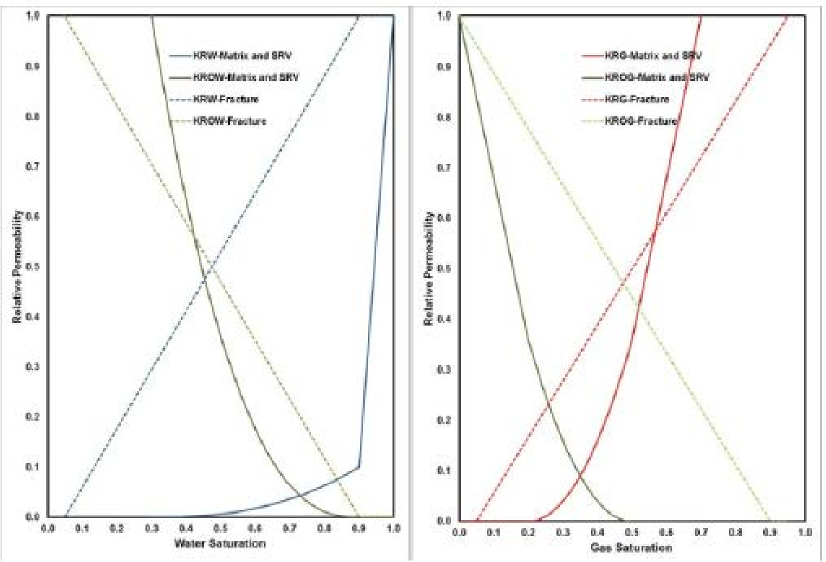
Use the FUNCTION keyword to set up the hydraulic frac perms by using a multiplier



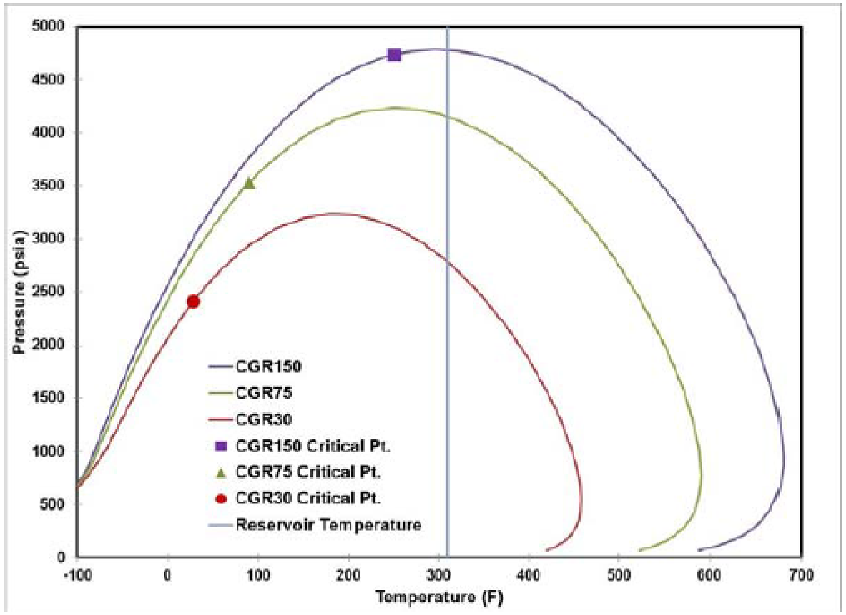
Example 1

South Texas SPE 166177
Completion and Production Strategies for Liquids-Rich Wells in Ultra-low permeability Reservoirs

Input Models



Relative Permeability Curves



Phase Envelopes for 3 Fluid Types

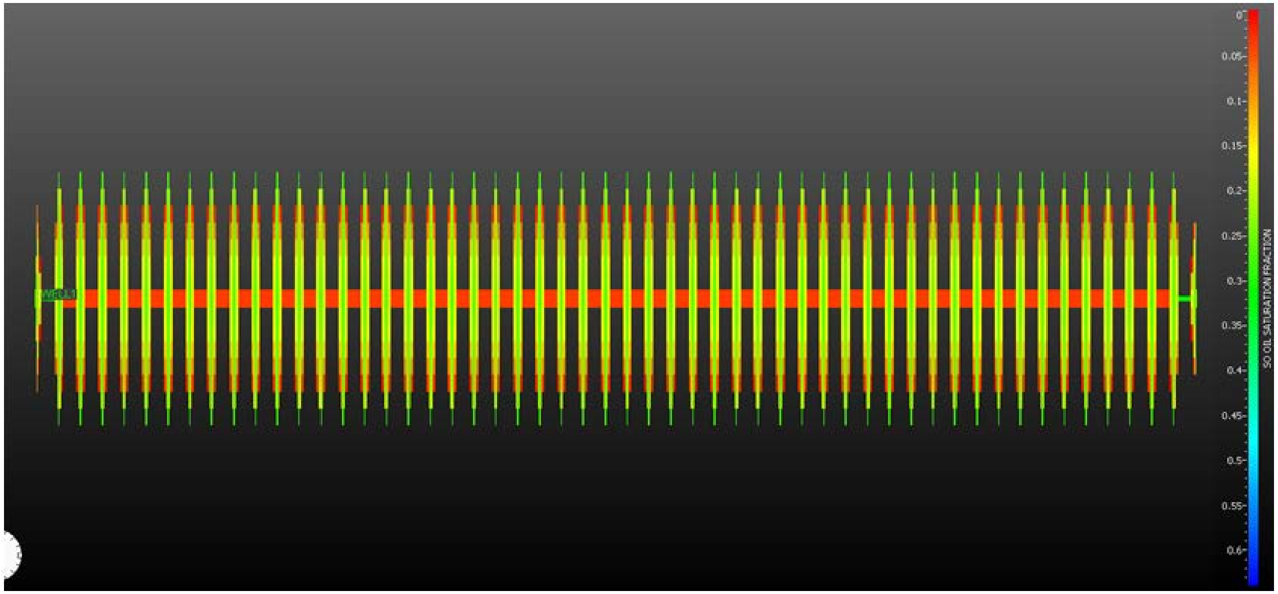
Simulation Variables; Fracture And Reservoir Parameters Considered for Impact on Recovery

Fracture Length, # of Fractures, Fracture Conductivity,

CGR, Matrix Permeability,

Proppant Damage Curves, Minimum BHP

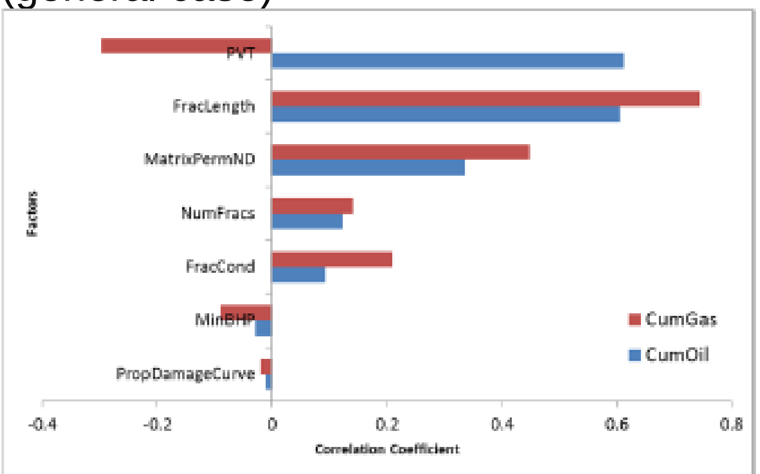
Top view of the hydraulically fractured reservoir showing the oil saturation at the end of 7486 days of production



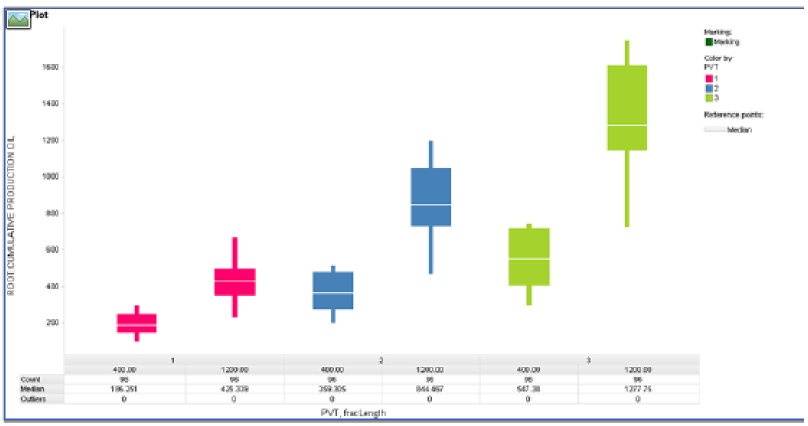
What Are The Most Important Factors Influencing Cumulative Oil And Gas Production

TORNADO CHART FOR ALL THE SIMULATIONS

(general case)



BOX PLOT SHOWING THE DISTRIBUTION OF CUMULATIVE OIL FOR COMBINATIONS OF FLUID TYPE AND FRACTURE LENGTHS



CGR30, CGR75, AND CGR150

FRAC LENGTH 400 FT., 1200 FT.

Example 2

Field X West Texas
Management of Volatile Oil – Gas Condensate Low K Reservoir

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The Fluid Dilemma Field X

Condensate Region

A slight change in temperature conditions can push the fluid above the critical point resulting in a condensate.

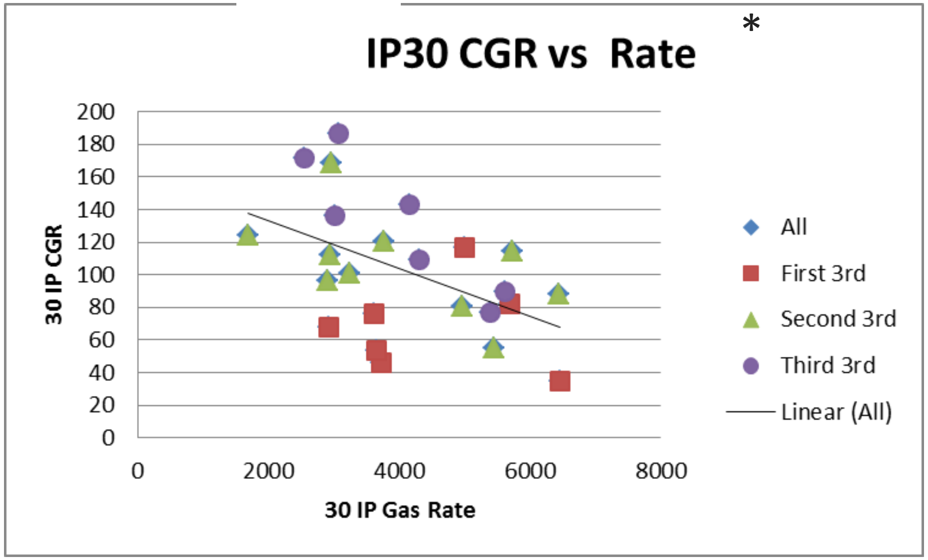
Lumping of the components leads to prediction of a dew point system close to critical point

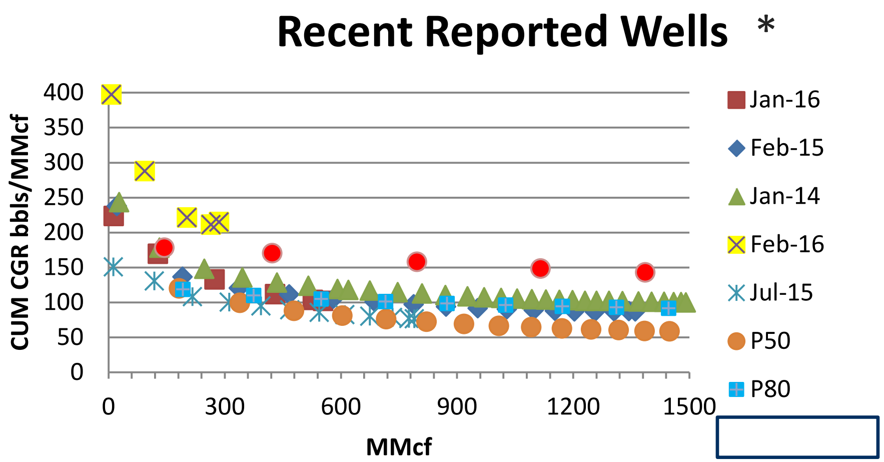
Critical point, reservoir temperature id 165F

Oil Region

Phase envelope shows that at reservoir conditions fluid is volatile oil system being very close to the critical point.

Condensate Yields Can be Enhanced





- Local wells were reviewed by the 1st, 2nd, 3rd third tranches
- The 1st third had low one month CGR regardless of rate
- The 2nd third had improved performance to allow low rate wells (limited drawdown) to have high CGR wells
- The final 3rd of the wells had further improvement in CGRs at low rates
- It is probable that with improved stimulation that wells of 6 +/- MMcfpd can be brought on with CGR's of 150 BC/MMcf
- Local and Offset Operators recent wells indicate much higher CGRs are possible, as high as 600 + MBC
- Drawdown management can be further enhanced with finer spaced & larger stimulations

* *From Public Data*

Conclusions

Optimal Development of Low Permeability, Condensate Reservoirs Requires and Integrated Planning and Delivery Team

- Co-location!
- Capture of needed rock and fluid data
- Integrated static, geo-mechanical, and dynamic modeling
- Evaluation of multiple well completion and frac design scenarios
- Translation of modeling into field procedures
  - Flow back
  - Drawdown / production rate management
  - Lift (if needed)
- Updating of the model through depletion phases

Thank You !