Hydraulic Fracturing in HPHT and Differentially Depleted Tight Gas Accumulations in Horizontal and Highly Deviated Wells

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Discussion Outline

• Framing The Challenges
• Why Horizontal Wells with Transverse Fractures?
• Transverse fracture propagation - What we observe?
• Hydrocarbon production – How these transfers fracture perform?
• Defining Strategies
• Observations
Framing The Challenges

- Ultra HP/HT
- Extreme HP/HT
- HP/HT
- Standard

Pressure:
- >20K psi (138 MPa)
- >15K psi (103 MPa)
- >10K psi (69 MPa)

Temperature:
- >300°F
- >350°F
- >400°F
- >150°C
- >175°C
- >200°C
Why Horizontal Wells with Transverse Fractures?
Transverse fracture propagation - What we observe?
Transverse fracture propagation - What we observe?

Horizontal Well

Induced fracture channels

Ketterij et al

\[ \sigma_{h,\text{min}} \]

\[ \sigma_{h,\text{max}} \]

\[ \sigma_{\text{vert}} \]
Transverse fracture propagation - What we observe?
Transverse fracture propagation - What we observe?
Transverse fracture propagation - What we observe?
How these transfers fracture perform?
How these transfers fracture perform?
How these transfers fracture perform?
How these transfers fracture perform?

Pressure

80% of total drawdown

Pres

BHP

Horizontal Well

Pd = Perpendicular distance from the well into the formation
How these transfers fracture perform?

\[
\nabla p = -\frac{\mu}{K} v_f - \beta \varrho_f v_f^2
\]

- Formation Matrix
- Non-Darcy coefficient
- Fluid viscosity
- Fluid density
- permeability
- Flow velocity
- Fracture
- Matrix
- Perforation
- Well
How these transfers fracture perform?

Estimated flow capacity
How these transfers fracture perform?
How these transfers fracture perform?

% Inflow Contribution

Detected Flow behind Liner

Observed flow capacity

Estimated flow capacity

H-Length
Defining Strategies

Flow Capacity

Zones and perforation strategy
Defining Strategies

Comprehensive integration of static and dynamic data

3D Grid Visualization Block

Comprehensive integration of static and dynamic data
Observations

- **Combined reservoir Characterization**, detailed fracture propagation modeling and diagnostic strategies were essential to **Increase Understanding** and orient subsequent drilling, completion and fracturing strategies.

- **Micro-seismic** monitoring proved to be essential to assess transverse fracture propagation behavior and **Reduce Uncertainties** during evaluation of the implementation.

- Fracture **Diagnostics** was **Enhanced** by the combination of **Microseismic** data with **Production Logging**.

- Observed **Fracture Complex Paths** created near wellbore and the partial well to fracture connectivity, significantly effect the **Pressure Losses** as gas expand and contract during the flow from the matrix to the fracture and finally into the wellbore.

- A **3D visualization** data approach provides a new dimensions for the selection of horizontal well locations to honor the identified parameters associated with **Enhanced Fracture Placement and Deliverability**.