Alternatives to Cased-Hole Completions in the Gulf of Mexico

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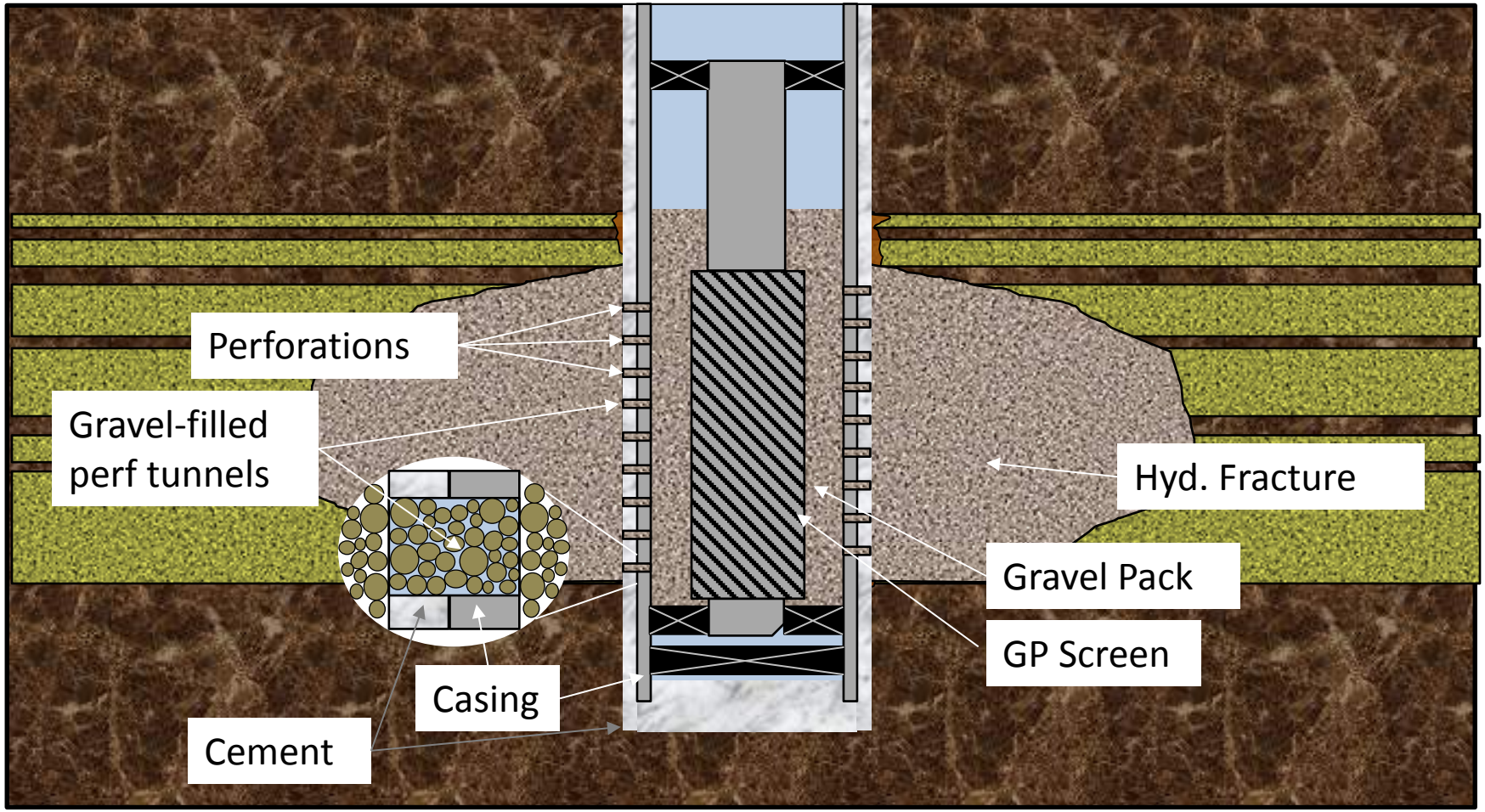
Overview

- Why cased-hole techniques are so common in GoM
- Features of typical cased-hole completion
- Performance limitations of cased-hole completions
- Features of typical open-hole completions
- Why OH techniques are attractive and gaining consideration
- Application of OH completion techniques in 3 GoM environments
- Summary

Why Cased-Hole Completions are So Common in GoM?

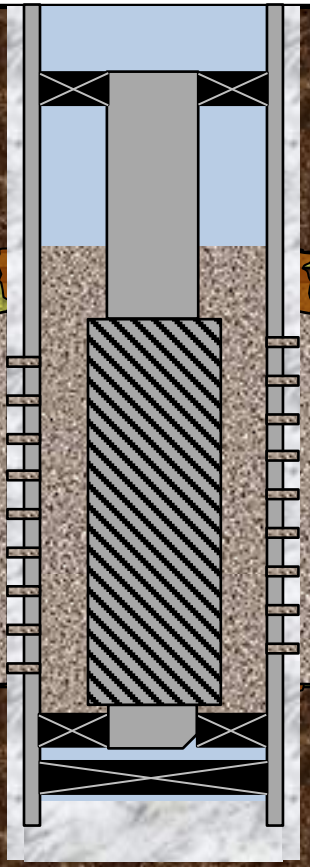
- Multiple, stacked pay zones requiring isolation from each other
- Wellbore instability, case-off weak zones as soon as possible
- Low K_v in turbidite/laminated formations limits production enhancement potential of openhole horizontal wells (vs. fracturing)

Features of a Typical Cased-Hole Completion



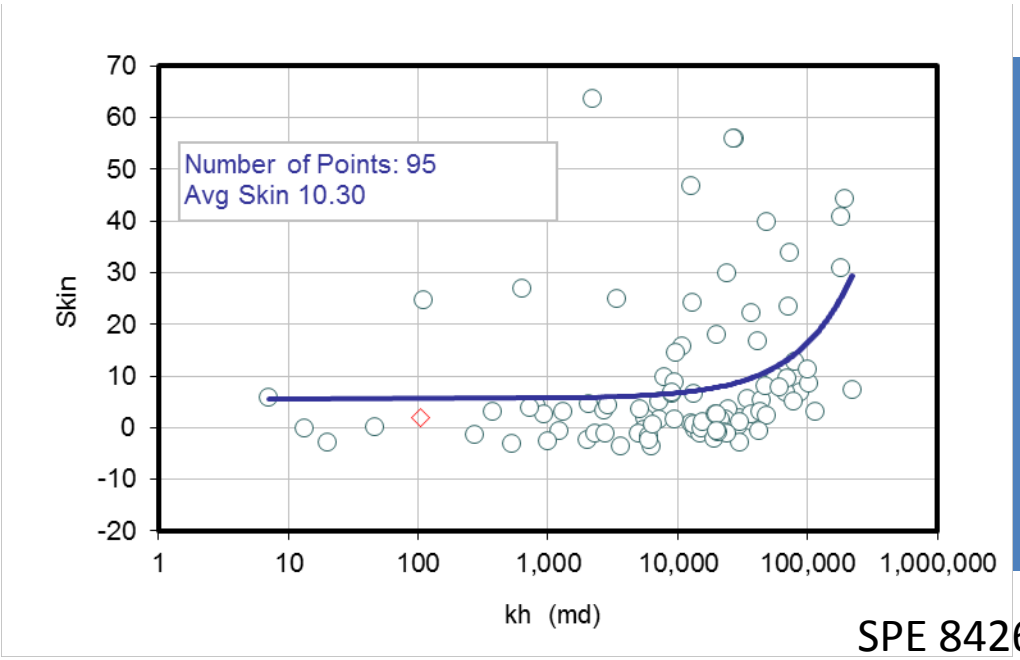
Features of a Typical Cased-Hole Completion

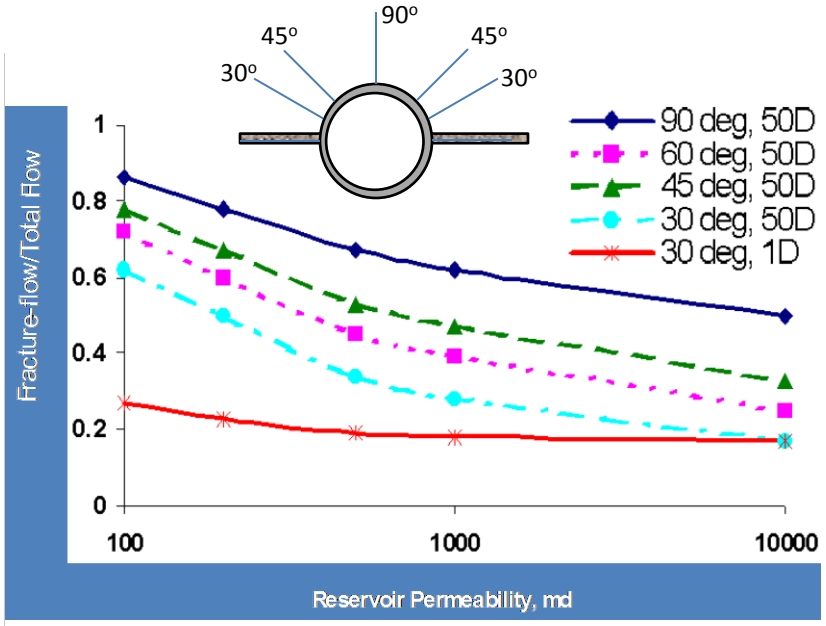
- Drilled with same mud as overburden sections (i.e. barite-weighted SBM)
- Cased & cemented
- Displace to comp. fluid
- TCP Perforated
- Run downhole tool system
  - Screens & blank
  - Fluid-loss control device
  - SC Packer/Service tool
- Pump gravel- or frac-pack treatment
- Reverse out excess slurry
- POOH, activate FLCD



- Mud not always designed to avoid formation damage
- Formation becomes sealed off
- Wellbore/reservoir connection is by way of perforated casing & cement sheath
- Hydraulic fracture to bypass near-wellbore damage
- Screen with annular gravel-pack to filter formation sand
- Perforation tunnels are not open-channels, but are instead packed with gravel
  - Source of ΔP

Performance Limits of CH FP/GP



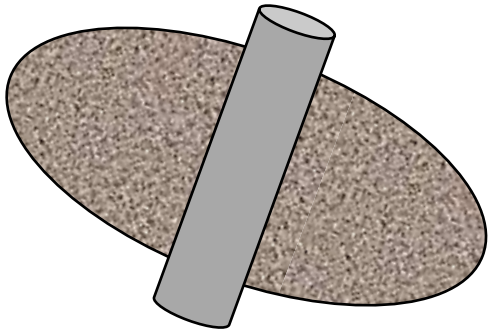


SPE 84263

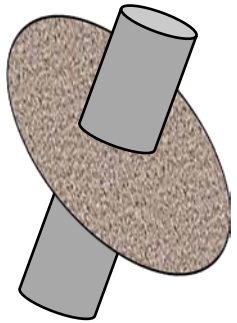
- At high *kh,* FP can have high skin, despite presence of hydraulic fracture
- High reservoir deliverability →perf tunnels choking effect more pronounced
- Also, high reservoir deliverability, more contribution from perforations that are not directly connected to the fracture (i.e. radial-flow contribution as high as 40% of total flow)

Additional Concerns

- Stacking completions across multiple zones
- Treating long-intervals, achieving full reservoir contact and complete annular gravel-packing
- Poor wellbore/fracture connection due to fracture plane misalignment

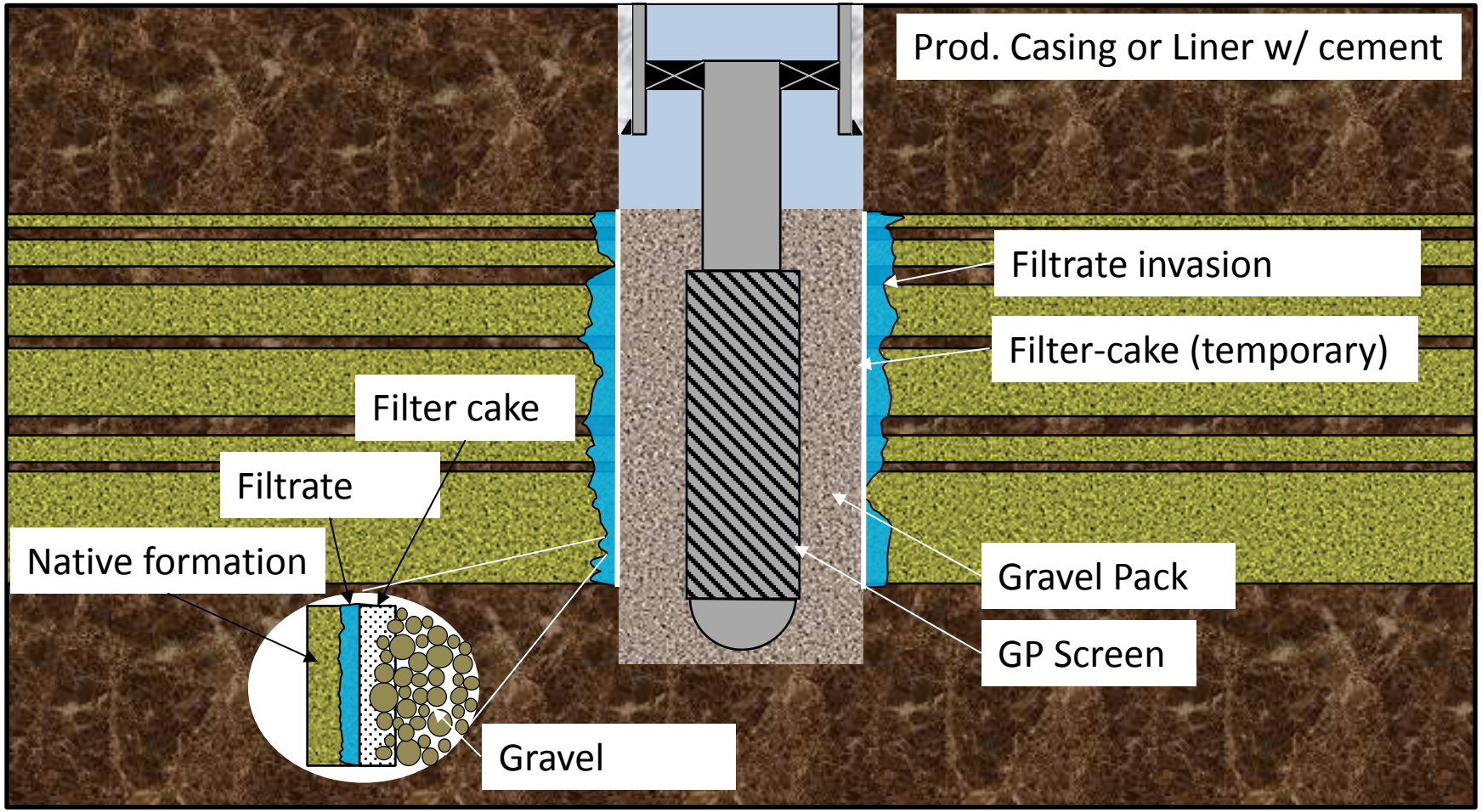


Good!



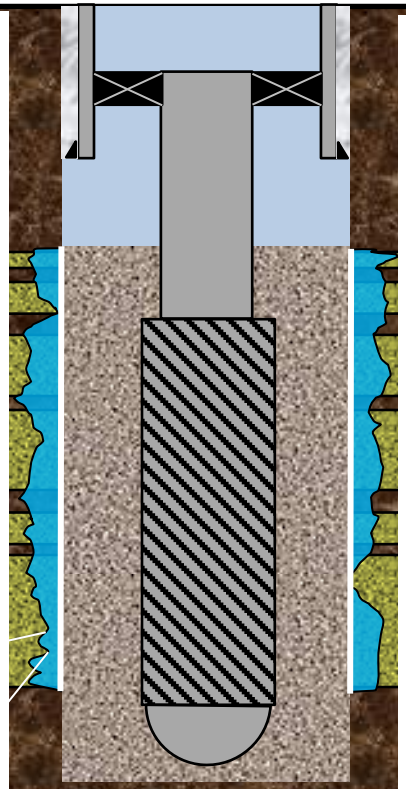
No So Good

Features of a Typical Open-Hole Completion



Features of a Typical Open-Hole Completion

- Drilled with dedicated reservoir drill-in fluid (RDF or “DIF”)
- Various displacement/fluid swap sequence options
  - Generally want to end up with Comp. Fluid in cased-hole above & non-screen-plugging fluid in open-hole
- Run downhole tool system
  - Screens & blank
  - Fluid-loss control device
  - SC Packer/Service tool
- Pump gravel-pack treatment, if not a standalone screen (SAS)
- Reverse out excess slurry
- Pump filter-cake breaker
- POOH, activate FLCD

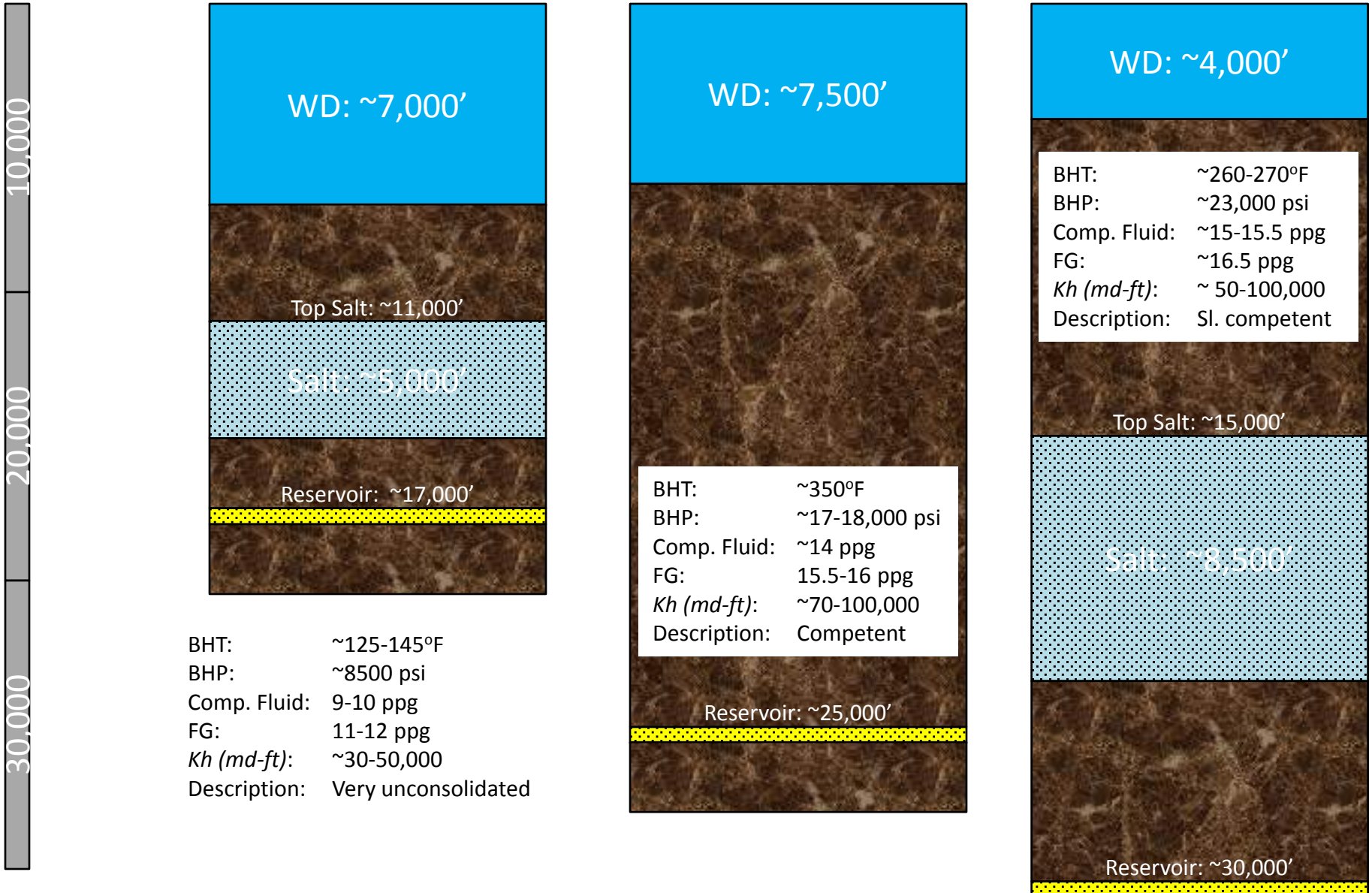


- Drilling fluid specifically designed to minimize/avoid formation damage
- Formation becomes sealed off temporarily with removable filter cake
  - Dissolvable
  - Lift-off & flow-thru during production
- Reservoir connection is by way length of wellbore in zone
- Screen with annular gravel-pack to filter formation sand
- Radial pressure losses thru
  - Filtrate-invaded zone
  - Remaining filter-cake
  - Gravel-pack residual damage

Why OH Techniques Are Attractive?

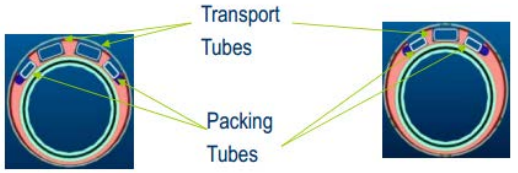
- Simplicity
  - Time savings of one less casing/cementing operation
  - Fewer trips (no TCP runs, blanking plug retrievals in multiple zones)
- Productivity
  - Properly designed & executed OH completions can rival CHFP in terms of skin factor and productivity
- Necessity
  - MW window/casing program limits hole size at TD
  - Some reservoir conditions pose difficulty to fracturing

Application of OH Techniques in GOM



Case “A”

- Zero-tolerance for sand; ruled-out SAS
- Pressure Window (FG-hyd) ~1,000-1,500 psi
  - Generally adequate for alpha-beta waterpack, but…
- Major concern: Extremely weak formation
  - Washout and filtercake erosion, HRWP is risky
  - Low-pump rate gravel placement dictates viscous carrier
  - Risk of wellbore collapse or bridge-off
- Alternate-path or “shunt-tube” design



Case “B”

- Competent rock, SC added as ‘insurance’
- Gravel-packing could be achieved with HRWP
  - Adequate pressure window
  - Low risk of filter cake erosion or washouts
  - SAS selected (low sanding risk, but also for filtercake removal concerns if gravel-packed)
- Very high temperature limits options for RDF
  - Usual components of polymers & starches…
    - Those that hold-up at temperature are hard to break
  - Considered use of high-solids-content DIF (i.e. insolubles)
  - Developed WB DIF using synthetic polymer & breaker
  - Filtercake cleanup by way of flow thru screen & breaker action

Case “C”

- Consolidated rock, however depletion plan likely to lead to later-life sanding, GP preferred over SAS
- Deviated, but not horizontal wells, gravel placement by water packing (non-alpha-beta, not as much limited by pressure window)
- High completion fluid density (>15 ppg) and use of $ZnBr_2$ limits fluid options
  - Potential adverse reactions between DIF components and Zinc
  - $CaBr_2$ based system avoids incompatibilities, gives good clean-up,

Summary

- When Cased-hole frac-pack techniques have reached their limits…
- OH completion techniques can be viable, even in most-challenging conditions
  - Correct application selection
  - Proper design and planning
  - RDF selection and clean-up methodology
  - Displacement sequence/wellbore preparation
  - Execution

Additional Info

- Burton, R. C., & Hodge, R. M. (2010, January 1). *Comparison of Inflow Performance and Reliability of Openhole Gravel Packs and Openhole Stand-Alone Screen Completions.* SPE 135294
- Morales, R. H., Profinet, J., Piedras, J., Gadiyar, B., & Harris, S. (2003, January 1). *Optimization of Frac/Pack Completions Based on Field Experience.* SPE 84263-MS
- Parlar, M., Tibbles, R. J., Gadiyar, B., & Stamm, B. (2016, March 1). *A New Approach for Selecting Sand-Control Technique in Horizontal Openhole Completions.* SPE 170691