Pursuing OHGP in Deepwater GoM

Miocene Type Formations

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Main drivers

- Non-optimal CHFPs seen in deepwater GoM Miocene type sands
- Good experience from other areas
- Less complex than FP
- Sufficient permeability in Miocene type sands
- Significant CAPEX savings

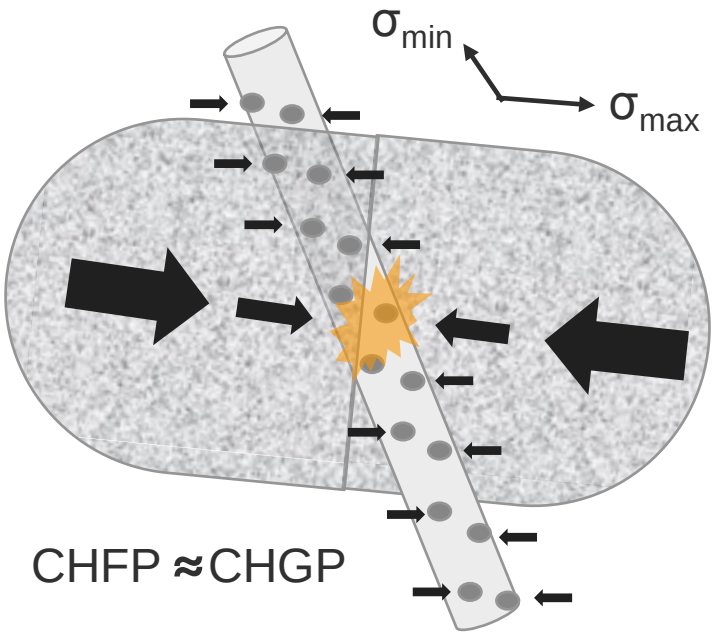
Challenges with CHFP

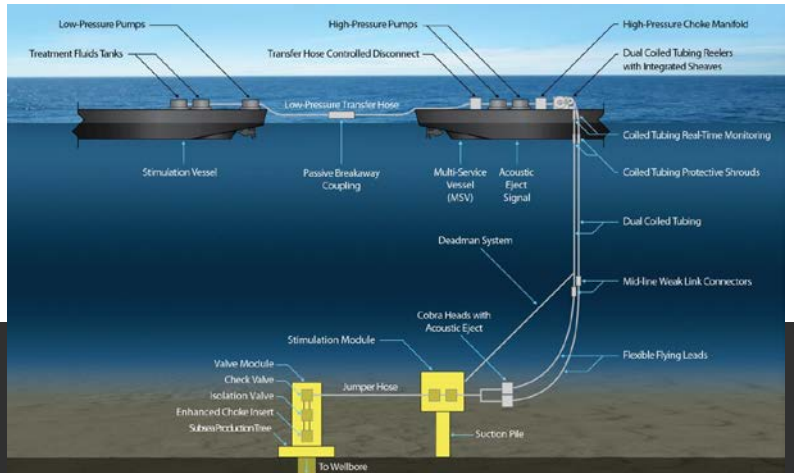
Fracs not connected to the wellbore

- Unknown stress regime below and near salt
  - Inefficient cased hole frack packs
    - Frac planes not connected to the wellbore
    - Perf plugging

➔ Consequences:

- Frequent acid treatments
- Costly mech interventions wit non-optimal remedial solutions
- Sidetrack and re-completion

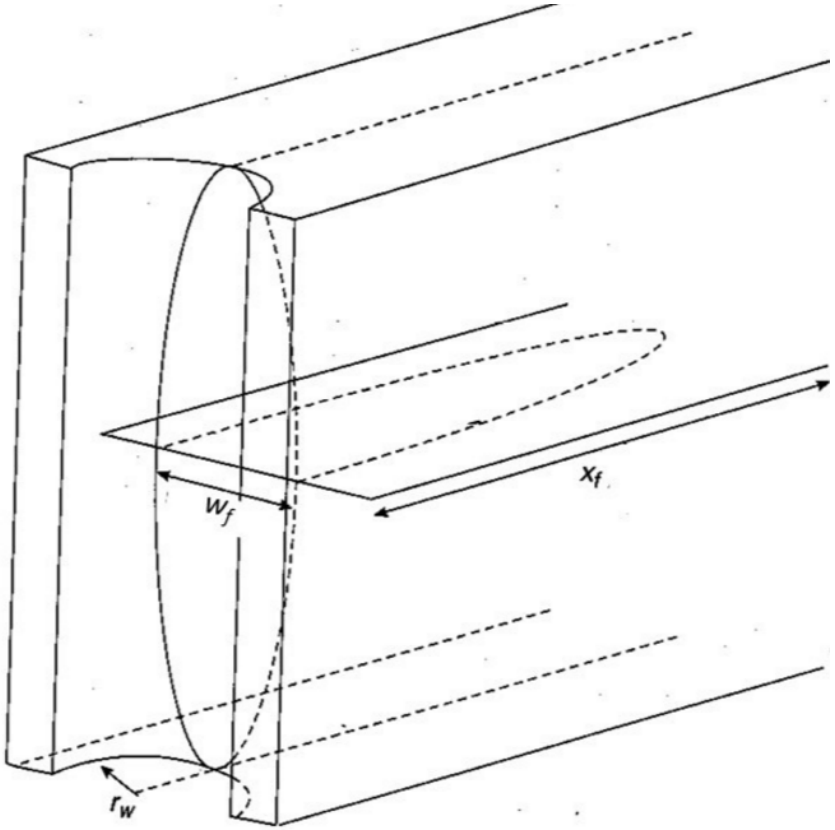




Challenges with CHFP

Achieve wide conductive fracs

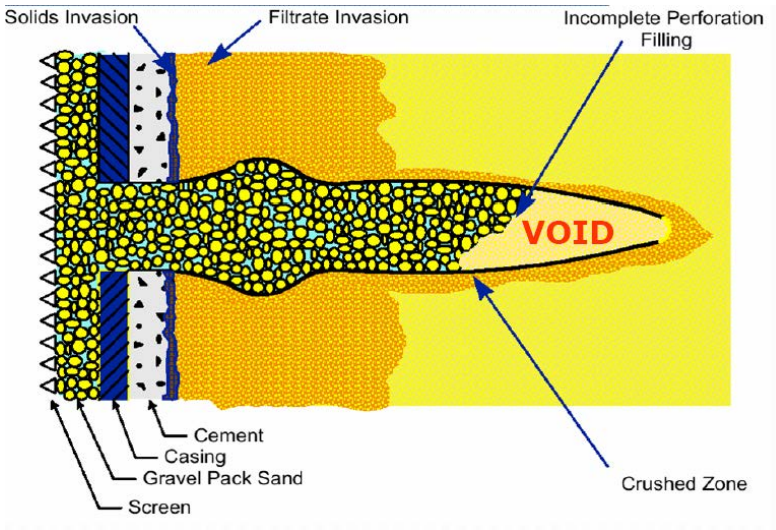
- Controlled leak-of
- Controlled fracture propagation
- Achieve ‘tip screen out’
- Create P_{net} = width
- Maintain P_{net} while placing a solid proppant pack around screens

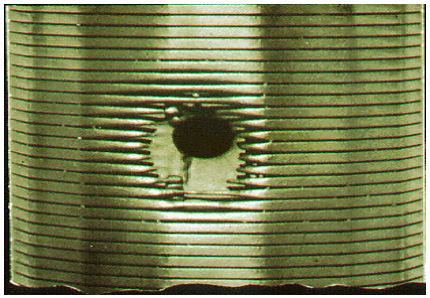


Challenges with CHFP

Plugging of perf tunnels and risk of eroding screens

- Poor proppant packing of perfs not connected to frac
- Mixtures of fines/sand and proppant combined with high flow velocities
- Only 1 % of the total casing area is open to flow.
  - Velocity through the perforation channels is 100 times the velocity on the wall of an open hole
  - High ΔP ➔ high erosion risk from hot spotting on screens





Why pursue OHGP
Facts (Claims)

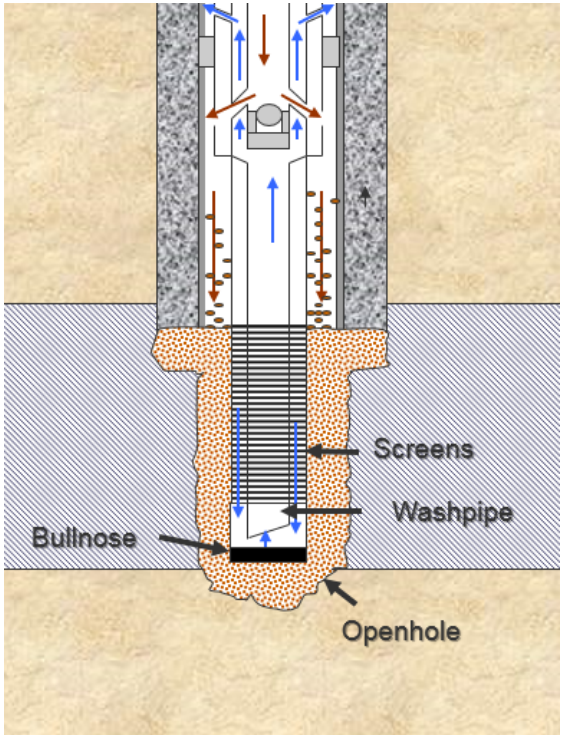
- Better sand control as annular pack quality improved with low-viscosity carrier fluid
  - Sand control more important than stimulation in Miocene
- No perf tunnels to collapse
  - Perf issues potential contributing factor to PI degradation
- No perf tunnels to plug
  - Plugging ➔ erosion
- Reduced near-wellbore flow velocity
  - Helps prevent fines transport
- No risk of fracturing into water bearing zones
  - Still might be a challenge to isolate them

One more…

"The benefit of a semi optimal -2 to 0 skin fractured completion (rarely achieved in Miocene) compared to the expected skin of +3 (0 to 6) for an OHGP might even be insufficient to cover the higher cost for the fractured completion"

Candidate targets for OHGP
Some limiting factors

- Lower pressure wells = less dense fluids
- Single pay zone preferred
- Lower angles (< 50 deg)
- Limited and stable shale sections
- Geological marker above target to select casing shoe
- Limited depletion reducing risk of formation damage during drill-in



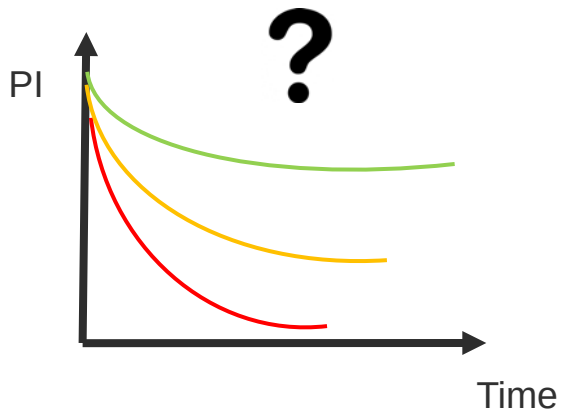
OHGP Challenges

- High density fluid requirement
  - Minimal formation damage from drill-in (desired: 60-80 % return perm)
  - Acceptable rheology, stable, shale compatible, …
- Achieve efficient and stable drill-in filter cake
  - Compatible with completion fluids
- Stable hole required for a significant time
  - Screen installation restrictions
  - Proppant placement

- Limited hydraulic window
- Limited losses required

} Vertical / Horizontal GP pattern

Unknowns
Yet to be proven



- Skin and PI development over time

- Longevity of OHGP completions
  - George King Database (SPE 84262) suggests CHFP is superior
    - Deeper analysis discovered that the FP database is skewed to lower rate wells (i.e. GoM Shelf – that may not be producing enough to produce sand in the first place).
    - Similar failure rate when sorting the database for higher oil rates

- Robust fixes when sand control failure
  - Side track and re-completions likely the only long term solution as with CHFP

Procedural overview

- Screens run in screened mud, brine or dedicated screen running fluid
  - Relying on the drill-in filter cake for little/no losses
- GP packer set and GP tool released
- OH (and casing) displacement
- Proppant placement
  - Vertical (<50):
    - Less hydraulic window and low rates required (~3 bpm)
  - Horizontal (>70):
    - Wider hydraulic window and higher rates required (~6 bpm)
- Fluid loss valve closed while POOH with wash pipe
  - Limit losses and barrier

‘’Heaps of alternatives”

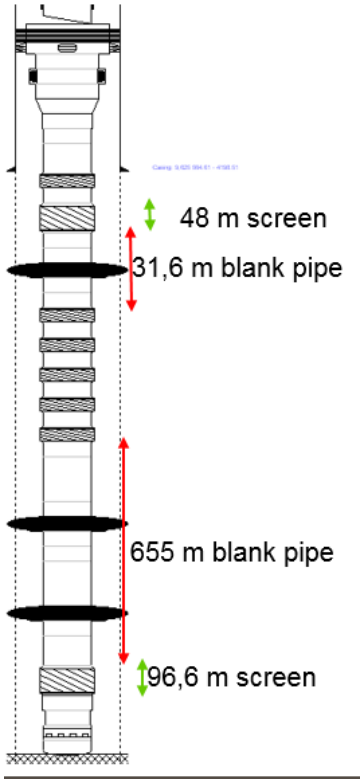
Equipment and rig up
All skid based!

- Low HP requirement
  - Single high pressure pump
- Low volume requirement, though mabye more fluid types
- Low proppant requirement
  - Single silo
- Proppant mixer, centrifugal feeder pump, rig floor manifold, etc
- Normally no fluid blender needed

Typical NCS spread

Options combined with OHGP

- Zonal isolation
  - Swell packers
  - Proppant
  - Blanks
  - Screens with mechanical sleeves
- Smart completions
  - Hydraulically operated via inner string
- Combined with (Autonomous) Inflow Control Devices ((A)ICD)
- Combined with Multi Lateral Wells (MLT)



NCS example: 100 % OHGP efficiency

Main takeaways

- Hard to get CHFP right in some deepwater GoM targets…
- OHGP **skin and PI** might be **sufficient**!
- OHGP is **not that complicated!**

- High density drill-in fluids with **limited formation damage** getting available!
- OHGP is relatively **cheap!**


Thank you!