

Multistage Annular Fracturing

BHI OptiPort combined with Optifrac
SureSet enables 49 frac stages, with over
3 million pounds of proppant placed in
record time!



Multistage Annular Fracturing

- Agenda:
 - Optifrac/SureSet Overview (Video)
 - Challenges of annular fracturing
 - 49 Stage Barnett Shale frac obstacles
 - Questions?



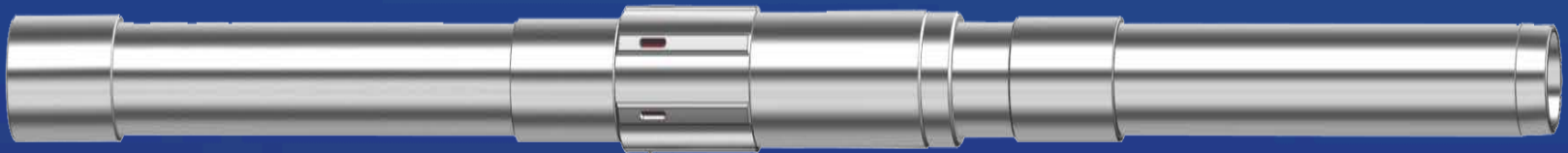
Multistage Annular Fracturing

- BHI Optifrac SureSet BHA
 - Coiled Tubing Conveyed Annular Fracturing BHA
 - Features include:
 - Hi clearance BHA - 0.4" (10mm) on diameter
 - On board abrasive perforator
 - Mechanical CCL
 - Hydraulic operation, fail safe design
 - Multiple casing sizes/weights

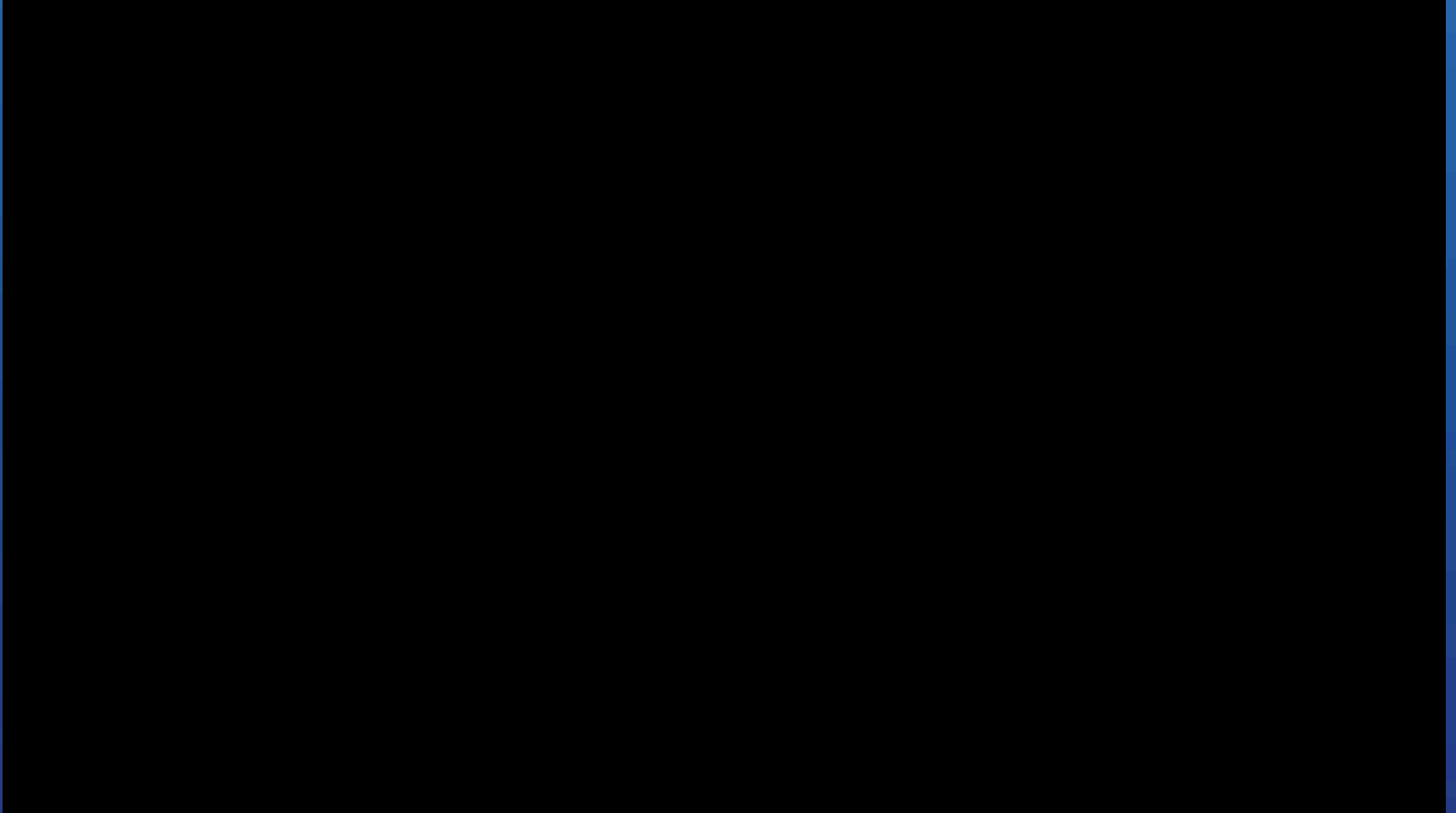


Multistage Annular Fracturing

- BHI OptiPort
 - Sliding sleeve frac port
 - Run with the casing/completion by the drilling rig
 - Can be used with external casing packers, or cemented liners
 - “Defines” frac initiation point
 - Provides full bore ID of casing
 - Equal pressure rating to casing
 - Functioned (opened) with properly placed frac tool or packer



Multistage Annular Fracturing



Multistage Annular Fracturing

- Challenges of annular fracturing
 - Getting Stuck! High clearance helps!
 - Available WOB to set Packer element (horizontal)
 - Packer design to withstand hi pressure @ temp
 - Ability to accurately locate, especially with OptiPort
 - Tool reliability/longevity in erosive environments
 - Speed, to reposition and operate BHA
 - The number of intervals/well is increasing!



Multistage Annular Fracturing

- 49 Stage Barnett Shale frac obstacles:
 - Speed! Optiport/SureSet combo < 10 min between fracs
 - Long horizontal wellbore provides less than 2k # WOB
 - Downhole temp in excess of 85C
 - High Breakdown pressures (tight formation)
 - Challenging recovery from screen out with 2" CT
 - High rate frac/erosion of BHA at perforations
 - Daylight pumping only- trip BHA-RIH to depth/penetrate sand in wellbore
 - Tool reliability

Multistage Annular Fracturing

- Long horizontal wellbore provides less than 2k # WOB!
 - Carefully modeled using BHI Circa TFA software
 - Proprietary “low activation force” packer element utilized
 - Horizontal length will become a limitation



Multistage Annular Fracturing

- Speed! Less than 10 min between fracs!
 - By using the Optiport system, abrasive perforating is eliminated
 - Fluid savings of approx 10 cubic meters of fluid/stage
 - First stage can be SJ perforated or use “P” sleeve
 - Mechanical CCL provides accurate first time locating feedback



Multistage Annular Fracturing

- Downhole temp in excess of 85C
 - Conventional elastomer elements will begin to flow
 - BHI proprietary unconventional element will withstand high temp @ high pressure with repeated pressure/temp cycles, while still being high clearance



Multistage Annular Fracturing

- High Breakdown pressures (tight formation)
 - Barnett shale formation may require isolation differentials up to 7000 PSI (48 MPA)
 - Not only challenging for the packer element, but all down-hole sealing devices; aggravated by high temp



Multistage Annular Fracturing

- Challenging recovery from screen out with 2" CT
 - With 2" CT in 5.5" completion, annular velocity required to clean out proppant is generally limited by friction from the CT itself
 - BHI CIRCA modelling software is used to tailor the cleanout to reduce the recovery time to a minimum
 - Clean out times can range from 1-10 hours, optimization is critical
 - Sand placement in the wellbore is critical to promote fracture growth/initiation, sand in the wellbore can simply cause a screenout shortly into the pad!



Multistage Annular Fracturing

- High rate frac/erosion of BHA at perforations
 - Shale formation = high rate slickwater frac
 - Major erosion can occur at the transition of fluid velocity from the annulus, around the corner, into the perforations/formation
 - Over 3 million pounds of proppant pumped past the BHA!
 - Extremely hard surfaced BHA components provide tool longevity.
 - Goal is to provide up to 50 stages per BHA deployment.
 - To date max stages per BHA is 27
 - BHA failure in this case was worn/rounded anchor slip teeth



Multistage Annular Fracturing

- Daylight pumping- trip BHA-RIH to depth/penetrate sand in wellbore
 - Operations dictate the BHA/CT must be brought to the vertical section of the wellbore overnight
 - Proppant migration into the well bore will restrict entrance, 10% full?
 - BHA flow through capability allows this proppant to be fluidized, and be penetrated.



Multistage Annular Fracturing

- Tool reliability
 - Ever increasing number of stages/wellbore
 - Optiport can be SJ perforated in the event of malfunction
 - Ultra reliability by using high end materials/components saves the customer \$\$
 - Each faulty tool string can cost up to \$50K in standby/tripping!
 - Especially important in Daylight only areas!

Questions?

