PPEPCA SEMINAR

“Untapping Tight Gas Reservoirs”

Pakistan Technology Forum

DESIGN & QUALITY CONTROL TECHNIQUES FOR OPTIMIZED FRACTURING OPERATIONS

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Overview

- Hydraulically fracturing low perm formations needed
- Fracture Design Keys to Success
- Lab Testing needs for pre job and location
- Post job recovery and testing
- Documenting and improving each time
- Scorecard to success
Optimizing Fracture Design Is The First Key
Fracture Design – Key Considerations

• What is Hydraulic Fracturing and what are you trying to accomplish
• Must review and design each well even in same field
• Must have proper reservoir information for proper candidate selection
• Need to know pre and post production to grade success
• Fracturing Introduces permeability, i.e. a measurable contrast
• Proper design and implementation can result in a several fold increase in production. $$$

- Principle stresses
  - \( Q_V \) = Overburden
  - \( Q_H \) = Maximum Horizontal stress
  - \( Q_h \) = Minimum Horizontal stress
- With a FRAC we try to get optimum Fracture length and width...
  - ...and extend the fracture past the near wellbore damage zone
  - Fractures normally grow perpendicular to the minimum Horizontal stress.
  - It helps to align perforations in the direction of the maximum horizontal stress
    - Rarely done
For fracturing, effective modeling of the pumping operation is critical to success.

To insure maximum value; the jobs are optimized using analysis software and then real time treatment is modeled using design software such as FracPro, StimPlan, MFrac, etc.

Running several iterations will insure that the job is not over or under designed.

Minifrac analysis and redesign if necessary.
Fracture Design - Fluid Systems & Proppants

- Wide variety of fracturing fluids
  - Guar based, Borate crosslinked fluid
  - CMHPG based, Zirconium crosslinked fluid
  - Visco Elastic Surfactants (VES)

- Breakers – “Be Aggressive”
  - Liquids, Solids, various temperatures

- Breakers should be tailored to each scenario

- Run temperature models for Optimum design

- Use information for proper lab testing

- Proppant Selection Process
  - Depth, Stress, Production Rates, etc.
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Fracture Design – Lab Design

- MUST simulate reservoir conditions
- Design fluids for optimum placement and clean pack after breaking
- Must perform testing prior to job in lab and also on location before job
- Need correct lab equipment and set up available near operations
- Qualify Proppants
Proper Chemicals Very Important

- Acid Corrosion Inhibitors
- Anti-Sludge Agents
- Bacteriacides
- Breakers
- Clay Stabilizers
- Crosslinkers
- Fluid Loss Additives
- Friction Reducers
- Gel Stabilizers
- Gelling Agents
- Solvents
- Iron Control Agents
- Mutual Solvents
- Oxygen Scavengers
- pH Control Agents
- Scale Inhibitors
- Surfactants - Defoamers
- Surfactants - Emulsifiers
- Surfactants - Fines Suspending Agents
- Surfactants - Foamers
- Surfactants - Non-Emulsifiers
- Wax / Paraffin Inhibitors
Fracture Design – Fluid Recovery

Load Recovery Agents provides these Benefits:

• Increase in the load recovery

• Higher relative Gas Permeability

• Changes in the wettability closer to neutral
Load Recovery Comparison

Effect of load recovery agents on the gas relative permeability vs number of porous volume of gas injected in Berea Sandstone. (K=55 mD, PV=18 ml, Conf. Pressure 1000 psi, DP 10 psi, Temp. 72 F)

- Untreated
- Tret. 1 gal/Mgal LRA
- Tret. 1 gal/Mgal Microemulsion

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Load Recovery Makes A Difference

Improved Flow Rates and Load Recovery with LRA

Gas rate (scm³/minute)

Cumulative Gas Production (scm³)

- Initial Permeability to N₂: 54 mD
- Confining Pressure: 1000 psi
- Temperature: 72°F
- ΔP across core: 10 psi

- treated sandstone
- untreated sandstone

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Equipment Requirements & Cost Considerations

- Fully Automated dependable equipment
- Frac jobs can require small to large footprints – right equipment essential
- Engineering Analysis of Real Time Data
- Proper procedure very involved and required
- Cost range
Production Increase Comparison

- Sustained increases range from 1 to beyond 10 fold increase
- Tight Gas production success requires fracture stimulation
- Production results
Key Conclusions for Consideration

• Fracture designs can be complex but tools available to aid success
• Tight gas reservoirs require stimulation for success
• Proper fluid and chemical packages lead to success
• To be successful, recognize all wells are not alike
• Simulate reservoir conditions for success
• Fracs designed for NPV and not purely economics more successful
• Proper planning insures highest level of success
• Expected increases from 1, 2, 5, 10, … times equal success
QUESTIONS & ANSWERS