Waste Water Disposal and Abandonment Philosophy

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Salt Water Disposal Overview

Multi-chem a Halliburton Service
Saltwater Disposal Wells

- Water plays a vital role in the oil field, whether used in the completions process or it occurs naturally in the formation being produced.
- Water must be disposed of in an environmentally sound and economically feasible way.
- Salt Water disposal systems or SWDs is one of the most economical ways to re-inject the produced water (brine) into a receiving formation.
- Operations can build their own facility or send it to a commercial SWD.
- Brine can be trucked, piped or sent by rail to the SWD, each of these includes its own set of challenges.
Operating Concerns
Maximize Oil Recovery and Water Injection Rates

**Challenges**
- Corrosion
- Emulsions
- Solids
- Scale
- Surface Equipment Operation

**Solutions – Mechanical/Operational/Chemical**
- Blanket Tanks / Chemical / Metallurgy
- Heat / Chemicals
- Filtration / Chemical
- Water conditioning / Predictive Models
- Proper design to handle the volume and quality of water
Monitoring and Economics

- Monitoring Programs
  - Well Defined Key Performance Indicators – Environmental Compliance
    - Corrosion – Coupons, Electrical Resistance, Water Analysis, etc.
    - Scale Modeling
    - Oil and grease
    - Operational Data and Proper Maintenance of Surface Equipment
      - Pressures
      - Temperatures
      - Injectivity – pressure constraints from oil and solids in the water

- Economics
  - Cost of Injection per Barrel
  - Oil recovery
  - Cost of Corrosion
    - Equipment Loss
    - Down time
Well Abandonment

Cementing
North Dakota Abandonment Philosophy

- Abandoned wells can act as a conduit in two ways.
  - Fluids from the well migrate up to other places
    » Enter freshwater aquifers
    » Transmitted to surface
    » Enter other reservoirs
  - Fluids from surface can migrate down into freshwater aquifers

- We use two methods in North Dakota to stop this from happening.
  - Squeeze Cementing
  - Plug Cementing
North Dakota Abandonment Philosophy

Squeeze Cementing

[Diagram showing Squeeze Cementing with labels for Existing Cement Sheath and Cement From Squeeze Job]

Plug Cementing

[Diagram showing Plug Cementing with a section of the wellbore and surrounding rock layers]
Plug and Abandon Process

**Squeeze Cementing**
- Retainer set high to meet regulatory plugging requirements
- Perform low pressure squeeze through retainer
- Run an injectivity test
- Utilize spacers and/or flushes
- Design slurry to meet formation and regulatory requirements

**Balanced Plug Cementing**
- Ensure the well is balanced and completely static
- Maximize hole cleaning and mud removal prior to cementing
- Utilize spacers and/or flushes
- Pull the pipe slowly
- Design slurry to meet formation and regulatory requirements
Typical Bakken / Three Forks Plug to Abandon

- Surface plug set a minimum of 50 ft. below surface and seals the annulus and casing.
- Base of surface casing squeeze.
- Dakota Group isolation utilizing a squeeze or balanced plug.
- Minnelusa isolation utilizing a squeeze or balanced plug.
- Bakken / Three Forks isolation utilizing a squeeze technique.
THANK YOU