Extra Energy, LLC

Huff and Puff Process Utilizing Nitrogen Gas

Licensee of:
Nitrogen Oil Recovery Systems, LLC (NORS)
US Patent 6,244,341
Canadian Patent CA 2310959
Topics Outline

- Huff and Puff Process Utilizing Nitrogen Gas
- Benefits of Nitrogen – Process and Operational
- Other Energy Uses for Nitrogen
- Nitrogen Membrane Unit
- Primary Target Formations
- Test Project
- Project Design – Optimization and Development
- Project Development
- Contacts
Huff and Puff Process Utilizing Nitrogen Gas

- Huff and Puff process needs a treatment gas that will bypass oil during the Huff phase and displace oil during the Puff phase.
  - Nitrogen gas has the characteristics to best meet those requirements at a low cost.
- Other Huff and Puff processes primarily utilize a solvent to increase oil production — such as steam or carbon dioxide.
Process Benefits of Nitrogen

- During the treatment phase, nitrogen remains in gaseous form and does not dissolve in oil or water enabling it to go further into the well drainage area.
- During the treatment, soak, and production phases, the nitrogen dissipates into the well drainage area where it
  - Becomes trapped due to structural position, gas relative permeability, and gas hysteresis; and
  - Increases in volume with gas vaporization from the oil.
- Nitrogen gas that is in the water phase reduces the relative permeability to water.
Operational Benefits of Nitrogen

- Can generate nitrogen on site with a membrane unit.
- Cost effective – total cost is dependent on cost of fuel, size of unit, and length of use.
- Inert - easy to compress and handle.
- Easily available and easy to dispose.
- Environmentally friendly - same gas that is used in food storage and water bottling.
Other \( N_2 \) Energy Uses

- Under balanced Drilling
- Offshore platform utility
- Catalyst regeneration
- Pressure maintenance
- Enhanced oil - attic recovery
- Pipeline purging
- Tank and tanker blanketing
Nitrogen Membrane Unit

On-site unit -- 850 MCF/D @ 95% N2, 5% O2 and 145 psig
Primary Target Formations

Pressure-Depleted Dual-Porosity Reservoirs

- Process uses high perm system for a delivery system for treatment gas and production of mobilized oil.
- System provides large contact area for gas to penetrate the low perm matrix.
- Established relative perm to gas and compressible system to allow gas movement into matrix.
- Provides an EOR process for a reservoir class that has limited ability for classical displacement processes.
Typical Target Formation

Hondo Canyon – New Mexico
Test Project

BIG ANDY RIDGE PROJECT – LEE AND WOLFE COUNTIES IN KENTUCKY
Net Project Production

![Graph showing BOPD and MCFD over time with events labeled]

- Net Prod Increase
- Nitrogen Injection

Date Range:
- Dec-97 to Apr-04
Project Efficiency

Graph showing monthly ratio and cumulative injection versus cumulative increase over time.
Cum Recovery

Cum Incremental Oil

Cum Nitrogen Injection

Ratio MCF/BBL
Thousands

Jul-98 Oct-98 Apr-99 Jul-99 Jan-00 Apr-00 Jul-00 Jan-01 Apr-01 Jul-01 Jan-02 Apr-02 Jul-02 Jan-03 Apr-03 Jul-03
Typical Lease Production Analogs

![Graphs showing production data over time for different cycles.](image-url)
Huff and Puff Process Utilizing Nitrogen Gas has shown a four-fold increase in oil production with only a slight increase in water production.

Production Increases have been sustained over a four-year program and are still increasing.

Cum Gas Utilization of 2.8 MCF/bbl with projected to date gas utilization of 1.4 MCF/bbl.
Project Design - Optimization

- The Process is a multi-variable process. The primary process design parameters are:
  - Treatment Pressure
  - Treatment Rate
  - Cycle Volume
  - Soak Time
  - Cycle Frequency
- The optimum levels for the parameters are based on the utilization of existing surface and well equipment with the well/reservoir drainage volume and characteristics.
The three phases of Project Development are:

- Injectivity Test
- Pilot Cycles
- Full Scale Development
Contacts
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