Using Reduced Emission Completions (RECs) to Minimize Emissions During Flow-back of Hydraulically Fractured Gas Wells

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Well Basics

- Move in, rig up drilling rig
- Drill well
- Run casing
- Cement casing
- Perforate casing
- Frac formation
- Cleanout wellbore and formation
- Install wellhead
- Put well on production
Well Flow:
- Depends on Delta P
- Flow Rate is a function of Delta P
- Rate Determines Velocity
- Velocity Determines Fluid Lift

Formations:
- Recovery of Frac Fluids Important
- Formation Pressure Must be Greater Than Sum of Back Pressure
- “Reduced Emission Completion” Adds Back Pressure
Reduced Emission Completions - ??

Flow-back and Clean-up of a Gas Well Following Fracture Stimulation With Most Gas Recovered
- Both new completions and re-completion/work-over post hydraulic fracturing
- Traditional completions - flowed to pit or surface tanks - gas vented or flared - Can be a significant source of methane and other pollutants

“Reduced Emission” Cleanouts – Pros and Cons

Pros
- Reduce emissions
- Sell gas instead of venting / flaring
- No visible flares
- No mixing of air and gas

Cons
- Requires a great deal of specialized equipment
- Can be Expensive – Especially in low pressure reservoirs
- Cleanouts not as effective (back-pressure from the pipeline)
- Low pressure cost - approximately 30% more than a conventional cleanout unit Value of gas sold - roughly equal to the additional cost
Basic Requirements

- Must have an operational pipeline
- Gas must meet sales specifications
- Must be able to adequately clean-up well and avoid permanent reservoir damage and lower productivity
  - Sufficient reservoir energy, flow, and characteristics to clean-up against pipeline backpressure —or—
  - Much more equipment and complexity to enable clean-up of low pressure/energy reservoirs
- Surface equipment must be in place to dry and meter gas into sales line
REC Equipment - High Pressure

- Truck, trailer, or skid mounted equipment to capture gas during cleanup
- Sand trap
- Specially Designed Three – phase separator
- Portable or permanent dehydrator
Wellhead, sand trap and sand separator.

Wellhead

Separator

Skid

Sand Trap
Sand Separator
BP – SW Wyoming Experience

- Began program in 2001
- Commissioned 6 sets of REC equipment
  - 18 sand traps; 6 large separators
  - Cost ~ $1.4 MM (2002 US$)
- Moved to rental equipment ~2008
- ~1,391 RECs to Date
- ~12.5 BCF of Gas Sold (14.8 MM SM³)
- ~228,300 Bbls Condensate Sold
- State of Wyoming made RECs mandatory in 2011
- EPA is moving to make RECs mandatory
Low Pressure Reservoirs

- RECS much more difficult, complex, expensive
- Requires added energy
  - Compression on flow-back –or-
  - Gas lift “reverse circulation

Source: Weatherford
Weatherford Green Completions

- Use pipeline gas with proprietary foaming agent as compressible fluid to initiate cleanout
- System includes
  - Wet screw compressor when well pressure is less than 80 psig
  - Booster compressor, three phase separator and sand trap
- Estimate cleanup pressure of 300 to 400 psig at a well depth of 8000 feet

Source: EPA
“Green” Completion Unit
Basics of Low Energy Reservoir Post-frac Cleanouts

◆ Underbalanced Cleanouts

- Compressor / pump is used to pump high-pressure fluid down the wellbore to wash the frac sand out.
- Tubing is run into the wellbore to provide separate paths for the fluid entering the wellbore and the fluid / sand leaving the wellbore.
- Fluid used can be a gas (air, nitrogen, natural gas) or a liquid (water).
- Using a gas results in an “underbalanced” situation (pressure in the wellbore is less than reservoir pressure).
- Consequently, fluid (frac gel, water and natural gas) will flow from the reservoir into the wellbore and then out of the well.
Basics of low energy Post-frac RECs

- Must have:
  - Pipeline for sales gas and initial fuel/injection gas
  - Eventually, the well begins making gas and the excess can be sold back to the pipeline.
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