Economical methods to improve production from Mature Gas Fields

A preliminary report on gas production optimization: focusing on ejector (eductor), chemicals and vortex tools technologies to revive mature gas fields
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Objective

- Optimize production with minimum CAPEX/OPEX
- Maximize utilization of the existing surface production facilities
- No wellhead or bottomhole modifications
- Focus on downhole/surface vortex technology, eductors (ejectors) and chemical surfactants/foamers
Well’s energy depreciation

**Typical Gas Well Progression**

- Flowing to here...
- ...then use well’s energy...
- ...then add power & $
Liquids loading

Loss of velocity during the production of a gas well

Gas rate below critical value, cannot effectively contribute to transport liquid to surface, resulting accumulation of downhole liquids!!
Predicting liquid loading

Critical velocity concept

Droplet reversal model

Film reversal theory

J curve method
Ejector or Gas Jet Compressor

- Lowering WHP and increasing production

**Graph:**
- Bottom Hole Pressure, psig vs. MMCFD
- Key points:
  - 30 psig
  - 15 psig
  - 125 psig
  - 50 psig

**Annotations:**
- **LP_well:** 30 b, 200 kN/M3/d
- **50 b Suction pressure of compressors**
- **HP_Well:** 150b Flow 500 kN/M3/d
Ejector (Eductor or Velocity Spool)

- Increased gas production

Total gas production with existing and future gas ejectors installations.

- Gas jet ejector performance
Surfactant/foamer

Well Diagnostics
- Static & Dynamic bottomhole temperature
- Static & Dynamic bottomhole pressure
- Wellhead Pressure
- Tubing ID
- Formation Fluid Analysis
- Depth
- Gas Production rates, etc.

Surfactant Selection
- Lab Tests (Bottle Test, Blener Test, Dynamic Test)
- Field Trial(s)

Application and Assessment
- Diagnostic Treatment(s)
- Routine Application
- Application Administration

Non Ionic
- Compounds of phenols or alcohols
- Good for unknown water chemistry
- Less emulsion prone

Anionic
- Alkyl ether sulphates and alpha-olefin sulphonates
- Excellent water foamer
- Degrate at 125 C+

Cationic
- Quaternary amines
- Better in brine than fresh water
- Good for foaming mixtures of oil and brine

Amphoteric
- Adaptable based on pH values
- Stable at 200F+ and salt content (10 wt % +)
Surfactant/foamer application

- Capillary String

![Capillary String Diagram](image)
Capillary String Injection

Cap string injection

- Relatively simple application
- Can be applied to wide range of completion (monobore, Short/Long String with nipple profile, selective produce through sliding sleeve, etc)
- Liquid soap/surfactant is easy to inject across perforation
- Continuous liquid soap injection maintain the gas velocity above the critical velocity for certain periods. However, to keep the well unloaded for a longer period of time requires continuous optimization.

Cap-String Component :
- ¼” Capillary String
- Bulk Tank for Chemical Storage
- Liquid Pump & Solar Power
- Consumable Chemical Injection
Surfactant/foamer

- Capillary string installation
Advantage of capillary string
Vortex tool

“The path of least resistance for liquid and gas is determined to be of a helical trajectory……”
(G.R Mingaleeva)

- Eliminate “slip” between liquid droplets and gas.
- Lower pressure drop due to friction.
- Lower critical velocity required to lift liquid.
Vortex surface tool

Vortex tool at end of pipeline – 6' from separator

Vortex Tool at start of 6 mile gathering line

Glycol tower on wellhead pad

Adding a Vortex tool upstream of the Glycol tower results in significantly reduced water vapor in the gas and consequently reduces glycol use by up to 80%.

Vortex tool (circled in red) is located between the HP separator and LP separator on the liquid leg
Vortex surface tool

Cumulative NGL Comparison (Gallons)
January 2010-March 2011

One Month without a VX tool

Over Four Months with a VX tool in place!
Vortex downhole tool
Advantage of vortex tool

- Surfactant and Vortex tools
Advantage of vortex tool
Conclusion

- Installation of Vortex tool in bottom most landing nipple is an excellent combination. Using the two together (i.e., surfactant and vortex tools), we have seen reduction in surfactant use by 50%.

- The Vortex tool continually unloads the well – as opposed to large slugs. It is therefore recommended to install vortex tool along with surfactant to optimize cost as well as production.

- Continuous injection should be the preferred solution for wells, where there is already chemical injection setup available. Vortex tool is recommended to be installed in the bottom most landing nipple.

- Application of Eductor on surface appears most economical and simple means to lower wellhead or line pressure.
Liquid unloading: Field glimpses
Thank You