Wellhead Compressor Installation on Liquid Loaded Gas Wells in Sicily: A summary of results and best practices

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In May of 2013, eniMed installed 3 GasJack Wellhead compressors on 2 liquid loaded gas wells (ALFA#1 and BETA#1) in Sicily, Italy.

Highly depleted gas & condensate sandstone reservoir; first gas in 1961 (R.F > 90%)

The production mechanism is depletion drive.

Prior to installation, the combined production from these two wells was about 6-7 KSmc/d gas and 0.7 STm3/day liquid, but this was only intermittent production at best.

Today, after 5 months of consistent operation with the wellhead compressors, the combined production from the initial two well is 30 KSmc/day gas and 2.2 STm3/day of liquids.
Well Selection

- The two wells selected originally were the ALFA#1 and the BETA#1
- Candidates selection criteria with over 30 wells in the field, producing in similar condition, was a challenge. Given this, the candidates were selected based on the following characteristics:
  - Wells currently shut-in or producing with intermittent flow
  - Clear sudden decline due to loading phenomena
  - Producing rate below the unloading rate ("Critical Flow" not activated)
  - Historically valuable producers thanks to good petrophysical characteristics
  - Remaining recoverable reserves by reservoir
  - Smaller ID tubing string should be preferred
  - Backpressure due to surface network
- WellHead Compressor Specification Design
  - Suction Pressure: 0 - 4.5 bar; Discharge Pressure: up to 32 bar;
  - Maximum Gas Rate: up to 20 kSmc/d
Well ALFA#1 – Well Area Scheme
Well ALFA#1 – Production Data

Volumes Recovered @ September, 30
- GAS CUMULATIVE: 1.546 MMSmc
- LIQUIDS PRODUCTION: 57 STmc
- STABLE AND REGULAR GAS RATE

Operative Conditions @ September, 30
- FTHP: 2.1 bar; FLP: 5.7 bar
- Suction Pressure: 1.7 bar
- Discharge Pressure: 8 bar
- Gas Rate: 10.3 kSmc/d
- Liquid Rate: 0.3 STmc/d

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Well BETA#1 – Well Area Scheme

On BETA#1, considering the high liquid/gas rates due to potential deliverability two WHC were installed since May 2013
Well BETA#1

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Volumes Recovered @ September, 30
- GAS CUMULATIVE : 2.485 MMSmc
- LIQUIDS PRODUCTION : 230 STmc
- STABLE AND REGULAR GAS RATE

Operative Conditions @ September, 30
- FTHP: 4.9 bar; FLP: 7.7 bar;
- Suction Pressure: 3.8 bar;
- Discharge Pressure: 9.7 bar;
- Gas Rate: 15 kSmc/d
- Liquid Rate: 1.6 STmc/d

Start-up I WHC @ May, 27
Start-up II WHC @ June, 1
Cyclic Production
One unit removed @ August, 19

Operative Conditions @ September, 30
Lessons Learned and Next Installations

- After the successful production increases seen on the first two wells (30 kSmc/d and 4.03 MMSmc reserves from May to September 2013) and the very short pay out time eni made the following decisions:
  - Well BETA#1 could be produced with 1 compressor, freeing up the other compressor to be installed on another well to maximize total uplift.
  - Optimal set-up parameters for both wells (e.g. suction pressure) were fixed thanks to field tests achieved in the last months.
  - 5 additional GasJacks were ordered in July 2013 for installation in October-November, 2013 in Sicily. Selection criteria are the same specified in slide 3.
  - A full screening of all gas strings being produced in Italy, wherever applicable, is on going to select additional candidates.
Compressco (GSJK on Nasdaq) is a majority interest owned subsidiary of Houston Based TETRA Technologies (TTI on NYSE)

Compressco Inc. created in 1999 has an installed base of ~5000 GasJacks operating world wide. World Leader in the niche product range for Wellhead Gas Compression technology.

Although our GasJack can be used in several different applications, our #1 market is marginal gas wells with liquid loading problems. This accounts for over 60% of our installations.

When a straight forward wellhead installation is not enough, our flexible GasJack compressor can be used in “Back-side Auto Injection Service” (BAIS) or continuous injection.

Both are forms of non-wellbore invasive simple Gas-Lift.

Both Sales and Rental Options available in most International Markets.
Value Proposition

- Eliminate liquid loading by assisting wells to achieve critical flow rates through reduced flowing-tubing-pressure and increased rate.

- Unlike other deliquification methods which mechanically remove liquids (like plungers or pumps) or lower the fluid weight (like foamers), wellhead compression dewater gas wells by lowering critical flow rates (by lowering pressure) and increasing flow rates (by reducing flowing tubing pressure).

This combination allows wells to unload and STAY unloaded due to new production levels above critical flow rate.

- Improved well life and potential incremental reserves
BAIS – Backside Auto Injection System

When the straightforward application of installing a compressor at the wellhead isn’t enough:

**Backside Auto Injection System (BAIS)**
and

**Continuous Injection**

BAIS is a form of gaslift which sense tubing pressures to identify when a well has fallen below critical flow (and therefore liquids are starting to accumulate in tubing)
1. Falling tubing pressure indicates that the well has fallen below critical flow and liquids are starting to accumulate in the tubing.

2. Discharge gas normally compressed into the sales line is injected down the casing-tubing annulus when sensors detect a falling tubing pressure.

3. This injected gas combines with produced gas to generate the higher rate needed to naturally lift liquids to the surface.

4. The detection of rising tubing pressure indicates the well is unloaded and compression resumes to the sales line.

In summary, BAIS is a form of gaslift for marginal wells that requires no down-hole equipment and only injects gas down the annulus when required.
We achieve this with 2 pilot-operated valves sensing the tubing pressure – one valve normally opened on the discharge – and the other normally closed going to the casing. We are still able to sell liquid down the discharge to sales or to a tank.

When the tubing pressure falls below the required set point – to provide maximum MCFD flow up the tubing, the normally closed valve running to the casing starts to open while the normally opened valve to the sales, simultaneously closes. This will remain in this position until the tubing pressure rises above our required set point.

This procedure allow us to be as far above the critical flow rate as possible, while selling and inverting flow. At the same time preventing the well from liquid loading.
GasJack - Specifications

- **Capacity:**
  - **Gas:** Maximum of 700 mcfd (20,000 m³/day)
  - **Liquid:** Maximum 50 bbls/day (8 m³/day)

- **Pressure Range:**
  - **Discharge:**
    - min 50 psig (3.4 bar)
    - max 450 psig (31 bar)
  - **Suction:**
    - min 0
    - max 60 psig (4 bar)

- **Compression Ratio:** Maximum of 20 ratio with single stage!
  - High compression ratio allows for very flexible compressor with wide application range.
  - Compared to a screw compressor, the GasJack is much more adaptable to changing operating conditions often seen on liquid loaded marginal wells.

**Integral V8 Engine/Compressor**

- 170 CID compressor
- 230 CID, 46 HP engine
- Highly efficient cooling
- US Patents: 4,961,691 & 5,203,680 & 5,189,905 & 5,267,843
GasJack – Specifications Continued

- CE certified GasJack compressor (ATEX and PED certified)
  - Current EU operations: Romania, Austria, Germany, Italy, Poland
- Emissions control equipment available to meet EU specifications.
- Noise suppression solutions available.
- Fuel Gas: natural gas from well head. No external power required.
- Minimal site preparation (no concrete pad)
Additional Applications for GasJack Compressor

Pumping Oil Wells – Annular Gas
- Compress annular gas to reduce flowing down hole pressure to increase oil and gas production from the well.

Flare Recovery / VRU
- Eliminate flaring and/or venting by collecting low pressure gas sources and compressing them to nearest pipeline.

Flare & Smoke at Semberah S-14
- Before VRU GasJack Compressor online
- NO MORE flare at Semberah S-14
- GasJack recovers 0.25 MMcfd ; Ps=0.5 psi ; Pd=59 psi
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