Casing Gas Compression

Compact Compression Inc.
Calgary, Alberta, Canada
Casing Gas

• Oil in formations includes natural gas in solution

• For oil to flow into a well, the pressure at the bottom of the well must be less than that of the formation. As oil flows into the well, gas will come out of solution and collect in the casing

• This gas was traditionally dealt with in one of two ways
  – Venting the casing to atmosphere
  – Connecting the casing to the flow line
Casing Pressure

**Vent to atmosphere**
- Venting methane to atmosphere is bad for the environment, methane has 25x the greenhouse effect of CO2 (based on 100 year global warming potential)
- Wasting a potentially valuable and finite resource
- This practice is now illegal in many countries for the above reasons

**Connect to flow line**
- Can reduce well performance due to high backpressure on formation
- Convenient, only 1 pipeline required, gas can be separated from stream and used at battery
**Historical Practice**

Casing Gas Vent to Atmosphere

Typical Installation

- Produced Gas Venting to Atmosphere
- Atmospheric Pressure in Casing
- Fluid Level
- Prohibited in Most Countries

**Current Practice**

Casing Gas Capture

Typical Installation

- Polished Rod
- Stuffing Box
- Production Tubing
- Casing
- High Pressure in Casing
- Perforations
- Low Pressure in Casing

Installation With Casing Gas Compressor

- Compressor
- High Pressure Gas From Compressor
- Oil and Gas Flow Together
- Oil and Gas Flow to Compressor

- Higher fluid level or increased production by increasing pump speed
- Fluid Level
Why Casing Gas Compression?

• No venting – deliver gas to flow line
• Can use gas as fuel or sell it
• Reduce casing pressure, lowering the backpressure on the formation. This will:
  – Increase rate of oil production
  – Increase overall oil recovery
Typical Site Layout

Simple CG Site Layout
1 Oil Well, with pumping equipment

Gas Collected From Casing

Compressor

Gas discharge equal to line pressure

Oil Production Line 200–400 psi

Oil and Gas Travel together to plant
What does it do

• Reduce pressure in casing, lowering bottom hole pressure
• Differential pressure between the formation and bottom hole is what drives the inflow of oil to the well
• Maximum flow line pressures can reach between 1380-2070 kPa / 200-300 psi
• A compressor can typically reduce casing pressure to 35-207 kPa / 5-30 psi, depending on size and gas flow
• Reduction of backpressure against the formation results in higher oil recovery rate
• This effect will be more significant on low pressure formations
  – Formation pressure of 20700 kPa (3000 psi), well is 1380 kPa (200 psi), drops to 207 kPa (30 psi), change is 6%
  – Formation pressure is 6894 kPa (1000 psi), well is 1380 kPa (200 psi), drops to 207 kPa (30 psi), change is 18%
IPR Curves

• Inflow Performance Relationship
• Indicate change in inflow rates with change of bottom hole pressure
• Essentially, the reservoir’s ability to flow to the well at a range of bottom hole pressures
• Depends on reservoir structure, permeability, pressure, and other factors
• Can be used as a first indicator of a well potentially suited for casing gas compression
Example IPR curve

IPR Curve – Effect of casing gas compression

- 220 psi – casing at flow line pressure
- 30 psi – compressor has reduced casing pressure
- Increased production from change in pressure

Bottom Hole Pressure (psi)

Flow into Well (BPD)  200 BBL/day  270 BBL/day
Suitability of a well for casing gas compression

Well A
Low reservoir pressure
High permeability

220 psi – casing at flow line pressure
30 psi – compressor has reduced casing pressure

Significant gains with change in pressure

Well B
High reservoir pressure
Low permeability

30 psi – compressor has reduced casing pressure

220 psi – casing at flow line pressure

Minimal gains with change in pressure
Wells Prone to Gas Lock

- Gas lock may occur due to a variety of conditions, such as high GOR, pump spacing, and pump landing location
- A gas locked pump can cause severe equipment damage
- On wells where this is a known issue, a casing gas compressor may aggravate the problem, as lowering downhole pressure will increase the rate of gas breakout
- Potential solutions would be:
  - Resetting pump spacing to maximize pump compression ratio
  - Adding a gas anchor or other gas separation device to the pump
  - Change to a pump designed to handle gas
  - Re-landing the pump further below the perforations
- If these do not solve the problem, this well may not be suitable for casing gas compression
- The solution may be to increase head pressure on the pump. This would involve maintaining greater fluid height in the well. Essentially, giving up some amount of production rate in order to avoid gas lock issues.
- Testing is critical, the only way to ensure that a well is suitable for casing gas compression is to test in advance
Testing for suitability

- Trailer mounted compressors are simple to move around, saving labor and time over testing with a skid mounted unit
- Screw compressors are quite flexible in performance can be adapted to a wide range of operating conditions
- Gas driven, will run off compressed gas, no need for an electrician to hook up power
- A test compressor will determine exactly how a well will respond to casing gas compression, making the economics of the application a certainty rather than speculation
- Can be equipped with a flow meter to precisely determine required size of compressor
How do we do it

– Small Hydraulic Compressor – CHC0615  
  • Low flow (0.1-3 e3m3/day or 0.3-105 mcf/d)  
  • Shut in pressure up to 10000 kPa / 1500 psi

– Large Hydraulic Compressor – CHC1050  
  • Medium flow (1-10 e3m3/day or 35-350 mscfd)  
  • Shut in pressure up to 10000 kPa / 1500 psi

– Oil Flooded Screw  
  • High flow (6-37 e3m3/day or 200-1300 mscfd)  
  • Shut in pressure up to 2070 kPa / 300 psi
Hydraulic Casing Gas Compressor

- Purpose design for low volume casing gas applications
- Ideal for single well application
- Compressor is designed for sweet or sour service
- No operator setup or adjustment is required
- Eliminates issues common with conventional casing gas compressors
  - No process valves or coolers to become contaminated
    - No inlet valve
    - No recycle valve
    - No intercooler
  - No liquid handling system (compressor can pump liquid or gas)
    - No separator
    - No level shutoff
    - No level switch
    - No liquid pump
- Ultra reliable gear pump and electric motor power supply
- Minimum moving parts
- Satellite call out system notifies operators if unit shuts down
- No external leak points for oil or gas seals
- Automatic restart if grid power is lost
- Capacity control
  - Compressor will adjust cycle rate to match flow
  - Up to 100% turn down
# HCG Performance 15hp (US units)

## CHC0615 with HC613 Compressor

*Maximum ΔP: 225 psi*

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## CHC0615 with HC616 Compressor

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*Projected Performance based on 2500 ft, gas density .665, temp 68 °F. Pressures in PSI Flow Rates in MSCFD*
**HCG Performance 50hp (US units)**

### CHC1050 with HC1022 Compressor

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### CHC1050 with HC1028 Compressor

Maximum \( \Delta P \): 380 psi

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*Projected Performance based on 2500 ft, gas density .665, temp 68 ºF  Pressures in PSI Flow Rates in MSCFD*
# HCG Performance 15hp (metric)

## CHC0615 with HC613 Compressor

**Maximum ΔP: 1550 kPa**

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*Projected Performance based on 760m, gas density .665, temp 20 ºC* Pressures in kPa Flow Rates in 1000 m³/day

## CHC0615 with HC616 Compressor

**Maximum ΔP: 2400 kPa**

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HCG Performance 50hp (metric)

### CHC1050 with HC1022 Compressor

**Maximum ΔP: 1550 kPa**

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### CHC1050 with HC1028 Compressor

**Maximum ΔP: 2600 kPa**

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*Projected Performance based on 760m, gas density .665, temp 20 ºC  Pressures in kPa Flow Rates in 1000 m3/day
Typical process diagram

Gas Suction From Well ▼

Gas Discharge to Flow line ▼

PSV to limit discharge pressure

Compressor

Hydraulic Return Line

Hydraulic Pressure Line

Powerpack Enclosure

OIL COOLER

OIL FILTER

OIL RESERVOIR

Hydraulic Pump

Electric Motor

480 VAC 3-PHASE
Shutdowns and warnings

- The PLC manages all aspects of compressor operation. It will provide the following alarms:
  - Low suction pressure
  - High discharge pressure
  - High discharge temperature
  - High oil temperature
  - Low oil level
- As well as shutdowns for these conditions:
  - Oil level low
  - Oil leak detected
  - Motor overload
  - Failure to cycle
- Compressor will send a message via satellite to indicate an alarm or shutdown condition
Shutdown Interlock

• When compressor shuts down casing pressure will rise
• This leads to a drop off in inflow to the well
• It is possible that while the compressor is shut off the pumpjack could pump itself off, damaging equipment
• Using an interlock so that both compressor and pumpjack shut off together will prevent this
• On certain wells this may not be needed, a simple auto bypass may be sufficient to maintain production until the compressor can be restarted