Fleet-wide Compressor Optimisation

Striving to reduce carbon footprint

22nd March 2017
Adrian Cowan, P.Eng.
Compression requires the burning of natural gas and/or consumption of electricity

Byproducts of which are potentially harmful emissions, including large amounts of Carbon Dioxide, CO$_2$

Are we compressing gas from A through B as efficiently as possible?

Study by Detechtion Technologies showed that it enables its customer base to eliminate over 600,000 metric tonnes of CO$_2$ emissions through ongoing compressor optimisation
Compression is used in:
- Gas extraction from low-pressure wells
- Transportation to market
- Enhanced Oil Recovery / Injection
- Storage and Processing

Power for compression
- Directly proportional to gas volumes and compression ratios
- Gas driven engine commonly used as power source
- Fuel for engine taken from production gas or alternatively sources sales gas
- Burning of gas for fuel results in release of combustion emissions, including CO₂
What causes excess power and fuel consumption?

Sources of inefficiencies:
- Recycle / Bypass valve open
- High interstage pressure drops
- Cylinder inefficiencies (Blowby)
- Excess compression (too many compressors)
- Under-utilised compressors
Recycling compressed gas:

- Happens when compressor capacity is greater than inlet gas volumes.
- Gas must be recycled from discharge back to suction in order to make up difference.
- Fuel gas is wasted as recycled gas has been compressed and then is reduced back to suction pressure to be compressed again.
Case Study:

Fuel gas savings generated by a bypass optimization on a 3 stage / 783 kW (Energy Industries FE650 / Waukesha L5108GL) compressor
High Interstage Pressure Drop

- Increase compression ratio across each stage
- Increase power and fuel gas consumption
- Decrease throughput
- Decrease efficiency on a basis of fuel gas burned per unit of production
Cylinder Blowby

- Cylinder inefficiencies resulting in gas slipping or recirculating within a cylinder
- Result of worn or damaged components – valves or piston rings
- Extra energy is used to compress gas resulting in excess heat being generated
- Causes elevated suction pressures and decreased throughput as well as excess fuel consumption
Case Study:

- Operating 3 compressors at reduced speed
- Plant performance curve generated
- Determined that only 2 compressors were required for desired operating conditions
Case Study:

- Operating 3 compressors at reduced speed
- Plant performance curve generated
- Determined that only 2 compressors were required for desired operating conditions
- 1 compressor shut down
- Total Fuel and Op Cost savings = $940k/yr
- Reduction in 8,800 tonnes/year CO₂

## Plant Consolidation

<table>
<thead>
<tr>
<th>Plant Summary Table - Potential Annual Savings</th>
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<tbody>
<tr>
<td>Total Compressors Running</td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td>Current Site Setup</td>
</tr>
<tr>
<td>Proposed Site Setup</td>
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<tr>
<td>Total Savings:</td>
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### Annual $ Savings

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Combined Fuel/Electrical Savings ($/Year):</td>
<td>$667,176</td>
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<tr>
<td>Total Op Cost Savings ($/Year):</td>
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<td>Total Consolidation Savings:</td>
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Reciprocating compressors can only be fully optimised for maximum throughput if either the cylinder capacity utilisation or the power utilisation is 100%.

- **100% Cylinder Utilisation** = Max use of Stage 1 Cylinders
- **100% Power Utilisation** = Maximum Driver Output

Under-utilised consume more fuel gas per unit of production volume.
Under-utilised Compressors

Demo Compressor Unit 9999
Waukesha L7042GL/ArielJGK/4 @ 6000 kPagd

Well Deliverability from IPR Curve

Optimized Configuration

Initial Operating Conditions
Case Study:

- 1 client with 95 compressor packages
- Trends show weekly average throughput per horsepower used and suction pressure
- Increase in fuel efficiency shown despite a declining field
- 6% improvement in fuel usage on a per unit volume of throughput basis

~24,000 tonnes/yr reduction in CO$_2$
Opportunity Identification

How do we set about identifying opportunities is a fleet of compressors with various engine and compressor manufacturers?
Compressor Monitoring

- Daily Plant Reads
- Visual Inspection
- Used Oil Analysis
- Vibration Analysis
- Valve Cap Temps
- Infrared Cameras
- OEM Performance Runs

➢ While all important, these methods are incredibly time consuming to analyse a heterogeneous fleet of compressors
Detechtion Technologies’ compressor optimization and fleet management software

- Individual Compressor Diagnostic Analysis
- Station-Level Analysis (reports, graphs)
- Regional / Field Analysis (reports, graphs, tables)
- Total Fleet Analysis (maps, reports, graphs, tables)
- Optimised Compressor Loading Curves
- Vendor / 3rd Party Activity & Information
- Compressor Design Data & Photos
- Maintenance Recording & Reports
- Emissions Rates & Totals (calculated)
- Compressor Simulation Capabilities
Fleet Management Tools

Environmental Reports
- Fuel Gas Consumption Summary
- Emissions Report
- Emission Factors Report
- Driver Summary
- Gas Analysis Summary
- BC Carbon Tax Summary
- Electricity Consumption Summary

Maintenance Reports
- Maintenance Status & History Report
- Mean Time Between Failure
- Workorder
- Maintenance PM History
- Maintenance PM Due/Overdue Report
- Valve Recession Summary
- Maintenance Cost Report (For Individual Unit)
- Maintenance Cost Summary Report

Performance Reports
- Annual Operating Cost Savings
- Asset Optimization
- Asset Utilization Summary
- Availability & Reliability Report
- Damaged Units Report
- Fleet Performance Snapshot
- High Blowby Report
- Production Engineering
- Runtime Report
- Suspected Bypass
- Units on Bypass
- Units over Recommended Overhaul Hours
- Utilization History

Fleet Summary Reports
- Active Non-Reported Compressor Summary
- Administration Summary
- All Unit Summary
- Cash Flow at Risk Summary
- Fleet Surveillance Report
- Customized Thresholds And Factors Summary
- Hydrate Formation Risk Summary
- Operator Log History
- Reasons for Downtime
- Downtime Classification Summary
- Reported Compressor Summary
- Serial Number Summary
- Standby Compressor Summary
- Surplus Compressor Summary
- Total Management
- Top 10 Performance Summary
- Units by Arca and Field Summary

Other
- Fleet Hardware Reports
Fleet Management Tools

- Cash Flow at Risk (CFR) Horsepower
  - Potential fuel gas / electrical savings resulting from bypassed gas, high blowby, and/or a high interstage pressure drop

![Recip Cash Flow at Risk Summary](image)
## Fleet Management Tools

- **Units on Bypass**

### Recip Units On Bypass

(From 02/01/2017 to 02/28/2017)

<table>
<thead>
<tr>
<th>Unit #</th>
<th>Compressor Name</th>
<th>Location</th>
<th># of Stgs</th>
<th>Flow (E3m3/d)</th>
<th>Increment Available (E3m3/d)</th>
<th>Suct. Pressure (kPag)</th>
<th>kW % Utilized</th>
<th>Bypass Open (%)</th>
<th>Total CFR ($1,000)</th>
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<td>West Rigal b46-J</td>
<td>b-46-J5/4-A-10</td>
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<td>13-16 (As43)</td>
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</table>

Total Number of Units: 17
Total Flow (E3m3/d): 1,774,115
Total Increment Available (E3m3/d): 413,472
Total CFR: $142,7750

1.800.780.9798  www.detechtion.com

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Fleet Management Tools

- Production Engineering Report
  - Potential opportunity to recoup production due to available incremental production caused by under-utilised asset
Fleet Management Tools

- **Emission Summary (calculated)**

### Recip Emissions Summary for Central Area
(From 02/01/2017 to 02/28/2017)

<table>
<thead>
<tr>
<th>Unit #</th>
<th>Compressor Name</th>
<th>Location</th>
<th>Inlet Gas Comp. (%)</th>
<th>Driver Type</th>
<th>Driver Make</th>
<th>Driver Model</th>
<th>Max. Rated</th>
<th>Avg. Used</th>
<th>YTR  (hr)</th>
<th>CO2</th>
<th>SO2</th>
<th>NOX</th>
<th>CO</th>
<th>VOCs</th>
<th>TPM</th>
<th>PM10</th>
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<td>103</td>
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<td>2.06</td>
<td>1.24</td>
<td>84.38</td>
<td>Turbo</td>
<td>Waukesha L7040CG</td>
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**Total Number of Units:** 40  
**Total CO2:** 10463.87 tonnes  
**Total SO2:** 566.28 tonnes  
**Total NOx:** 131.83 tonnes  
**Total PM10:** 0.43 tonnes  
**Total PM2.5:** 0.54 tonnes  

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Detechtion Study

- ~800,000 Enalysis reports generated over the last 4 years analysed

- Checked for instances where the configuration was adjusted where the cylinder and horsepower usage were reduced – optimise for fuel savings
  - 1,381 unique assets across 6 companies
  - 452 of those (33%) assets adjusted the pocket configuration at least once in the last 4 years where the utilisation decreased (cylinder or horsepower).
  - The 452 assets were optimised a total of 852 times in a span of 4 years
  - BEFORE: 3,885 $E^3m^3/d$ in fuel (2,978,300 tonnes$CO_2/yr$)
  - AFTER: 3,513 $E^3m^3/d$ fuel (2,693,500 tonnes$CO_2/yr$)

- SAVINGS: Cumulative reduction of daily fuel consumption by 372 $E^3m^3/d$ (284,800 tonnes$CO_2/yr$)
Results: Extrapolate for the remainder of Detechtion’s Assets, annualize the results, and assume that utilisation levels as a result of optimisation are maintained for 1 year;

- **Fuel Reduction**: 60,200 $E^3m^3$ / Year = $4,260,000$ Savings / Year
  - **CO₂ Reduction**: 126,000 Tonnes CO₂ / Year
  - **Electricity Reduction**: 9,972,000 kWh / Year = $1,000,000$ Savings / Year

@$2.00/GJ and $0.10/kWh
Results (cont): Assume that utilisation levels as a result of optimisation have continued since the start of the study in 2012 to present day – *Continuous fleet-wide optimisation*:

- **Fuel Reduction:** ~285,000 E$^3$m$^3$
- **CO$_2$ Reduction:** ~600,000 Tonnes CO$_2$
- **Electricity Reduction:** ~47,500,000 kWh
Thank You

For more information please contact

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