ENGINEERING & DESIGN SERVICES
FIELD SERVICES
OPTIMIZATION SERVICES

Optimization Example
Keeping it running smoothly

Performance and Optimization Examples: Reciprocating Compressor

1. Develop Load Curves & Identify Performance Improvements

This gas producer has numerous compressors used in its field gathering system. BETA was hired to evaluate the compressors and determine:

- Current asset utilization;
- Improvement opportunities in current deployment; and
- Potential for increased throughput

This example is a field compressor (White Superior W62, 2 throw, engine drive). BETA was able to increase cash flow immediately through better operation of the compressor.

The current performance is summarized in the table (using BETA's optimization software). Loading curves were also generated.

Current Asset Utilization:
Performance indicators were calculated to be: Compressor Capacity Utilization (39.9%); Driver (Engine) Power Utilization (40.2%); and Overall Efficiency (66.8%)

These values are below ideal performance metrics. For optimum operation, capacity and/ or power utilization should be 100%. Overall efficiency should be above 80%.

Optimization Measures	Results	Goal
Suction pressure used for analysis (kPag)	687.5	
Discharge pressure used for analysis(kPag)	2200	
Operating speed (RPM)	865	
Compressor Capacity		
Measured flow (e3m3/d)	80	
Capacity at load step 0 & rated speed (e3m3/d)	200.4	
Actual compressor capacity utilization	39.9%	100%
Capacity at analysis conditions (e3m3/d)	192.6	
Cylinder volume utilization incl. recycle	96.1%	
Recycle volume (e3m3/d)	113	
Recycle volume, per cent of compressor throughput	58.5%	
Driver Power		
Rated driver brake power @900 RPM (BHP)	600	
Calculated compressor brake power (BHP)	452	
Driver power utilization (%)	75.4%	
Brake power if recycle = 0 (HP)	334	
Effective driver power utilization	40.2%	100%
Power consumed by recycle (HP)	266	
Value of fuel consumed to recycle ($/mo)	$6,968	
Compression Efficiency		
Compression efficiency	66.8%	>80%
Value of excess fuel consumption ($/mo)	$ 2,152	
Asset Utilization		
Compressor incremental production potential (e3m3/d)	120.4	
Compressor incremental cash flow ($/mo.)	$ 631,908	
Driver incremental production potential (e3m3/d)	175.5	
Driver incremental cash flow ($/mo.)	$ 921,145	
Operating Margins		
Calculated gas rod load (% of allowable)	40%	
Max. discharge temperature (deg C)	132.5	
Discharge temperature margin vs spec.	27.5	

Improvement Opportunities in Current Deployment:
The units are currently being operated by utilizing the recycle valve to maintain flow through the compressor (as shown below - load step #1). Recycling 113 e3m3/d of gas is inefficient and costs $7000/month in additional fuel gas. BETA evaluated many different load steps, speeds, and torque considerations. The optimal approach is to run the unit at load step 4 and at 560 RPM (see highlight below). This avoids recycling gas and reduces fuel gas consumption.

Load Step	Speed (RPM)	Power (BHP)	Torque (%)	Compressor Capacity (e3m3/d)	Recycle Volume (e3m3/d)
1 (current)	865	452	78.4	193	**113 – expensive loss**
4 (open 3")	865	355	61.6	124	44
4 (open 3")	560	250	61.6	80	0

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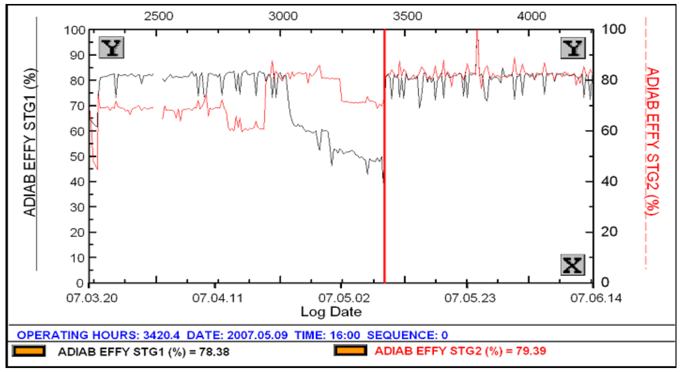
Optimization opportunity findings:
The customer has opportunities to add additional gas to the system. How much more could be produced through this compressor? Using the load curves and our performance analysis technique, BETA identified that 120 e3m3/d of extra gas could be compressed, with a value of $635,818 per month.

2. Compressor Efficiency:

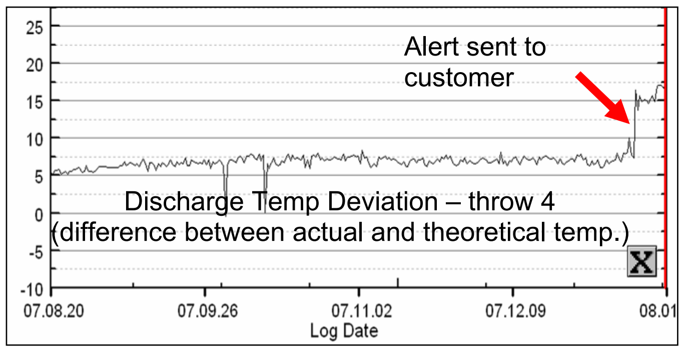
BETA's monitoring program found the efficiency of both stages of a reciprocating compressor trending down. Recommendation for valve repairs was made and efficiencies restored. Unit throughput increased 10%, which is an increased cash flow of about $75,000/month at $175 per e3m3.



3. Discharge Valve Problem:

The performance monitoring program is remotely tracking the actual discharge temperature and comparing it to the theoretical temperature. This critical measurement is called discharge temperature deviation (actual versus theoretical).

This performance monitoring technique is accurate and can indicate valve or ring leakage problems.

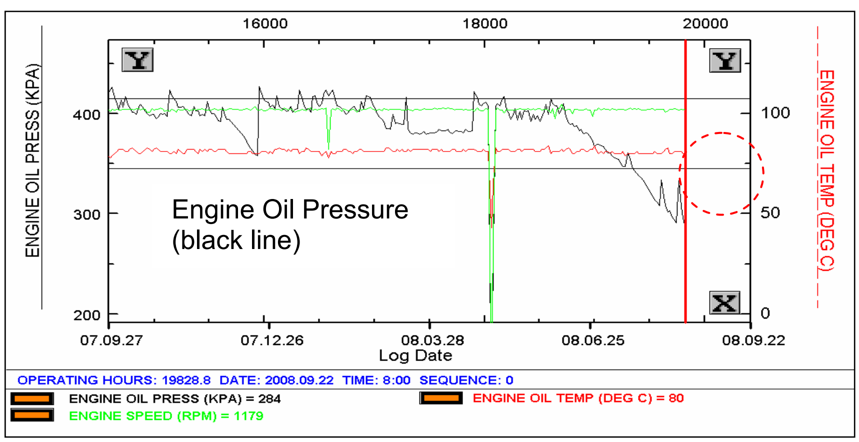


In this case, the performance monitoring program identified the problem quickly to operations staff and avoided over $300,000 in downtime related costs. (Note: tracking raw temperature data would not have caught this problem.)

4. Avoiding Engine Downtime:

Engine oil pressure is at the lowest level of 284 kPa (red circle) on September 24, 2008. The pressure regulator control system and/or a faulty pressure relief valve are suspected problems.

BETA sent out alarms in August and September on this issue. The customer found the main oil relief spring had worn into the housing and caused it to hang up.



The customer indicated that the monitoring program saved the engine and avoided unplanned downtime.

For more performance and condition monitoring examples, contact BETA's application support team.