

Compression Monitoring: Applying Technology for a Safer, Lower Cost Operation

Jim Ferrero, Vice President, Business Development
GloboLogix

The efficiency and economic outlook of upstream oil and gas operations have never been more critical issues for oil and gas operators. As the industry continues to grapple with economic pressures, reductions in staff and a volatile market, operators realize that now is the time to seek out technologies that will help them lower costs and improve productivity.

Less than 30 percent of the oil and gas industry's US field sites are remotely monitored. The assets on these sites include: wellheads, tank batteries, production equipment, measurement facilities, pumps and compressors. Out of all of these assets, compressors can often seem like a small contributor, but in fact, they are an asset that stands to generate significant return on investment. The potential benefits of optimizing compressors make this field asset a prime target for remote monitoring.

Moving from Milk Runs to Proactive Problem Solving

Most oil and gas fields are traditionally operated in what can be called a milk run mode. Under this model, a field technician visits the sites in his field based on a schedule, a daily milk run. He begins his day at the field office and then heads out to visit his sites in rotation. If a compressor shuts down after his site visit, there is the potential for it to go unnoticed until the next scheduled visit. This can mean up to 24 hours of downtime, resulting in lost production and revenue.

For example, take a compressor at a site that has been set up with the discharge temperature shutdown at 300°F. A milk run field technician has his scheduled visit of this site near the end of his shift, around 4:00 pm. A quick look at the compressor's panel shows a discharge temperature of 265°F, which is well below the alarm threshold. The technician moves on since he has an hour drive back to the office and there appears to be no issue with

the unit and no alarm or shutdown.

What the milk run field technician may not know is that the discharge temperature at that location should only be 235°F, and he definitely doesn't know that the temperature has been rising for the past few hours. This is where a dispatch mode field operation model has a clear advantage. Under the dispatch mode, this same compressor would be monitored constantly and in real time from a central control room. The control room operator assigned to monitor that area would be well aware of the increasing discharge temperature because of the trending capabilities of the SCADA system, and could dispatch a field technician as soon as he noticed the change. This technician would arrive at the scene with full knowledge of the current issue before the unit goes down on a high temperature shut down. Most likely, he would have already surmised that the cause was a failing compressor valve, and he would have a replacement valve with him to quickly remedy the situation.



Less than 30 percent of the oil and gas industry's US field sites are remotely monitored. However, installing these capabilities in just one piece of field equipment, such as a gas compressor like this one, can yield significant ROI and increases in operational productivity and efficiency.

This ability to proactively address field problems and avoid shutdowns saves hours of time and significant expenses. The most likely ending to this scenario for the technician in the milk run example is that the compressor reaches its discharge temperature shutdown level hours after he has left. If he does get an alarm call out it will be much later when he is at home and off-duty. In the best-case scenario he responds that night. But, it is possible he may not know about the situation until the next day. Regardless, without information other than the fact that a shutdown occurred, he may not have the parts necessary to resolve the issue in one trip to the field.

Dispatching technicians from a control center has a number of benefits for operators. In this example, dispatching the field technician while the temperature is still climbing, before the unit shuts down, results in the minimum overall downtime. A field technician who addresses the shutdown after the fact results in the maximum downtime.

Increase Productivity Through Smarter Time Management

This dispatch model also allows field technicians and engineers to work more efficiently. Instead of making the same daily rounds week after week, as they do in a milk run operation, employees are sent to a specific site only when an issue arises. The field technician can cover more assets and the amount of drive time is reduced.

Additionally, regular meetings to share operating data are no longer necessary when everyone on the

team already has access to the data in real time. Time previously spent reviewing and analyzing operating reports can now be better spent developing an action plan based on the data. These improvements in operational efficiency save dollars and improve production reliability.

Making a Safer Operation and Addressing Environmental Concerns

For operators working in environmentally sensitive areas, dispatching field operators based on need, rather than following a set schedule, means that their operations will be run with fewer employees driving fewer miles than under the milk run model. From an HSE perspective, this allows operators to decrease their foot print on an area by eliminating unnecessary travel. A SCADA-based dispatch model also reduces chances for injury because it reduces safety incidents as a function of drive time.

In the Rocky Mountains, for example, many sites are under the regulatory oversight of the Bureau of Land Management (BLM). Reducing the amount of operating vehicle traffic on the service and lease roads leading to these sites is a key concern of the BLM. A dispatched mode of operation reduces this traffic significantly. Also, in sites where there are higher concentrations of H₂S, a dispatched mode of operation reduces unnecessary site visits. When a field technician is dispatched, he knows what he is getting into based on the monitored gas detection units. This has a huge safety benefit to an operator.

Lower Costs with Preventive Maintenance

Each hour of downtime costs oil and gas operators thousands of dollars in lost production. For example, if a field compressor produces five million standard cubic feet of gas per day (MMSCFD) and the volume of that gas is worth \$3.50 per thousand cubic feet (MCF), each hour of downtime is worth \$730. Also assume the site averages 20 hours of downtime in a month. This equates to \$14,600 in lost production. Reducing that downtime by just 10 percent (two hours) will bring increased revenue of almost \$1,500. Achieving a reduction of 20 percent results in an additional \$3,000 a month. In general it is reasonable to expect to achieve reductions in downtime of as much as 25 percent.



Each hour that a compressor like this one is down can cost an operator thousands of dollars in lost production. Implementing remote compression monitoring at one field site can result in a reduction in downtime of up to 25 percent.

Operators will achieve these reductions in downtime and increases in production and revenue by adopting the proactive dispatch-based field operation model. As seen in the earlier example, the dispatch model enables a proactive approach. In turn, this also allows operators to implement condition-based maintenance and root cause failure analysis to increase equipment efficiencies and

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Condition-based maintenance is a scheduled maintenance program based on reviewing trends in certain operating conditions, such as vibration readings, discharge temperatures and the results of regular oil analysis. Maintenance is scheduled and planned based upon the indicated need, rather than based on the calendar or run hours. The result is a proactive and truly preventive maintenance program that lowers costs and increases the mechanical availability of the compression equipment.

Mechanical availability is the amount of time in a period that the equipment is ready and able to compress gas. This differs from the run time or down time metrics most commonly tracked by oil and gas operators in that sometimes a compressor is able to compress gas, but is shut down for process or pipeline reasons that have nothing to do with the maintenance of the compressor. By watching the trends in operating conditions, mechanical failures can often be averted with scheduled maintenance. Scheduling the replacement of a failing valve or even a major overhaul to coincide with the scheduled shut down of the system or pipeline maximizes the throughput of the equipment.

An operation that does not use some form of preventive or condition-based maintenance relies upon a calendar or possibly the number of run hours to drive scheduled maintenance activities. Condition-based maintenance keeps a finger on the pulse of the equipment, watching its health to determine when an overhaul is actually needed. This always results in lower operating costs. Sometimes condition-based maintenance will indicate that a costly overhaul can be pushed to the next budget period. Sometimes it indicates the overhaul may be needed sooner to avoid a major catastrophic failure which would result in higher costs and significant lost production.

The data provided by remote compression monitoring also makes root cause failure analysis (RCFA) possible. It is proven that operations that apply RCFA have lower unplanned maintenance costs over time because the dispatch model drives proactive and preventive maintenance, moving the operation away from the reactive repair. RCFA builds the library of experience necessary to spot the trends that cause downtime and costly failure.

All too often the most commonly followed metric for compression operation is run time. This measure is somewhat meaningless without more information. By identifying the causes for downtime future incidents will be prevented. In other words, by categorizing the various reasons that cause a compressor to shut down into as few as five categories, the patterns for downtime can be analyzed and their root causes addressed.

The five buckets into which all downtime hours can be gathered:

- Causes based on events up-stream of the compressor (low suction pressure shutdowns or high liquid level shutdowns in the first stage scrubber)
- Causes based on events downstream of the compressor (high discharge pressure)
- Causes attributed to mechanical shutdowns or unplanned downtime (this is the critical list of items for preventive maintenance plan using condition based maintenance)
- Causes attributed to scheduled shutdowns (these should be minimal, and if they are not, it points to scheduling issues)
- Causes attributed to operational requests (shut ins at the request of the line operator or due to well work or due to contractual issues)

Basically, all downtime on a compressor can be placed into one of these five buckets. And only the third on in the list, mechanical shutdowns and unplanned downtime, points to a compressor problem. Categorizing the down-

time for a compressor can be automated into a SCADA system based on alarm reporting. This guides the control room operator and the local operation management in the pursuit of the real causes for downtime.

Managing the Compression Asset

Managing the compression assets in an operation employing proactive compression monitoring allows operators to more efficiently use their available compressor horsepower. Gas compressors are a major capital expense that may have a usable life of about 30 years. However, due to reduced volumes and suction pressures over time, the average well head compressor is only ideally suited for a specific location and application for less than three years before its cylinder sizes, staging and BHP make the compressor package no longer an ideal fit for the site. At that point, volumes decline and the field operator is left with underutilized equipment and wasted resources. If it is a leased piece of equipment, they end up paying for horsepower they can not use.

Currently, most operators will check that a compressor unit is operating within acceptable ranges, but rarely will they report on a unit's BHP efficiency, a measure of the utilization of the available horsepower. There are advantages to reviewing equipment efficiency as part of the ongoing monitoring process. Monitoring allows operators to check the efficiency of their compression equipment and rotate or downsize operations to optimize the complete fleet of equipment over an entire region.

For example, assume a compressor is installed at well A. The suction and discharge pressures and projected volumes indicate a 1,200 BHP two-staged compressor is required. Over the next few years, the suction pressure lowers and the produced-gas volumes decrease. A new well is drilled in the same operating area. Well B has the same suction pressure and discharge pressure and volume design basis as the original well A. A field that is managing its compression assets by monitoring BHP efficiency of each unit would note that the well A site is now using 750 BHP and the lower suction pressures are starting to indicate a three stage compressor is a good idea. The management of this field would seriously consider relocating the well A compressor to the well B site and installing a lower cost 750 BHP compressor package at well A. The determining factors, of course, would include the relocation costs for the 1,200 BHP compressor. A traditional operation that does not track BHP efficiency by the unit would not necessarily consider the well A unit in its decision process, and would possibly order a second 1,200 BHP unit for well B. The savings in capital costs for a purchased compressor or in operating costs for a leased unit are significant. This one incident could easily result in cost savings that cover the cost to conduct an asset management effort that monitors BHP efficiencies and tracks field wide trends.

The capital expense of compression is significant. However, over time that cost is dwarfed by

the operating expense of that same piece of equipment. Compression monitoring addresses both costs. Monitoring BHP loading and driving a proactive fleet management approach to compression reduces capital expenditures. Moving toward a dispatch mode reduces operating expenses. Furthermore, the savings in dollars, and potentially lives, resulting from creating a safer operation more than justify a remote monitoring approach. All of which, indicates that now is exactly the right time to pursue the proven technology and cost saving benefits of remote monitoring.

The ability to learn from the past and apply it to the future is at the heart of compression monitoring, dispatched operations, condition-based maintenance and RCFA. These approaches result in safer operations, improved efficiencies and lower costs.

Jim Ferro is a vice president with GlobaLogix, a Houston-based oilfield services company that helps oil and gas companies achieve greater efficiency, productivity and accuracy in their oilfield operations by providing access not just to data, but to the right information at the right time. For more information, visit www.globl.com.



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