Brüel & Kjær Vibro

A member of the NSK Group

Case study – Chemical factory decides reciprocating compressors require online comprehensive monitoring strategy

Application Note

Chemical

A major US chemicals company has been struggling with reciprocating compressor problems for a number of years. There had been a number of faults, including catastrophic failures, resulting in significant lost production and high maintenance costs. Portable monitoring instruments were used for measuring the pressure-volume plots to detect leaks and cylinder component damage, but many times the faults were not detected early enough, if at all. A better solution was required.

Figure 1. One of the two CO_2 reciprocating compressors used in the ammonium carbamate process.

Reliability issues for several years

The machines in question were two 3-throw, 3-stage reciprocating compressors operating at low speed (257 rpm), shown in Figure 1. Both machines compress CO_2 in an ammonium carbamate process for making urea, which is then converted into melamine. Most of the faults were due to the valves, but there were other faults, including cylinder liner fractures.

In many cases there was insufficient information for troubleshooting the faults, which consequently resulted in expensive, recurring reactive maintenance and a lot of unplanned downtime.

Fast, reliable, cost-effective solution needed

Very eager to resolve the reliability issues, an investigation was launched to end these issues once and for all. Therefore, the chemical company contracted TF Hudgins, a channel partner with Brüel & Kjær Vibro (B&K Vibro). What was the Plant Manager's primary goal? To operate the compressors for a minimum of two years without major maintenance issues. In other words, the solution should provide early fault detection and reliable diagnostics. This would consequently enable maintenance to be cost-effectively planned ahead of time. The solution should also be quickly installed and commissioned without interrupting production.

Selected monitoring system

The VC-8000/SETPOINT® monitoring system was selected for the task together with training services. One of the important benefits for the rack-based system was that there was no proprietary monitoring server or database needed. All data is stored in the existing AVEVA™ PI System™, including both vibration and dynamic pressure time waveform signals. All the machine condition monitoring to alarm limits is also done in AVEVA™ PI System™. For diagnostics, this could be done on the scalar data as well as on the time waveforms. Moreover, it can be done by either a 3rd party system and/or by SETPOINT® CMS software.

Figure 2. Rear view of the two VC-8000 monitoring racks mounted in the cabinet.

Fast-tracked project

The customer required fast implementation, and the API 670 compliant VC-8000/SETPOINT® monitoring system made this possible. Firstly, the 2 racks are populated by identical monitoring modules. There was no need to install specific modules for specific monitoring tasks. Secondly, the IT footprint for the system was small since there was no need for extra servers. The system was completely installed and commissioned within 6 months, despite a 90-day delay due to a world-wide chip shortage.

Comprehensive monitoring solution

The VC-8000/SETPOINT® monitoring system offered monitoring techniques that gave early fault detection plus there was post-processing diagnostics capability for more insightful analysis and root cause analysis. The reciprocating compressor monitoring techniques provided include:

- Rod drop
- PV diagrams
- Rod load, rod reversal
- Pressure vs. crank angle Cylinder vibration (valves)
- Crosshead vibration
- Frame vibration
- Process variables – Suction/discharge pressure, suction/discharge temperature, compression ratio, maximum and minimum pressures

These monitoring techniques can be used to detect many kinds of potential failure modes. In addition to detecting worn or broken parts, the measurements can also detect leaks, excessive loading and liquid ingestion.

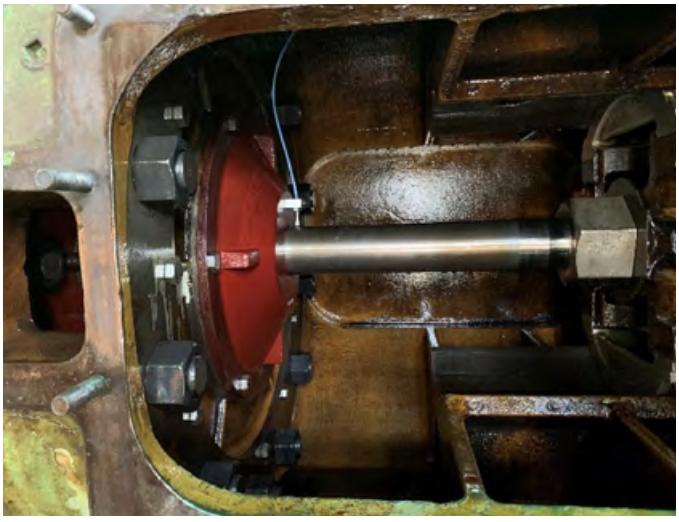

Figure 4. Displacement sensor mounted on a bracket above the piston rod for monitoring rod drop.

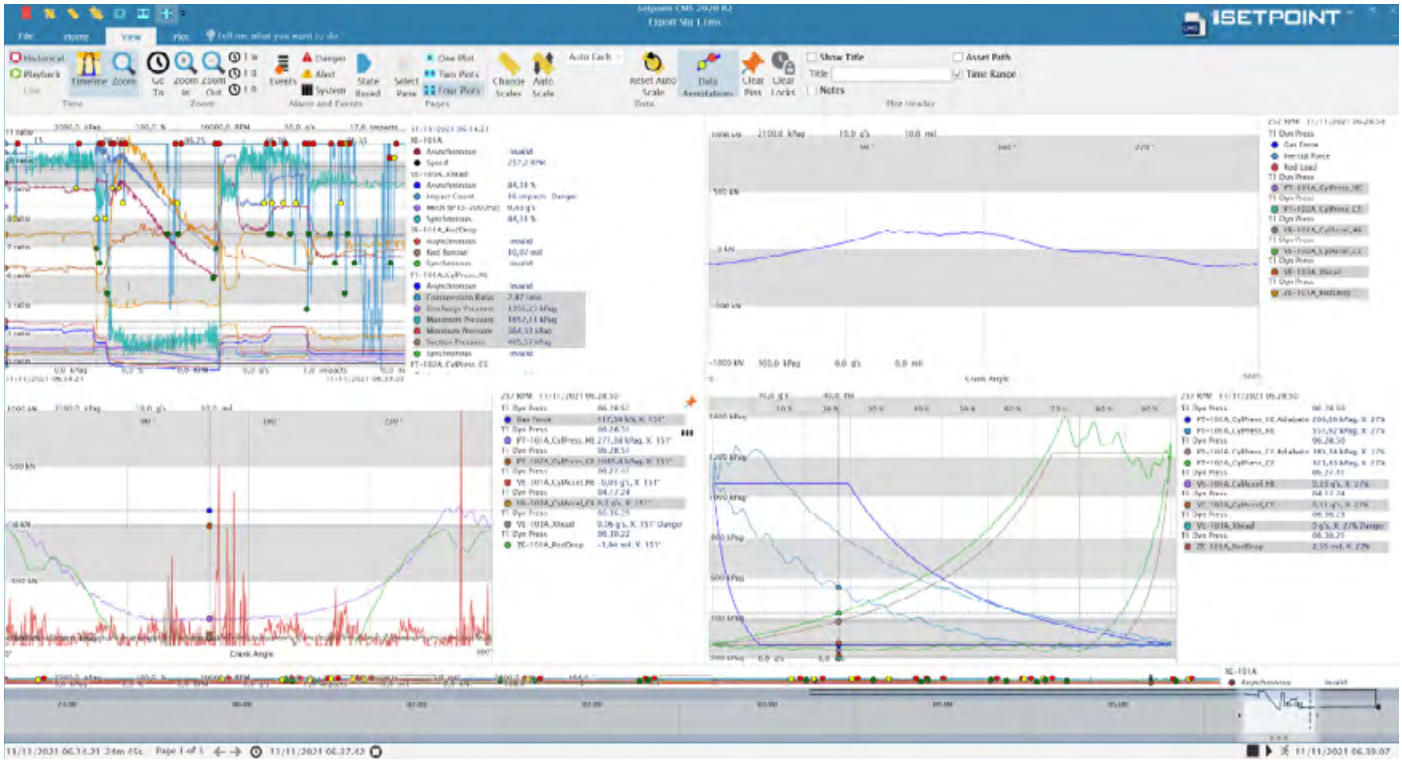

Figure 3. SETPOINT® CMS screen during testing and commissioning showing various scalar values (upper left), cylinder head vibration/ rod load/pressure vs crank angle (lower left), rod load (upper right) and HE/CE PV plots (bottom right).

Conclusion

The chemical company now has the technical means to migrate from reactive maintenance to preventative maintenance. Asset health management now becomes more cost-effective and efficient, which results in reduced life cycle costs for the machines. There is also major risk mitigation for catastrophic failures, unsafe conditions for personnel and loss of production. Just as importantly, there is also less risk of market dissatisfaction resulting from loss of production.

A comprehensive condition monitoring strategy with the VC-8000/SETPOINT® monitoring system is also being evaluated for other machines in the plant.

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