FLOWSERVE

SERVICES AND SOLUTIONS

SUCCESS STORY

Compressor Train Retrofit Improves System Reliability and Output

GASPAC Dry-Running Gas Seals Key to Successful Solution

The Challenge: A seven-stage DHT centrifugal compressor was providing recycle gas service in the crude distillation unit (CDU) of a Dutch refinery. This 20-year-old steam-turbine driven compressor was becoming increasingly unreliable with several failures attributable to bad rotor-dynamic behavior. Secondly, inadequate steam supply (refinery was at maximum steam balance) limited compressor output.

The Solution: Based upon rotor-dynamic lateral analysis and supported by vibration signature measurements, Flowserve Technical Services engineers re-engineered the compressor train to include GASPAC dry-running gas seals, tilting-pad bearings and condition monitoring instrumentation to address reliability issues. A new electric motor with a fluid coupling/step-up gearbox replaced the steam turbine. Due to a compressed project timetable, an industry-first “low-tuned” (spring-supported) honeycomb steel skid foundation replaced the existing concrete foundation. The 3.8 million Dutch guilder (~ $2,360,00) investment resulted in significant energy, maintenance and production loss savings. Payback was approximately four years.

In 1997, the Nerefco Rotterdam Refinery was experiencing severe reliability issues with the steam-driven, sevenstage BCL Nuovo Pignone compressor providing recycle gas service in its CDU. Bad rotor-dynamic behavior, including oil whip and excessive vibration due to seal-oil build-up on the impellers, had resulted in several failures. Furthermore, inadequate steam supply and poor steam quality were limiting the output of the compressor.

The refinery operators turned to Flowserve for help. They tasked Flowserve engineers with three clearly defined goals:

- Eliminate production losses
- Reduce energy costs
- Reduce maintenance spend, especially costs related to the seal oil system

Before

After (Packaging at Flowserve facility)

Findings and Corrective Actions

Vibration root cause analysis revealed the compressor's radial cylindrical bearings were causing critical rotor frequencies, which in turn led to sub-synchronous vibration problems. This analysis also explained the sensitivity to imbalance resulting from seal-oil build-up on the impellers. Floating-ring oil seals were hanging up, causing rotor instability, recurring "oil-whip" conditions and even complete seizure at around 11 000 rpm. These problems were solved by installing tilting-pad bearings and dry-running gas seals, allowing the compressor to run without vibration problems up to its maximum design speed of 12 970 rpm.

Flowserve GASPAC dry-running gas seals not only improved reliability through enhanced rotor-dynamic behavior, but generated significant energy savings. Before retrofitting, this high-suction compressor experienced continuous gas leakage over the throat bushings, which mixed with the seal oil. After GASPAC installation, throughput increased nearly 20%. Further savings were obtained by eliminating the seal oil system where high-energy oil pumps were used to generate the required injection pressure. Costs for reconditioning contaminated seal oil were also eliminated. Additionally, Flowserve engineers replaced the high-maintenance seal oil auxiliary system with the maintenance-friendly seal gas panel, another money-saving benefit.

Compressor capacity issues were addressed by replacing the steam turbine with a 1400 kW (1877 hp) electric motor and a fluid coupling/step-up gear. This enhancement allowed a stepless speed regulation from 4000 rpm to 12 970 rpm. The new drive configuration, however, resulted in a footprint too large for the existing concrete foundation table. Compounding the problem, the project timetable precluded extensive new civil construction.

Flowserve introduced a new foundation concept for refineries, a "low-tuned" honeycomb steel skid with spring supports that virtually eliminated sensitivity to operating excitation forces. (Sensitivity to nozzle load forces and foundation resonance were also minimized.) The entire compressor train, with all instrumentation, control and auxiliary systems, was constructed and tested in a Flowserve Service Center and then transported to the refinery CDU. With the new non-grouted foundation/baseplate, installation and commissioning was accomplished in just 2.5 weeks.

Conclusion

This compressor train is still in operation after 13 years of continuous service with no unexpected outages. The 3.8 million Dutch guilder (~ $2,360,00) investment produced significant improvements in equipment performance:

- Equipment availability is reported at 99.8 to 100%
- Throughput increased approximately 20%
- Energy consumption fell by 10%

The cost savings realized from the project amount to roughly 1.4 million guilders (~ $870,000) annually.

Bulletin FSG-SS-015 (E) Printed in USA. December 2010.

To find your local Flowserve representative:

For more information about Flowserve Corporation, visit www.flowserve.com or call +1 937 890 5839

USA and Canada
Flowserve Corporation
5215 North O'Connor Blvd.
Suite 2300
Irving, Texas 75039-5421 USA
Telephone: +1 937 890 5839

Europe, Middle East, Africa
Flowserve Corporation
Parallelweg 13
4878 AH Etten-Leur
The Netherlands
Telephone: +31 76 502 8100

Latin America
Flowserve Corporation
Martín Rodriguez 4460
B1644CGN-Victoria-San Fernando
Buenos Aires, Argentina
Telephone: +54 11 4006 8700
Telefax: +54 11 4714 1610

Asia Pacific
Flowserve Pte. Ltd.
10 Tuas Loop
Singapore 637345
Telephone: +65 6771 0600
Telefax: +65 6779 4607