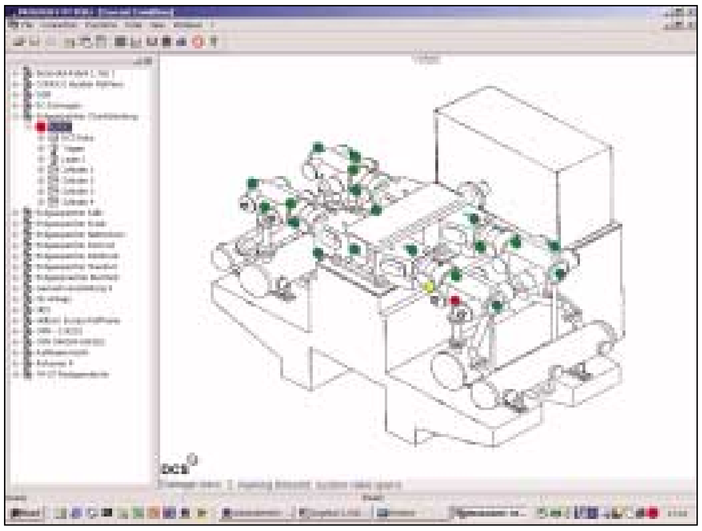
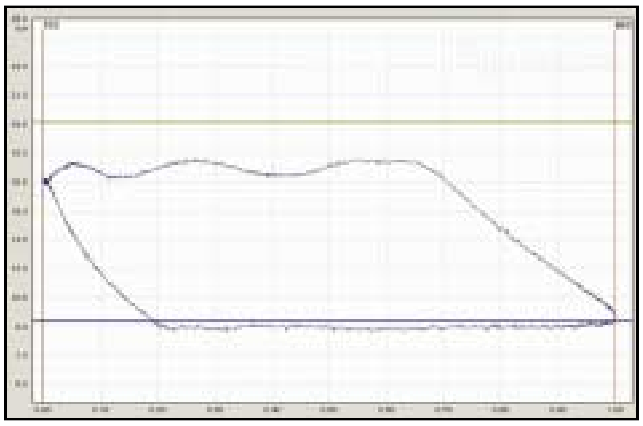




■ Left User friendly visualization with clear machine and sensor overview. Below Damaged discharge valve indicated by PV diagram.

Compressor Monitoring Via Internet

State-of-the-Art Monitoring Systems Allow Monitoring Reciprocating Compressor Performance and Detecting Faulty Operation Before Actual Machine Damage Occurs

By Roberto Chellini

Kötter Consulting Engineers, based in Rheine, Northern Germany, has gathered 23 years of detailed experience with compressor problems. Twelve years ago Erwin Kötter, founder, had the idea of a monitoring system which informs the operator, at any time, of the condition of his machine and so he developed the on-line telemonitoring system, Prognost-NT, for reciprocating compressors. The big challenge was to create something really new and to merge two completely opposite disciplines — compressors and computers — together into a new level of quality: the "smart" compressor.

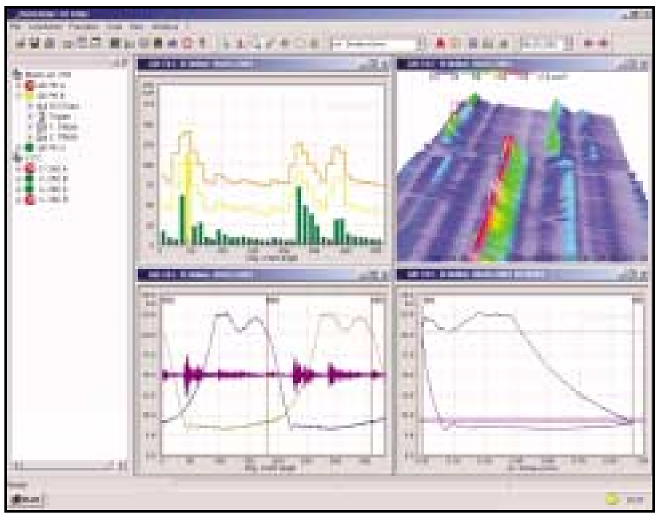
The on-line machine-telemonitoring business has grown to the point where it is separate from the original company created by Kötter Prognost Systems GmbH guided by Alex Deitermann, as managing director. "To be effective and successful in a typical system business, it is absolutely necessary to build up the right structures inside and outside the company, explained Deitermann. However, it is not enough just to create and sell products, because nowadays the customer is looking for more — a comfortable solution that is easy to handle. Consequently, we made a conserted effort to involve our clients in providing a customer-oriented service, specifically through user training, workshops and 24-hour-hotline support. Customer involvement is a very important part of our company philosophy. To be nearer to our customers, we have created subsidiaries in Hamburg, Houston, Texas, U.S.A., and recently, Paris."

Telemonitoring systems initiate a revolution of maintenance strategies into condition-based maintenance," Deiterman stated. "In the past, experienced technicians used their ears, fingertips and eyes as human sensors to detect failures in the machine. Instrumentation, for example, for temperatures at valves and packings, proximity probes for piston rod position and vibration probes have been added in the last two decades to obtain more precise information about condition changes of the compressor. But even with 'snap shot' analysis it is not possible to get a complete overview."

With the introduction of technology driven systems, an important step has been taken toward data collection and trend storage and automatic analysis leading to a quicker and more precise interpretation and evaluation of measured values. With the right strategy this information can be correlated to the compressor functions to allow a high level of automated results.

According to Deitermann, the system provides a higher than 90% accuracy related to pinpointing the location and the function of the occurring failure — a high performance in practice. A reciprocating compressor operates totally different from a centrifugal and needs a special philosophy to understand its language. Considering this, the compressor will tell the operator exactly what is right or wrong.

In Kötter's approach, the first step for all mechanical influences is a vibration analysis related to the crank angle of the compressor. To combine the functions of the compressor with the produced vibrations, the system generates 36 independent vibration analysis for every 360° stroke — one complete analysis for every 10° crank angle segment with all relevant statistics behind. The second method is the PV-diagram analysis which covers the fluid dynamics. The third base is the integration of all wear parameters such as rod drop, packing temperature, oil condition, etc. And number four is the import of all existing measurements in the environment of the compressor, such as suction and discharge pressures, gas temperatures, flow rates, etc., by the integration of the DCS/PLC system of the plant. These four methods or any combination of them, together with intelligent analysis methods like pattern recognition, are the most important when creating a reli-



■ Comfortable overview of different analyses includes: left, easy plant overview with visualization of alarm levels; center (above), threshold visualization; center (below) pressure and vibration signal; right (above) pressure and vibration signal; right (below) PV diagram analyses.


Damaged valve plate.

able condition evaluation.

The Prognost reciprocating compressor monitoring system relies on industrial PC's and MS-Windows NT, this offers a big chance to keep all users up to date on the same latest level. New features, additional analysis, user-friendly helps are delivered by modem or CD to update existing systems to the latest release. This means an up-to-date guaranty for the future and is not meant to underestimate the value of the investment.

With a laptop and a modem, every authorized person can access all information about the particular compressor without travel and time delay. Even if a plant is in the desert or somewhere offshore, personnel can react within seconds from a remote location. Moreover, this monitoring system is extremely user friendly. It generates automatic alarms and informs its user with clearly understandable messages even for non-specialists in data analysis.

Deitermann pointed out that Kötter customers like BASF, Bayer, BP Amoco, Celanese, Conoco, DSM, DuPont, Lyondell-Equistar, just to name a few, have adopted Prognost-NT on-line telemonitoring systems within their safety, reliability and maintenance strategy because of: increased safety — this is most important for most customers, since safety and the avoidance of catastrophic failures is related to four aspects, personnel, environment, production and machinery; increased reliability — this is important especially for unspared machines and compressors with a high performance, the operator knows earlier about an impending failure and is able to prepare a targeted maintenance measure and minimize downtime as well as a loss of production; reduction of maintenance costs, going along with reduced costs for wear parts — since maintenance can be organized and completed, condition-oriented wear parts can be exploited up to the maximum level and because a worn part is clearly identified, only that one will be exchanged (e.g. one valve instead of four) — this reduces parts and labor costs; increase of efficiency — the experience of on-line PV-diagram analysis shows that most compressors do not show ideal PV-cards. The on-line system recognizes influences like wrong valve springs, which normally are not recognized, or pressure pulsations, which lead to high energy losses. A customer saved up to $80.000/year for a 4292 hp (3.2 MW) refinery compressor just through efficiency increase.

The architecture of every telemonitoring system has to be as individual as the compressor and its use, and, consequently, it must be, of necessity, of modular design. This leads to customized combinations, depending on the need and the budget of the operator.

"In general," concluded Deitermann, "one can say that the price of a good and reliable compressor monitoring system ranks between 5 and 15% of the value of the monitored machines and meets the common range of comparable applications. Once installed, the use of the internet is a very cost-effective base for the transportation of compressor information. Service databases with the chance to select information horizontally for research and development purposes offer new opportunities. Our customers already have the most extensive compressor laboratory ever possible — real machines with true measurements under true conditions instead of simulations. I am also convinced that condition monitoring will influence the construction of compressors in the future. True figures over long periods of time, including all kinds of influences, like changes in temperatures, pressures and load are the best base for further development of machines, efficiently. I find it absolutely fascinating when I observe what is happening — reciprocating compressors being built to last for about 100 years. And, now this machinery is equipped with a virtual brain and becomes an intelligent system. Isn't that fascinating?"

At the time of this writing, the Prognost-NT monitoring system has been installed on Ariel, Dresser-Rand, GHH, Neuman & Esser, Nuovo Pignone, Sulzer-Burckhardt and Thomassen compressors in refineries, petrochemical plants, the technical and natural gas industry. All machines are operated in hazardous, explosion-protected areas and comprise various constructions in the range between one-cylinder verticals with 500 hp (370 kW) up to 10-plunger, horizontally opposed, LDPE hyper compressors with up to 46,000 psi (3200 bar) discharge pressure and 16,500 hp (12,000 kW) electrical drive. ■

Right Alex Deitermann, managing director, Kötter Prognost Systems GmbH. Below For the Conoco Ltd. Humber Refinery in Humbersided, England, Prognost-NT was installed in 2000 on a four-cylinder process gas reciprocating compressor rated 3500 hp (2.5 MW) for multiple services.