Fine-tune monitoring of critical compressors

In this case history, a new monitoring system was installed on a critical service hyper compressor for a Middle East (ME) ethylene complex. This unit supported two 400 Mton polyethylene (PE) units; downtime for the compressor was extremely expensive to the operating company.

The advanced monitoring system features an automatic safety shutdown when a pre-defined number and level of critical signal levels for compressors, in this case for a hyper compressor is violated. The goal is to guarantee a cost-efficient operation by protecting plant equipment and minimizing unit unavailability. The new monitoring system provided extensive data, thus allowing the reliability team to draw conclusions on the reasons for the shutdown and appropriate action to implement (FIG. 1).

**Installation.** The Principal Petrochemical Complex in Jubail, Saudi Arabia, consists of several plants—a 400-Mton high-density PE and a 400-Mton low-density PE plants. Approximately 70% of polymers are sold on the world market and 30% is consumed in the ME Gulf region.

**Overview.** The respective compressor is an ethylene hyper compressor built in 2006/2007 that operates as a secondary compressor. It is equipped with an advanced monitoring system. This system monitors vibration and pressure, as well as plunger run-out ($x/y$), as shown in FIG. 2.

**Sequence of events.** Only seven minutes before trip, the hyper compressor was running normal; all signals were within the defined safety limits (FIG. 2). Cylinder 2B showed deviations in the vertical plunger position. The peak-to-peak value changed from 150 µm to 420 µm and violated the safety limit that was set at 400 µm. The horizontal plunger position stayed on a normal level (FIG. 3). Shortly after, the higher plunger run-out occurred and the plunger temperature increased from 60°C to 70°C.

Both the crosshead and cylinder vibration levels remained at normal, as shown in FIG. 4. Based on the safety limit violation, the advanced monitoring system shut down the compressor. The event occurred on a weekend; only the operations team was on site. Operations staff decided to restart the machine after adjusting the lubrication system to 100% quantity without consulting the reliability team. After the restart, the plunger vibrations returned to an acceptable limit. The temperatures

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*FIG. 1.* Sensor installation chart for the hyper compressor.

*FIG. 2.* Seven minutes before the trip, all signals of cylinder 2B were good. The vertical plunger position was at 150 µm peak to peak. Cylinder and crosshead slide vibrations and dynamic pressure were at normal levels.
also returned to normal. No further data analysis was done.

Pre-failure conditions. For 24 hours, the compressor ran without reaching any critical values. The operations team reduced the lubrication to 90% and the plunger displacement values increased to 220 µm. Again, the reliability team was not informed. After the weekend, a reliability study was conducted.

The operations team had reduced the lubrication for another time to 85% quantity to analyze the effects. With the reduced lubrication, the vibration radically increased again, reaching 320 µm. The reliability team recommended replacing the packing and central valve. When the compressor was inspected, several findings were made:

- The sealing for packing cups 2 and 3 were found with polymer sticking over the entire portion.
- The throttle ring for the packing cup 7 had lost its garter ring.

The teams came to the conclusion that the temporarily provided large amounts of lube oil helped to fill the gaps in the damaged cups, which allowed the plunger to run smoothly.

Tripping events require analysis. For the operating company, this sequence of events led to several conclusions to avoid similar cases in the future. After the automatic shutdown of a compressor, meaningful diagnostic analyses are mandatory by trained personnel. Focusing on 100% lubrication may lead to wrong conclusions for the compressor malfunction. The result may be severe damages to critical parts, leading to longer downtimes.

Using a reliable compressor monitoring system can provide all relevant data to conduct such an analysis and to yield correct conclusions on the compressor. HP

NOTE

1 The PROGOST-NT Monitoring system features an automatic safety shutdown when a pre-defined number and level of critical signal levels has been reached within a compressor.