



Expertise in Turbomachinery Controls

CASE STUDY

Petrochemical Plant Retrofit Project



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Situation

One of the two largest petroleum refiner and oil products producers in China was facing a retrofit project on the Changling, Baling refinery in Yueyang City, Hunan Province, China. The original compressor control system was obsolete and could not meet the expectations of the unit's new operational targets. An initial retrofit began in 2005, with installation of an updated system completed in 2007, after the raw material was changed from coal to oil. The compressor train ran successfully with improved ability to compensate process disturbances, enhanced automation of the unit and reduced steam consumption and maintenance costs. After the event, the unit's system began showing problems. The aging of the unit and the increase of domestic demand caused an upswing in the frequency of surge, rotor repairs and seal failures. The plant began to experience frequent shutdowns.

Solution

After a CCC site inspection and client consultation, several issues were determined. These included:

1. The current control system could no longer accurately time and detect surge. The simple anti-surge control system consisted of only one anti-surge valve. This outdated control strategy was based upon the flow ratio between Stage 4 discharge to Stage 1 suction, and then added a safety margin.
2. The actual surge line was never measured. As a result, the anti-surge control was in manual mode, so the unit could not be properly protected during process disturbances. Also the unit's start-up was in manual mode and relied on operator experience.
3. The original mechanical/hydraulic speed control/steam-extraction control strategy could not meet the plant's speed and steam control requirements. Trip risk events rose significantly during critical speed periods.

These issues, with the obsolete, traditional control strategy resulted in large steam waste and low unit efficiency.

The Series 5 Control solution updated the original system, including two operator stations to replace the original operator keyboard, one Guardian® Overspeed protection system; retrofitted lube oil control system and three (3) electro-hydraulic converters to control high, medium and low pressure control valves were implemented.

The Series 5 provided a deterministic, multi-tasking operating system with mechanical/ instrumentation system controls, PID control systems, antisurge control, speed control and over-speed protection. CCC also measured and produced the actual surge line and actual performance line. The system also improved the process set-points and operational parameters. By adding the Guardian Overspeed protection solution, the client gained a reliable, economical way to protect the turbine. Turbine speed was monitored and a trip command feature is initiated in the event of an overspeed condition. The Guardian system also measures a frequency input signal from a passive or active magnetic pickup sensor.

Results

The client saw improved system control accuracy and safety of their compressors. Unit start-up and warm-up was in automatic mode an automatically compensated for process disturbances. This resulted in a reduction in consumption of raw materials and energy during the start-up and warm-up period. The anti-surge controls improved reaction time. With the system now in automatic mode, responses were much faster than manual mode and avoided surge more efficiently. An added benefit of the controls was avoidance of unnecessary compressor trips during the process disturbance. This enhanced both the safety of the facility and optimized plant personnel.

Implementation of a limiting-control strategy optimized the operational envelope by allowing the unit to operate near the surge line, thus reducing the consumption of steam. The unit now operates with the least amount of energy consumption as well as load-sharing to optimize the multi-compressor's efficiency.

A centralized operator monitoring and controlling process simplified the operator control ability. This allowed operators to quickly determine process problems and resolve issues quickly and efficiently – greatly reducing the operator's burden and solving operator staff shortages.

Since implementing the Series 5 and Guardian, the units experienced no surge events, thus the compressors experienced no internal damage. Vibration on the train remained under 2.0Mil and very stable. By optimizing the CO2 units, the facility saw improved coordinated control of speed, loading, and Stage 4 to Stage 1 recycle valve. Increased efficiency was achieved by reducing the compressor start-up time by one hour – which is a savings of 60 tons of medium pressure steam per start-up. Also, under the same operating conditions, the unit now saves 6 tons of steam per hour.

The level of automation for the CO2 units was greatly enhanced. The client enjoyed success in meeting their goals of enhanced safety; safer, more reliable and more efficient operations; increased production and optimization of staff.