TIME TO UPGRADE

Nik Dillier, AST Turbo, Switzerland, outlines how upgrades on rotating equipment in the fertilizer industry have gained importance to satisfy future operations in terms of safety and reliable production operation.

Rotating equipment in the fertilizer industry, or generally any chemical process industry, accumulates decades of wear-and-tear, meaning that safety regulations are continuously revised or extended, and crucial safety systems become outdated. Consequently, related upgrades becme vital to satisfy future operations in terms of safety and production reliability operation.

A central element for steam-turbine driven compression-trains is the governing of live steam speed- and trip-valves by electro-hydraulic actuator-control. Upgrading an existing outdated system with specific, given interfaces poses several challenges, from engineering and manufacturing to its implementation in the field. This article discusses an implementation to increase plant

reliability in a petrochemical plant, which is also applicable to fertilizer producers, due to similarities in critical machinery.

As an independent service provider and upgrade engineer for critical rotating equipment, AST Turbo was awarded an upgrade of existing turbine control systems to conform with SIL2 ratings by a major European petrochemical producer. The supplier's objective for its client was to rely on a partner to engineer, plan, and implement the upgrade from a single source, without interfering with planned turnaround activities. The multidisciplinary challenge was approached in terms of engineered hardware and the process of its implementation.

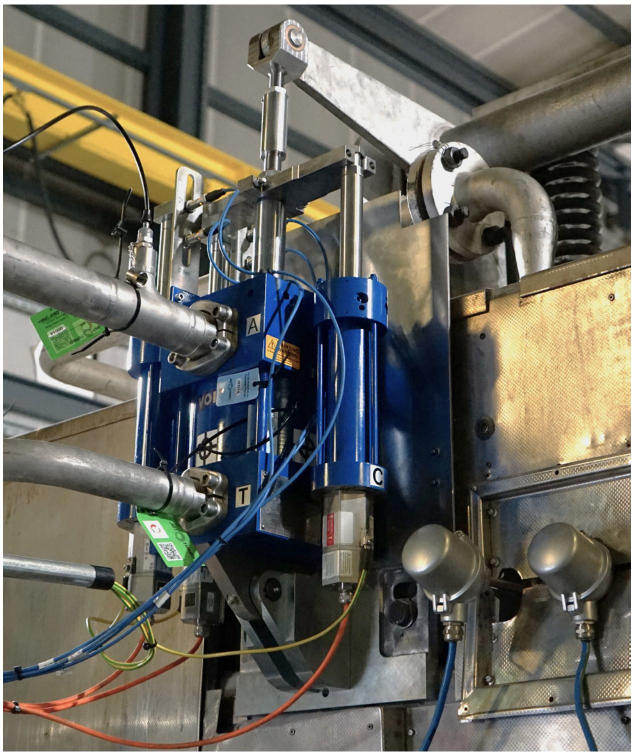

Figure 1. Fully equipped live steam control valve actuator.

Figure 2. Rack integrated into existing compression train.

Figure 3. Setup during FAT.

For modernising turbine control to be accordingly safe, fast, and accurate, the company came up with the concept of a compact, standardised and modular rack-frame. The concept accommodates redundant components, which are independently customised to the type of speed and trip actuators. In particular, the rack's functional elements are duplex filters, redundant accumulator, electro-hydraulic-converter, a 2-out-of-3 trip system, an automatic pre-heating function for the turbine, and a partial stroke module. Careful pre-heating during cold start is facilitated by a way valve to gradually supply live steam into the turbine. The automatic partial stroke module regularly conducts minor movements of the trip valve, to ensure functionality by excluding a stuck valve. Moreover, an ergonomic and maintenance-friendly design manifests itself by well visible control elements, like view-glasses, transmitter-screens or easily accessible levers or switches.

Supplier nomination was 22 months ahead of installation, which itself had to happen during a normal plant turnaround window of 30 days. Besides the short overall timeframe, a given valve- and oil-system, space-restrictions, a tight implementation window and complex project-interfaces posed the framework conditions. Furthermore, despite controlling two different actuator types of four steam turbine driven compressor trains, the racks should be as standardised as possible, easy to operate and – as directly operation-critical equipment – highly reliable. Before this background and beyond the requirements, note that the racks are ready prepared to satisfy even SIL3 level.

The following demonstrates how this project-scope was tackled and brought on track without disturbing any major turnaround activities.

Beyond corresponding experiences in meticulously planning, preparing and executing such complex projects, the toolbox required specific technical competences, detail and quality dedication and customer-oriented flexibility. Knowing and managing all present interfaces with sub/co-suppliers, reporting duly, and limitlessly being available in case of timepressing troubleshooting across and beyond responsibilities was crucial. Last but not least, it was important not to underestimate the human-factor. Knowing whom to deploy with their individual competences, mutual compatibility and capability to cooperate can be decisive when setting up a task force team and their leader, especially when going the distance in a stressful and tense environment/critical phase.

Eventually, on-time and quality-conforming finalisation of such a multidimensional project is rooted in the very beginning, far ahead of installation. Concrete execution was organised with the following steps and actions, demonstrating an applied and distinctive understanding of quality and dedication.

Besides selecting the right tools, update-frequency and group of informed stakeholders for efficient project tracking, a key strategy was to apply the single-minute of die (SMED) principle. All four racks were installed six months ahead of the turnaround – even before preparations like scaffolding, which aggravates and limits access to the racks drastically.
However, this idea only works as well as the preparatory actions it is based upon.

During the engineering phase, the components were defined, according to the respective machine with pressure or way valve driven actuator, and made redundant. As such, they were entirely exchangeable during operation.

The first activity on-site was to analyse positioning, mounting- and space-conditions around the turbines for the control racks and the corresponding new turbine actuators. This input finalised the geometrical overall layout, especially for the piping interface flanges, to keep external supply- and return-lines short and avoid intersections.

After the completion of the manufacturing process, the factory acceptance test (FAT) was carried out in a more detailed way than conventionally performed. In particular, it involved a hydraulic test skid to provide necessary oil supply towards representative test actuators, including a PLC cabinet to simulate a realistic control environment with the actual software. With this setup, all functions could be tested and controller tuning could be commenced in advance. Any rack-internal signals were validated by loop-checks upfront, to rule out the possibility of any faults originating from the internal rack cabling. This presents a potential time advantage during commissioning by limiting the source of error.

Following the SMED principle, during full commercial plant operation, all four racks were rooted into the foundation at their final location next to the running turbines. This built the precondition for the next pivotal steps.

For having premanufactured piping spools between the rack and the control actuators ready-to-install before the start of the turnaround, they had to be correctly dimensioned and virtually routed beforehand. A specialist was deployed to utilise its internal laser-tracker tool to digitally map the centre of every connection flange. The hereby generated metadata defined the start and endpoint of each piping spool. Running steam turbines with thermal expansion and vibrations presents a special challenge for sensitive laser measurement equipment. Thus, careful result quality validation was required to exclude unacceptable deviations. The effect of thermal expansion was calculated beforehand and was considered for the laser-measurement results. The piping and their supports were designed to compensate the thermal growth, allowing for the required degree of freedom within acceptable stress levels for the installed parts.

Also, during this stage, the final routing of required signal cables from the PLC cabinet into the field junction boxes was finalised. Like this, the acceptance test with all loop checks between field and UCP could be signed off before any restricting turnaround gear was put in place. In addition, all correlating signal cables from the steam turbine side to the rack – i.e. trip and speed actuator feedback – were routed to the respective, rack-internal junction box.

All procurement and supplier interactions were done during the COVID-19 peak-phase, late 2021 to early 2022. Globally shaken supply chains and accordingly poor lead times, especially for electronic equipment such as transmitter, magnetic switches or position transducers, meant make-or-break uncertainties. In the end, the key to receiving all parts on time was close coordination with suppliers and the preservation of flexibility.

Conclusion

A standardised, modular solution/concept to equip outdated hydraulic turbine control systems with a wide steam turbine fleet-range was developed. Moreover, it was proven that such a major upgrade can be implemented without interfering with turnaround activities, if respectively planned, managed and executed. Safety and reliability need not to be considered competitive but compatible with a quick and lean turnaround. WF