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Ensuring the operability of a Turboexpander Dew Point Unit

Dynamic Analysis helped to determine the adequate sizing of the unit's equipment and of its protection measures

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Técnicas Reunidas is a leading international engineering company that develops projects to meet the needs of energy demand and environmentally friendly products for a wide range of clients around the world. Committed to optimizing resource efficiency, TR has designed and built more than 1,000 industrial plants in over 50 countries throughout its more than 60-year history.

Detection of valve saturation and trip conditions in the early design phase saved time, reduced costs, and maximized engineering value

Challenge

The correct operability of a Turboexpander Dew Point unit depends on the adequate sizing of the equipment involved, the correct values of the control tuning parameters and the optimized operating proceedings.

Solution

An Aspen HYSYS dynamic model of the unit was built and several operating scenarios were carried out which revealed some design issues that were possible to correct before unit commissioning.

Benefits

- Adequate Equipment Sizing
- Understanding the transient behaviour of the unit
- Optimization of the PIDs tuning parameters
- Operating Procedures enhancement
- Testing of New Operating Procedures
- HAZOP limits confirmation
- Early risks identification resulted in cost reduction and prevented later unexpected modifications

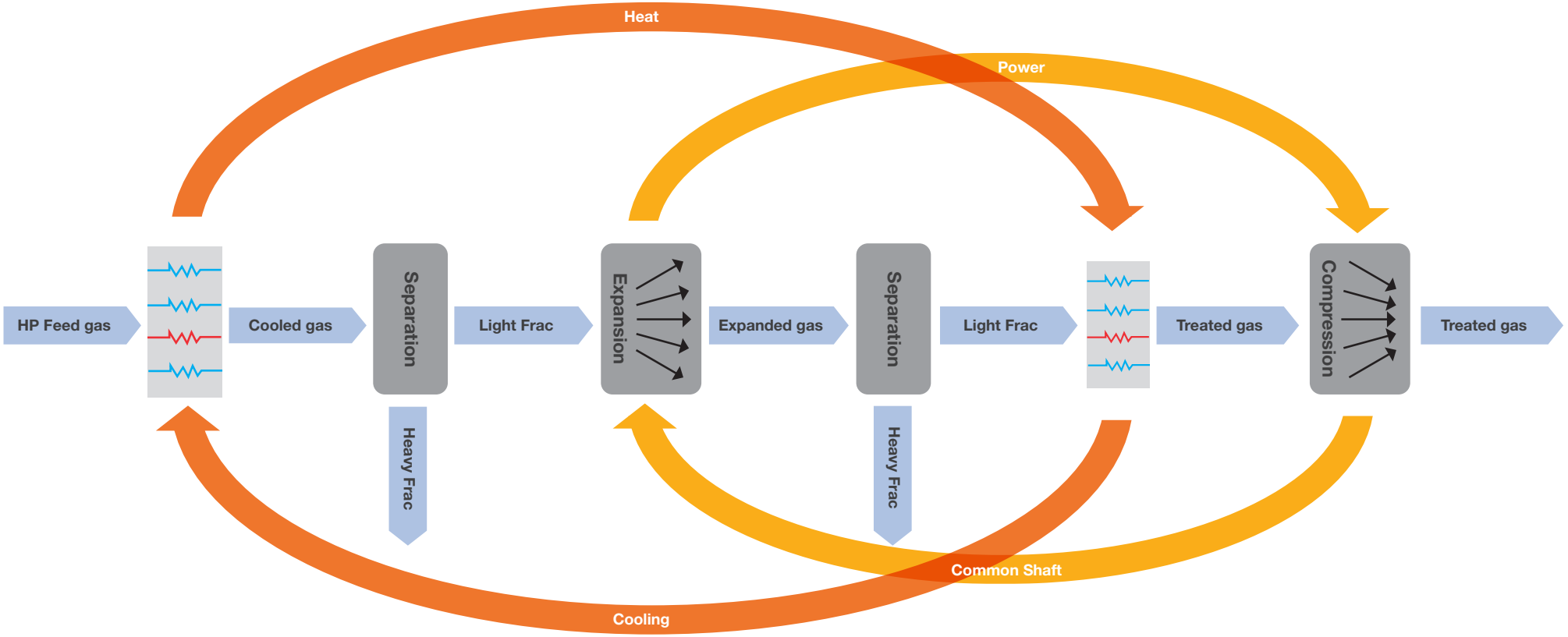
The Challenge in context

A turboexpander is a rotating machine with an expansion turbine that converts the energy contained in a gas into mechanical work, much like a steam or gas turbine. A steam or gas turbine's goal is to convert the mechanical work into useful power, by either driving an electric generator or being the prime mover for another rotating machine, such as a compressor or a high-power pump.

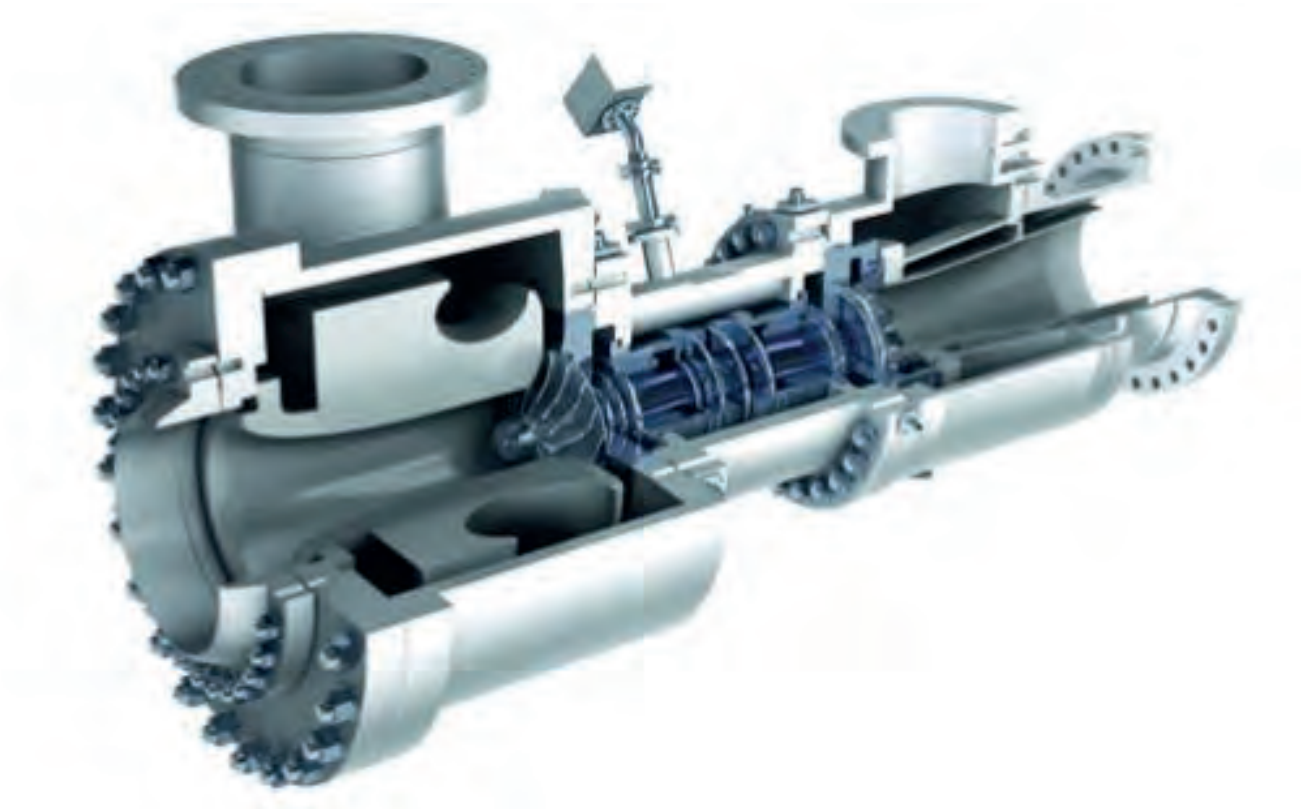
Turboexpanders find uses in many applications. They are standard in the natural gas industry for dewpoint control. They are also used in the petrochemical industry for ethylene plants, refrigeration and power generation.

In natural gas dewpoint control, the cooling effect that is a consequence of the gas expansion provokes the condensation of heavier hydrocarbons, reducing its amount in the sales gas, thus "purifying" it, in a sense.

The mechanical work obtained is used to recover, in a compressor station, part of the pressure that has been lost during the expansion process.



The Dynamic Study Motivation



Future operational issues needed to be considered during the design and sizing of the equipment, its parts and its control system.

In this particular case, the turboexpander was expected to be installed in a country with marked differences in weather conditions between summer and winter. Variations in the raw gas composition were also expected during the anticipated years of operation.

Therefore the dynamic simulation study had to confirm that a number of operational objectives were achievable with the proposed machinery design:

- Adequacy of the proposed overpressure protection system
- Suitability of the construction material selected, based on minimum design metal temperature
- Correctness of the re-compressor anti-surge protection
- Operability assurance within product specifications for several different upset scenarios
- Adequacy of the protection features to ensure a safe shut-down of the machine
- Capability of the turboexpander to start-up with the selected driver

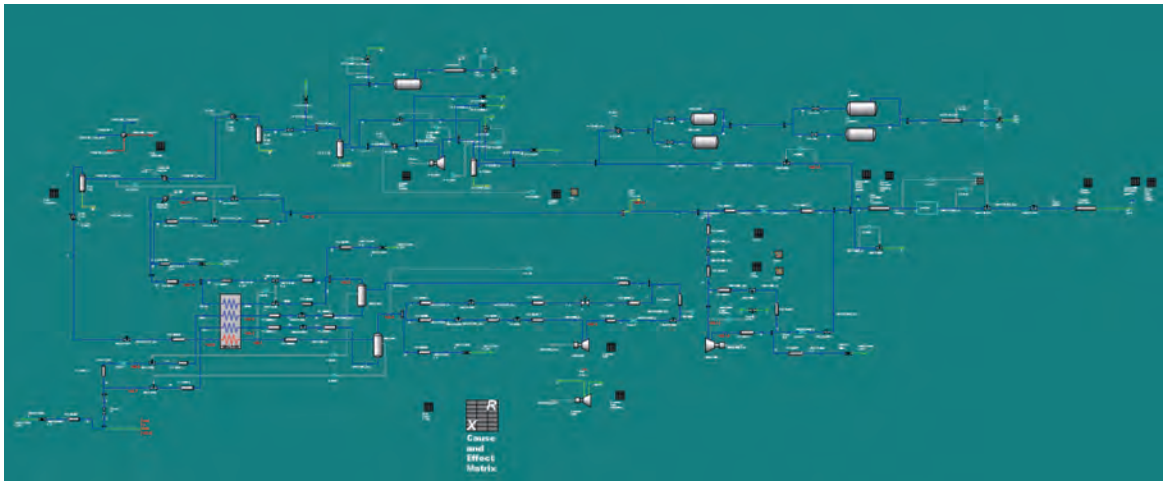
Implementation by Inprocess

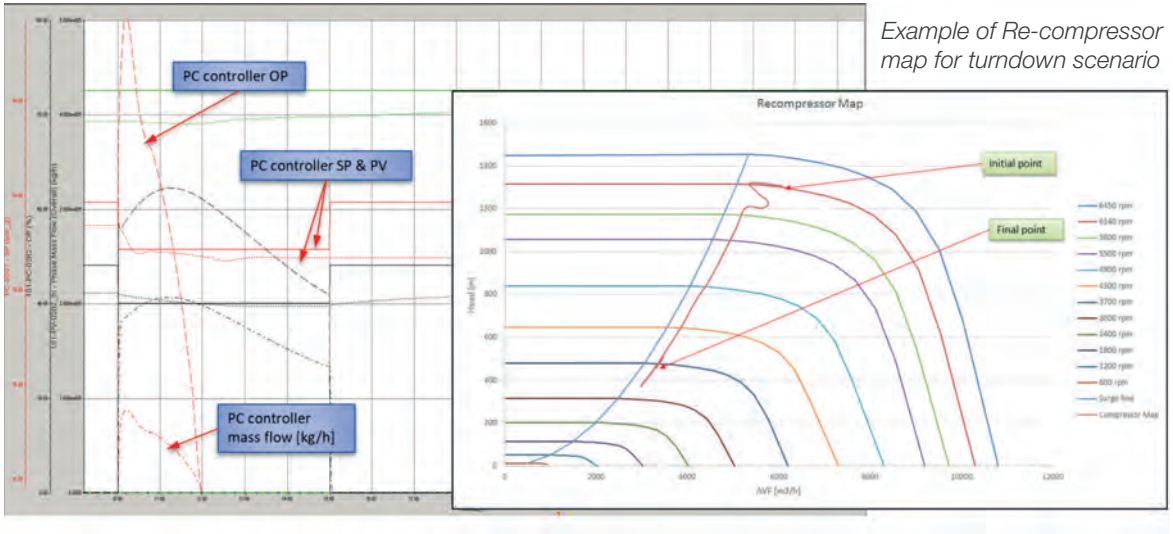
Inprocess developed a dynamic process simulation model using Aspen HYSYS. The model was validated against design and manufacturer data.

In order to properly model a turboexpander unit in the commercial simulator with Inlet Guide Vanes in the expander, some expertise was required in order to match manufacturer design data with expected unit details. Fast transient in critical valves also needed to be tuned with the help of the spreadsheet formulas.

Once the model was ready, Inprocess created several operational scenarios for various normal and upset conditions (summer, winter, gas feeds), including:

- To JT mode with recycle and partial export
- To JT mode without recycle
- Turndown (40%)
- Sudden valve closure at export pipeline
- Start-up of the turboexpander, including transition from JT mode to normal operation through inlet guide vanes
- Emergency shutdown
- Normal shutdown





Example of Re-compressor map for turndown scenario

Key Benefits

- **Adequate Equipment Sizing:** Most of the scenarios confirmed the right sizing of the equipment, but certain cases revealed some issues (valve saturation, trip condition, off-spec, etc). Most of the issues were solved by re-setting or ramping setpoints, changing sequences or tuning the controllers.
- **Understanding the Dynamics of the System:** The transients gave precise information of the available time before off-spec or trip conditions were reached, allowing the possibility of optimizing certain procedures, alarm and SP settings and to increase the reliability and availability of the unit.
- **PID Tuning optimization:** The PIDs tuning was revised several times since scenarios required a number of more or less aggressive actions. A single set of tuning was provided to satisfy all scenarios.
- **Optimization of Existing Operating Procedures:** When export gas is cut, the plant works in recycle and a detailed procedure was tuned to bring the unit back online.
- **Testing of New Operating Procedures:** The start-up of a new machine is tested through simulation, allowing for early risk identification and thus avoiding loss of production during real operation.
- **HAZOP:** The Dynamic model allowed the checking of those limits established during the HAZOP meetings, an impossible action to carry out without the use of dynamic model.
- **Early Risk Identification:** when the engineering project is in the design phase an early stage issue finding leads to achieving the best solution with minimum cost and modifications.

Inprocess

Inprocess is a leading services and consulting company that supports its clients with results from process simulation in an effort to help them achieve safer, more reliable and more profitable industrial operations. Our services and products provide guidance to the design and the operation of highly complex hydrocarbon and chemical processing plants where it is critically important for operations to reach and remain at optimum values. Inprocess' independence of any specific technology provider facilitates our ability to exceed customer expectations as we are free to combine results from any piece of software available in the market. Our added expertise in software development helps to fill the functionality gaps when commercial products do not meet all our customer's requirements.

Inprocess' passion for knowledge transfer has contributed to the acquisition of skills by our clients, delivering high returns in their investments, in both current and future projects.

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