PROCESS CONTROL/ INSTRUMENTATION

Advanced process control boosts plant performance

by Andrew Taylor, Daniel Duffy and Randall Yeates

This article describes an initiative undertaken by Santos and Apex Optimisation to improve the profitability and operability of the Port Bonython liquid hydrocarbons processing plant in South Australia through multivariable predictive control (MPC). Commissioning was completed early this year and in June the project won the 2009 PACE Magazine Zenith Award for best entry in the oil, gas and hydrocarbons category.

This project illustrates how advanced process control technology, which has been used for decades in the oil refining sector, can be successfully applied to different processing industries to improve profitability and energy efficiency, and reduce the environmental footprint.

MPC incorporates a matrix of modelled dynamic process responses with an optimiser to maintain the plant at the most profitable vertex of the allowable operating envelope. The benefits delivered often include improved profitability, operability and safety metrics. As MPC is purely software-based, it extracts maximum value out of the existing assets with negligible production impact and favourable project economics.

The project proposal identified areas where MPC technology could be exploited including:

- management of the natural gas flow limit to minimise propane consumption and improve stability of the fuel gas calorific value

The LPG fractionation columns at Port Bonython.

The lead story reports on a recent installation of new process control software at a liquid hydrocarbons plant in South Australia. Also included are stories on laser sampling, a contract in New Caledonia and an international automation award presented to an Australian engineer.

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- maximisation of heat recovery from the deethaniser feed and product exchangers to reduce reboiler energy consumption
- improved propane yield.

This article focuses on some general project challenges and the deethaniser application in particular. The deethaniser column removes ethane from the hydrocarbon mix supplied from the Moomba gas plant located in the Cooper Basin. Propane, butane, naphtha and crude oil components then undergo further processing.

The project presented some significant challenges as this was the first implementation of a large-scale MPC at Santos. This required extensive consultation to ensure that the operators remained supportive throughout the transition to the new technology and operating philosophy. In addition, interfacing the new MPC software with the existing Foxboro Spectrum distributed control system used at the site provided a significant challenge.

The control of the percentage of ethane in the propane is fundamental to the main control objectives. After "pretesting", it became obvious that this would be difficult to achieve as:

- at 7-8 hours, the response time for ethane in propane, as measured by the online analyser, was much longer than expected
- the MPC handle traditionally selected for the deethaniser cutpoint had limited correlation to the ethane percentage in propane
- plant feed ethane percentage was set at Moomba and pipeline flows dictated that any changes would take two weeks to arrive at Port Bonython.

However, variation in the amount of ethane in refrigerated propane above the specification limit was tolerable as it is reduced by vapour draw from storage. In order to control the natural gas consumption in the face of varying fuel gas demand and occasional treater depressuring in the fuel gas system, good control of the deethaniser offgas was important. Fortunately, the offgas responded quickly to changes in reboiler duty.

After some careful consideration of the plant characteristics a more effective and robust approach was developed. The target offgas flow would take into account the amount of natural gas consumed so far and the number of hours remaining in the day. The reboiler duty was modulated to deliver the target offgas flow and the deethaniser fractionation was controlled by maintaining consistent reflux flow.

Assuming the ethane control at Moomba

was reasonable and the deethaniser fractionation was steady, the amount of ethane in the propane product could be implicitly controlled via the mass balance without referring to the ethane analyser.

This approach exploited the available degrees of freedom to automatically meet the shorter timeframe constraints and acknowledged that the longer timeframe constraints, with more surge capacity, could be resolved by the operator using slower process handles.

The benefits of the project have exceeded expectations. This includes reduced consumption of propane as fuel gas, as the natural gas consumption giveaway achieved post-commissioning is an order of magnitude lower than the baseline identified in the project proposal. This benefit alone delivers a payback of two months on the entire project.

The increased amount of ethane in propane provided by the MPC delivers a 1.3% propane yield increase. This facilitates increased ethane sales and is highly favourable from an economic perspective.

Control of the deethaniser reflux is now automated, providing an operability benefit because low reflux can cause column instability and reflux pump problems. More stable fuel gas heating results in smoother furnace operation, which could be optimised further to reduce fuel consumption.

By reducing propane burning, the project decreases carbon dioxide emissions by approximately 1800t per year. Furthermore, the MPC also automatically attenuates regular depressurising of treater beds in the fuel gas system to reduce flaring.

The project received positive feedback from the operators. It achieved an application uptime of more than 97% in the first quarter of 2009 and Santos is evaluating future applications of MPC technology. ■

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Laser sampling recovers ore

Rio Tinto Iron Ore installed an Outotec PSI 500 particle size analyser at its Paraburdoo mine in the Pilbara in June.

While such analysers are used in the base metals industry, this was the first system to be installed in an iron ore operation in Australia.

The device uses laser diffraction to help recover fine iron ore from the mine's cyclones. Without such a system, some of the ore would escape from the overflowing cyclones and end up in the mine's tailings, Outotec's application engineer for automation in Australia, Brian McPherson said.

"With 80 cyclones per stream, the cyclone overflow reporting directly to the thickener, and tailings pumped 7km, it was critical to ensure correct cyclone operation at Paraburdoo. Dependable monitoring is vital for mass recovery and optimised thickener/tailings operation," he said.

"The analyser is one of the few in the market which can actually cover particle size measurement in the 1-500µm range. It monitors particle size distribution and therefore cyclone performance. Also, laser diffraction is a well-established, proven technology, delivering greater precision for particle size analysis.

"Particle size monitoring and control increases average throughput and reduces particle size variability in grinding circuit products, leading to easier thickening as there is a more consistent feed."

Paraburdoo's two-stream analyser installation uses a pair of two-stage samplers to monitor thickener feed from four modules of cyclones. The installation was designed and commissioned by Outotec and Rio Tinto Iron Ore plant projects coordinator, Brady Stump.

Outotec is a Finnish supplier of instruments and control systems for mineral and metal processing industries. ■

An operator uses the Outotec PSI 500 to check the size of iron ore particles at Rio Tinto's Paraburdoo mine.

Instruments developer honoured

The International Society of Automation recently bestowed its UOP Technology Award on Vince Dooley, an electrical engineer at Alcoa's international refining research and development group based in Western Australia.

The prize recognises "outstanding achievement in the conception, design, or implementation of instrumentation and/or process control".

Vince Dooley received an award for outstanding achievement in process control and instrumentation.

Dooley has developed a range of online analytical instruments during his 29 years at Alcoa. He said that his online production liquor analyser and online mud level instrument were essential to the success of the Quality Automation Solutions in Alumina Refining (QUASAR) project.

The project, implemented by Alcoa and Honeywell, involved replacing the process control systems at seven alumina refineries around the world and linking them to a common information system.

QUASAR received a National Project Excellence Award from Engineers Australia's National Committee for Automation, Control and Instrumentation last year.

"Our refineries simply cannot operate at their current productivity levels without Vince's online instruments," said the company's director of research and development for global refining, Dr Ian Harrison. ■