

Dynamic simulation can accelerate APC payback

Despite scepticism in some quarters, simulation is proving an effective tool for implementing advanced process control projects, writes **Andy Coward**

ADVANCED PROCESS CONTROL (APC) DELIVERS process stability, which can drive a process towards a more profitable operating point. Payback times can typically vary from three weeks to around six months. However, for the start-up of a new plant the process is often left for up to 12 months to “settle out” before any form of APC is implemented. Given that an average APC project will take around six-nine months to deliver, a payback equivalent to about double the cost of a project is often missed by the time it is finally commissioned. On a greenfield site, meanwhile, things can be more challenging as there has been no process running, and APC is very data-centric. So how can an APC project be delivered as soon as possible after start-up?

Accurate representation

The answer to that question lies with simulation. Since the process and equipment design are all based around process simulations, a representation of the process exists before the physical process is commissioned. The heat and mass balance can be closely matched by dynamic simulation, which also provides accurate representation of the process dynamics when vessel and piping volumes are accurately specified.

When a normal APC project is implemented, there are various stages which take time. These include:

- Documentation and design review
- Base control loop tuning
- Process step testing
- Response model identification
- Commissioning of the final applications

An accurate dynamic process simulation can be used to facilitate all of the above stages. On a recent project delivered by Honeywell Process Solutions for a customer in the Middle East, Honeywell's UniSim Design software was used to develop APC for a demethaniser from a dynamic process simulation that had been created for an operator training simulator (OTS).

The simulation was compared to the design heat and mass balance and found to be within 2% at starting conditions. This dynamic model was then used as the process for the development of the APC. In other words,

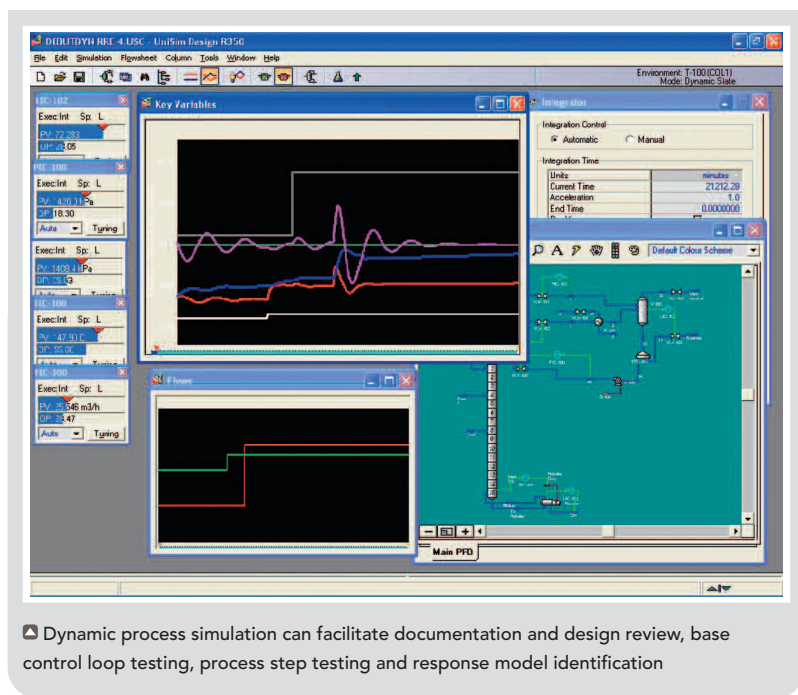
it would be this process which had its base control loops tuned, was step-tested and then controlled using the developed APC – in this case Honeywell's Profit Controller, a multi-variable control application.

Because the dynamic simulation accurately represented the process and included all the major control loops, the design of the APC application could be performed. The objectives for the application were reviewed and the various control loops then reviewed from an inclusion or exclusion perspective. The overall design of the application — manipulated variables, controlled variables and disturbance variables — was then progressed.

One of the first activities on the simulation was the tuning of all the process control loops to achieve representative behaviour. Because the simulation had been developed for a training simulator, loops were

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tuned for stability of the model. The loops were then retuned to give the model representative dynamics and to facilitate set-point tracking. This gave the model an approximately correct time to steady state and highlighted changes required to the control strategy.

The overhead pressure on the demethaniser column could be achieved through two means – either the inlet guide vanes to a turbo expander or through the use of a Joule-Thompson valve.

Two control loops existed and were based around the same instrument; however, their relative merits were different in that the “cold” recovered into the system compared to the work recovered through the turbo expander made a big difference on the process performance.

APC objectives

Utilisation of these loops was, thus, clarified and built into the APC objectives. Similarly, the tuning activities highlighted that predefined expectations on the APC manipulated variables were incorrect.

One of the expected loops was upstream of the propane chiller, which was run on a closed temperature control; therefore the upstream control loop was decoupled from the demethaniser. All of these issues were resolved long before construction commenced on the actual process.

Once loop tuning was completed, the model was step tested. The process was intentionally perturbed to identify responses between manipulated and controlled variables. The dynamic simulation enabled the model to be accelerated by over ten times real time. And, as the

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process did not have any unmeasured disturbances, it needed only one or two steps in the manipulated variables. Overall, this took hours on the dynamic simulation where on the real process it can take weeks, meaning that operational expense and risks were reduced as fewer disturbances are required on the live process.

Using the data collected, the process responses were identified and the Profit Controller application simulated, using the desktop tools. This enabled optimal tuning settings to be derived, including the optimisation strategy for the on-line application. This was fundamentally simple – reduce loss of ethane and propane into the methane stream whilst keeping the methane in the ethane and propane stream up to the specification using as little energy consumption as possible.

Extra recovery

For the factory acceptance testing, the designed Profit Controller was installed and commissioned onto the process unit within the UniSim Design environment. The application inside UniSim was identical to the on-line Profit Controller, so all the simulation tuning settings were then loaded and tested to determine what operating point the APC would achieve compared with the starting point of the design heat and mass balance. It was found that an extra 1-1.5% recovery of ethane and heavier components could be achieved through using APC.

When testing was complete, the implementation of the APC application onto the DCS could begin. Using the designed controller configuration, all of the schematics could be integrated into the normal operator schematics, DCS-based logic could be implemented and tested, enabling the operators to become familiar with the APC from the earliest point of their training. Communication channels, displays, fallback strategies and hardware integration had all been fully tested in the factory in a risk-free environment.

Once the actual process is commissioned, the matrix of relationships in the APC will be matched to the real process. This will be done by using the UniSim-developed matrix as a “seed” matrix in the Profit Stepper closed-loop step testing and model identification tool. The APC applications across the process can then be completely commissioned within six weeks of the actual process commissioning being completed.

There are sceptics who will claim that using a dynamic simulation to develop APC will never work. The fact that any process is designed from a simulation and that dynamic simulation tools are now such high fidelity, coupled with the catch-all activity of matching the simulation models to the actual process during commissioning, means that this argument is **foundless.**

Andy Coward is a solutions consultant at Honeywell Process Solutions. His report is based on a paper given at the APC8 conference in York, UK.