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Precipitation Tanks – MPC Magic

Background

BHP Billiton Worsley Alumina Pty Ltd (WAPL) has been quick in the uptake of Advanced Process Control (APC) techniques, and specifically Multivariable Predictive Control (MPC) technology at the Collie refinery in Western Australia. A large number of applications have been commissioned since 2004.

Acceptance of MPC by the operations personnel has been very good, resulting in high reliance on the availability and functionality of these applications. The applications have improved plant profitability, enabled safer plant operation and reduced load on the Control Room Operator (CRO).

Project Information

Problem Statement

BHP Billiton has the goal of zero harm to employees, communities and the environment. It was therefore very important to address and prevent a potential problem with tanks overflowing, at higher throughput rates, when it was identified by the operations groups. The only response would be to reduce the throughput, resulting in production losses.

Overflowing tanks not only poses a safety hazard to personnel, because of the caustic liquor, but also a serious housekeeping problem. It can take a significant amount of manpower and effort to clean up after an overflow incident. Preventing and controlling these incidents proved to be quite a challenge for the CRO, as the tanks prone to overflowing have no level measurements. It was therefore near impossible to predict, from the control room, when a tank was overflowing (or close to overflowing).

Project Challenges and Solutions

In July 2007 Apex Optimisation (Apex) was involved in a project to minimise the potential for overflow incidents. Apex had been heavily involved in the implementation of a number of MPC applications at the Collie refinery, with a successful track record of design and development.

There were two major challenges faced by the project team, one can be categorised as a technical challenge and the other as a project management challenge.

Technical Challenge

The biggest challenge was that the key constraints (tank levels) were not measured – bearing in mind the old saying that "you can only control what you can measure". This meant that any traditional control schemes would not be able to provide the level of regulation required to prevent the tanks form overflowing. Another approach and/or technology were needed to provide a practical solution.

Due to the success, acceptance and reliance on the existing MPC applications the majority of the project team believed that an MPC application would be the solution to the problem. After careful consideration and review of the problem, it proved that this 'gut feel' was indeed correct.

Control Room Operator using new MPC application

A technique used in Hydrocarbon Processing applications is to use other process measurements to infer plant and process constraints, which are unmeasured. An example would be the output of a distillation column's overhead pressure controller, used as an indication of the overhead condenser capacity constraints. The team's experience in MPC implementation in a variety of industries was therefore valuable in this situation.

Most MPC technologies are based on a dynamic model of the process, coupled with embedded optimiser engines, to predict the response of the process to changes and to calculate a control solution to meet the operator's objectives. It is therefore possible to include a known measurement, which has a correlation to a real (but unmeasured) process constraint, in the MPC application in order to adhere to the process constraint by inference.

This technique has been also been successfully used in a number of the MPC applications commissioned at the Collie refinery. However, in most of these instances the inference variable was more obvious.

The problem faced in this instance was there were no clear 'substitute' constraints that could simply be used to replace the unmeasured constraints. In this case an experienced MPC designer/implementer was able to quickly come to grips with the customer's process and business needs, by being able to interpret information, from a variety of sources and personnel (ranging from operators to managers). This permitted the team to develop an application design that will not only meet the objectives, but will also be implemented in the shortest amount of time without the need to iterate on the design. This is where the saying "time is money" is quite true, as any time saved in

developing and commissioning an MPC application will be time available to the application to generate benefits.

This approach enabled Apex to identify a number of measurements that could be used to infer the potential of a tank overflowing, following interviews with CRO's, engineers and other operations personnel.

It was realised quite early on, in the interviews and discussions, that there will not be a single 'substitute' constraint that will infer whether a tank is overflowing with 100% accuracy. It was therefore important to identify a number of 'substitute' constraints that could be used. Having more than one constraint provided a hierarchy of safety nets, based on estimated accuracy, in the design of the MPC application. This application design assured that the utilisation of the MPC application will be maximised, as the performance and utilisation is not reliant on a single variable but rather this hierarchy should the more accurate 'substitute' constraint become unavailable.

Project Management Challenge

The other challenge was that the customer wanted the solution implemented as soon as possible, hence the normal MPC project cycle of three to six months was too long. Some 'outside the box' thinking was required to in order to negotiate these challenges and present an acceptable solution. This meant that a project that did not seem overly complicated suddenly had some complex issues to deal with.

It was decided, in consultation with the customer, to streamline the implementation process by deferring some of the typical project steps, but without any increase in risk. An example is where the typical formal design and review cycle (of conceptual, functional and finally detailed design) was streamlined by moving directly from the concept to implementation (something akin to rapid prototyping).

Implementation

Once the conceptual design was finalised, the implementation phase of the MPC application was started. Under normal circumstances the implementation phase could take many months. For this application, Apex developed the controller model and commissioned the MPC application within two weeks.

A number of factors contributed to the successful streamlining of the project process. The combination of each of these subtle aspects facilitated the delivery of a successful project and an extremely happy customer:

- A relatively small and uncomplicated MPC application design meant that not only would the model development be simpler, but commissioning and operator training would require less time.

- The time spent on model development was significantly reduced, compared to typical MPC projects. It was possible to develop the controller model without the need for lengthy plant testing by having a clear and good understanding of what would be required, for the MPC application to perform and behave as expected. A thorough understanding of both the process and the MPC technology used at the Collie refinery gave Apex the edge in this regard.

- Apex has enjoyed a very good working relationship with all the stakeholders, from the CRO to management, over a number of years. Their understanding of each level's needs and expectations means that they can deliver solutions to meet everyone's requirements. This also ensured that all the stakeholders were aligned

and in agreement, allowing the smooth and uncomplicated implementation of the MPC application. This was further aided by Apex's track record, at the Collie refinery, on delivering working solutions with no disruption to the process and meeting expectations.

- The commissioning effort was further reduced by quick operator acceptance. This can be attributed to the CRO's good experience with the MPC technology used at the Collie refinery.

Project Results

The final outcome was a very successful project where all the goals and customer requirements were met.

- The MPC application was implemented and commissioned within two weeks. This was much quicker than a typical MPC implementation project, achieving the goal of having a solution in place as quickly as possible. The operator acceptance is further demonstrated by the application online time of more than 95%.

- There have been no reports of any incidents of tanks overflowing following the implementation of the MPC application, even though throughput has been pushed. This means that potential safety and environmental hazards have virtually been eliminated, achieving the primary goal.

- Most MPC applications are justified on some financial benefit; however, the main objective for this particular MPC application was to reduce the risk to personnel and the environment. The embedded optimiser was used to maximise production up to process constraints, without exceeding them. The result was increased production rates, as well as the avoidance of costs associated with clean up efforts.

- Based on these financial benefits the project had a payback period of less than a month, based on the cost of a typical project for an MPC application of this size.

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