The DCS as enabling platform

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Justifying the decision to invest in a new or upgraded control system is always going to be difficult. Andy M Smith explains how a more compelling business case can be made by regarding the modern Distributed Control System (DCS) as an enabling platform with a proven ability to reduce the cost of future projects by orders of magnitude. Martin Davis details a replacement project that used such a benefit case, of the inherent capability of a modern DCS, to gain a business sanction.

When a company decides to install or upgrade to a new generation Distributed Control System (DCS), the justification is normally based on a conventional assessment of the benefits of a 'like-for-like & added value' replacement of the existing system. Typically these might include increased safety, often to comply with a more stringent regulatory environment, and operational improvements in terms of, for example, throughput, quality and resource utilisation. The successful vendor is then selected on the basis of the least cost option: who is offering the lowest cost solution at the time of the project and whose solution requires the least changes to the existing infrastructure?

That was certainly the case when Huntsman European Base Chemicals & Polymers, one of the six major regional businesses making up Huntsman Corporation, decided in 1999 to install a new DeltaV system from Fisher-Rosemount (now Emerson Process Management) on the paraxylene plant at its highly integrated facility on Teesside in the North East of England. Subsequent experience, however, has clearly demonstrated that by treating a new generation DCS as an 'enabling platform' to which a wide range of existing and potential future applications could be transferred, a much stronger business case could have been presented to justify the original installation.

Huntsman produces some 3 million tonnes of petrochemicals a year at the Teesside complex which includes some of the largest plants of their kind in Western Europe and, next year, will bring on stream the world's largest low density polyethylene (LDPE) plant. The paraxylene plant, the third largest in Western Europe, has a capacity of 360,000 tonnes per year, its output being used to produce intermediates for the manufacture of polyester polymer.

The key indicator of the purity of paraxylene is its freezing point. Pure paraxylene freezes at 13.26 °C but the presence of impurities lowers the freezing point by approximately 0.01C for every 0.03% impurity. Freezing point - or more correctly meltpoint - analysis is thus a critical aspect of paraxylene production and the Teesside plant incorporates no less than 15 meltpoint analysers, housed in their own analyser building. With a price tag of £60,000 ($100,000) each, Huntsman was therefore faced with a potential bill of some £900,000 or $1.6m when all 15 analysers came due for replacement.

Martin Davis explains the analyser process: - In order to determine the meltpoint of paraxylene, an analyser cools the liquid sample until it reaches its lowest value, termed the 'supercool' point. At this supercool point the temperature starts to rise again due to the latent heat of crystallisation, although the sample is still being cooled, and then reaches a plateau as the sample freezes. The analyser determines the supercool point and then waits 15 seconds to ensure that the temperature has 'plateaued'. Calibration of the instrument then allows the plateau temperature to be translated into the rather higher true freezing point.

In the original configuration each analyser had its own control unit with the sequence hard coded into a PROM chip, which was housed in the plant's old, pre DeltaV control room and ensured the correct sequence of operations:

1. Fill cell with sample;
2. Cool sample;
3. Detect supercool point;
4. Wait 15 seconds;
5. Read plateau temperature;
6. Heat to melt sample;
7. Drain sample from cell.

Sample temperature was measured using a Platinum RTD connected in one arm of a Wheatstone bridge within the control unit. The corrected temperature signal was then used to calculate the purity of the sample which was passed to the DCS as a 4-20mA analogue input.

Although this arrangement, had been retained when the new DCS was originally installed in 1999, it was clear that DeltaV had the capability to render obsolete all 15 meltpoint controllers in the old control room by both controlling the analyser sequence directly and performing the necessary calculations. As a result, when the meltpoint analysers came due for replacement, it was proposed that the functions previously handled by the control units could be performed by a batch programme running in the DCS which would communicate with the analysers over Foundation fieldbus. The only change to the analysers themselves would be the replacement of the Wheatstone bridges in the obsolete control units with Emerson 3144 Foundation Fieldbus temperature transmitters incorporated into each analyser. The key criterion for these new instruments was not one of accuracy but of repeatability, with such data seldom quoted by manufacturers.

In the new arrangement the temperature input to the DCS is logged directly to the DeltaV historian and also passed to a function block within the batch program which calculates the plateau temperature. This value is then passed to a second function block which calculates paraxylene purity.

This arrangement offers several advantages over the previous configuration. Not only does it address the obsolescence issue by replacing outdated hardware with batch software running in the DCS, the fact that the sequence is no longer 'locked' in a PROM; with the DCS allowing continual improvements to be made easily & instantly, it promises improved accuracy and repeatability of measurements, introduces the possibility of replacing manual calibration and trouble-shooting procedures with on-line functionality and greatly improves the visibility of the analyser sequence, all of which were realised.

The new temperature measurement arrangement eliminates the need to transmit a fully compensated signal from the analyser building to the DeltaV I/O, and also removes the Wheatstone bridge and a number of Zener barriers. Communicating over a digital fieldbus also reduces drift and results in a more stable measurement.

The existing system looked for the supercool temperature and then waited for 15 seconds before recording a single measurement of what was assumed to be the plateau temperature. By contrast, the batch programme running in the DCS would be able to adjust the waiting time to ensure that it was indeed the plateau temperature that was being measured. It would also be possible to use averaging to damp out noise in the temperature reading.

Calibration is essentially a matter of adjusting the temperature difference (ΔT) between the plateau temperature and the true freezing point. In the existing configuration, this was achieved by taking the analyser off line, inserting a calibration sample, measuring the resultant plateau temperature and adjusting the analogue controls to achieve the appropriate offset. With the calculation being performed in the DCS, however, it would no longer be necessary to take the analyser off line. Instead several date-stamped samples could be taken and the results of their laboratory analysis compared with the results from the DCS. The offset could then be adjusted in software to an average of the samples, thereby calibrating the device without incurring any downtime. The profile of the temperature curve could also be used to diagnose faults in the analyser including such conditions as plugging of the vortex cooler and stirrer failure.

The decision to replace the existing conventional wiring by Foundation fieldbus not only promised improved accuracy through the elimination of A/D and D/A conversion errors, but also offered the opportunity to gain experience with fieldbus technology on a low risk project involving only measurement rather than control. Installation of Foundation fieldbus at this stage would also reduce the infrastructure costs incurred by future projects. The combination of all of these digital techniques resulted in the temperature measurement variation being reduced from 0.5% to 0.03%, an order of magnitude improvement and a very good indication of the repeatability of the installation as a whole.

Martin Davis used the DeltaV Phase Logic Module, to implement the batch sequence which is based on the S88.02 batch standard. A significant proportion of the code required was already written by using this module type, including that required for error trapping and watchdog functions. The completed application comprises a mixture of sequence and real time modules, the former to step through the analysis process and the latter to calculate and store the parameters. In addition it was necessary to create new graphics and custom faceplates for the operator and engineering displays.

The meltpoint analyser project has demonstrated, at a business level understanding, the inherent and often unrealised capability & benefit which a DCS can provide. Projects which would otherwise fall into the 'nice-to-have' category become economically justifiable because a large proportion of the infrastructure cost is eliminated by the DCS functionality. The adoption of fieldbus technology will have similar further effect on the infrastructure requirements of future projects.

The new meltpoint analyser arrangement has both greatly improved signal accuracy and repeatability and reduced the maintenance requirement by eliminating the need for off-line calibration and non-essential maintenance. However the argument most likely to convince a sceptical management that there are real benefits, as distinct from intangible benefits, is to be obtained from regarding a DCS as an enabling platform and comes in the simple form of life cycle costs over a period of 5 to 10 years.

As we have seen, replacing all 15 meltpoint analysers on the Teesside paraxylene plant on a like-for-like basis was not possible due to the obsolescence, so replacement with a modern equivalent would have cost Huntsman a total of £900,000 or $1.6m, however the re-use of selected glassware and sample systems reduced the potential spend to £300,000 or $0.6m. By exploiting the inherent capabilities of the existing DeltaV DCS the entire project was completed for just £25,000 or $44,000, an astonishing 92% plus saving. Add to that the potential, in a typical plant, for eliminating the need to replace ageing PLCs, burner management systems and sequence controlled instrumentation - in the case of the paraxylene plant, catalyst regeneration panels and centrifuge control PLCs are just two further examples – and it's clear that careful consideration of the DCS as a true enabling platform could, and indeed should, greatly ease the task of justifying investment in state of the art DCS technology.