Reducing Variability for Optimal Plant Performance

Experience the Cernay PlantWeb Dynamic Performance Loop

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Process Management

Control loop performance

It is well known and documented that control loop performance has an impact on plant performance and hence profitability. If the variability within the process is too high it can lead to scrap, downgrading of product or rework. Often the solution is to move the operating point outside of the most profitable area, even to run the process in manual. This can lead to higher than necessary energy or raw material costs and you may be producing a product that exceeds specification by a wide margin.

Control loop performance naturally degrades over time and a great deal of money is spent maintaining equipment and tuning loops to ensure variability is kept to a minimum. Many companies have invested heavily in advanced process control and auto tune functions to improve performance. The problem is that these solutions focus on DCS controller functions and do not take into consideration the deterioration in field equipment where the underlying problem exists.

An independent process control consultancy has accumulated evidence, from years of research that suggests control valves are the biggest contributor to poor loop performance and the destabilisation of product uniformity. They advocate that more attention should be paid to control valve choice, performance monitoring and maintenance.

Variability will always exist in a process; it is the function of the process control equipment to reduce the variability to a level that is acceptable. It is easy to understand how a badly maintained valve may increase variability but what is less easy to understand is how a brand new, high quality valve can also increase the variability.

There are many factors that influence the ability of a control valve assembly to minimise variability, these include valve style, design and size. Reference specifications, including 'The control valve dynamic specification, version 3', from EnTech, an independent process control consultancy, and the ISA standard SP75.25 both provide performance criteria that can be applied when selecting a new control valve to ensure it has the ability to minimise process variability.

Emerson Process Management have significant experience of monitoring and maintaining control valves on process plants. The experience they have gained has led to new valve designs and extensive performance testing in their research and test facilities around the globe. Tools and techniques have been developed that enable optimum performance to be established by selecting the best control valve for the duty, maintain that performance by routine, on-line monitoring and retrieve the performance to previous levels should it deteriorate.

Establish
Maintain
Retrieve

A three phase approach to optimising control loop performance.

Variability will always exist in a process; it is the function of the process control equipment to minimise variability, even new equipment is not always effective at doing so.

Variability

Variability is the statistical difference between the process variable and process set point. In a perfect world these points would always coincide, however we know this rarely happens and there will always be a degree of variability.

Generally the greater the variability present the further the set point needs to be from the optimum level. This is so that there is less risk of the loop operating outside of safe or economically desirable parameters. Often the level of variability can be hidden from the operators because of filtering, or averaging within the DCS. Even if the level of variability is hidden the symptoms can still be seen.

The symptoms and effects of high levels of variability can be seen at the business level with increased raw material costs, higher than expected energy usage, lower output, reduced operating equipment effectiveness (OEE) and product quality issues. At the operating level variability can cause oscillations leading to process alarms or plant trips, reduced plant capacity and the need to slow the process down or switch to manual operation.

Variability has many causes that can originate from poor process or plant design, poor control strategy or tuning or badly selected and maintained instruments and control valves. Independent audit findings show that as much as 40% of all variability is caused by the control valve. This may be due to reduced maintenance activities or to incorrect sizing and selection.

Variability often cannot be seen, but the symptoms can; including product quality issues, plant trips, process alarms and reduced capacity.

Establish optimum loop performance

To ensure any control loop is able to consistently perform within required parameters it is necessary to establish the performance requirements of the control valve. The EnTech control valve dynamic specification, version 3, and the ISA standard SP75.25 both detail dynamic performance criteria that must be complied with if the valve is to have a minimal impact on process loop variability. Criteria include non linearities, step response and valve sizing.

Emerson has been performing dynamic performance tests on control valves since the early 1990s. Five PlantWeb® dynamic performance loops in Europe, USA and Asia have been used to build up an extensive knowledge base concerning control valves that are most effective in enabling process loops to control variability. The knowledge gained, coupled with many years of field experience has been verified by subjecting the valves in question to closed loop dynamic testing to simulate the plant environment.

All tests performed within Emerson's laboratories are conducted in accordance with independent test specifications[1], to ensure they are unbiased. Control valve performance tests clearly prove that valve type, valve design and valve manufacturer can have a significant impact on process performance.

Following the selection of the correct valve design and size to match process needs, Emerson will tune the valve assembly to ensure optimal installed performance. Diagnostic tests are performed in manufacturing that will establish a performance benchmark.

To ensure a control loop is able to consistently perform within the required parameters it is necessary to **establish** *the performance requirements of the control valve.*

[1] Flow Capacity tests performed in accordance with IEC 60534-2-3, Noise tests in accordance with IEC 60534-8-2, Fugitive Emissions to ISO 15848-1 and Valve Performance in accordance with control valve dynamic specification, version 3', from EnTech and ISA standard SP75.25.

Maintain optimum loop performance

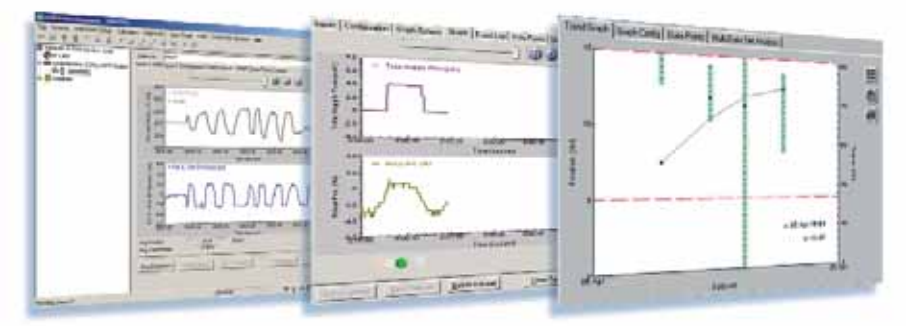
Control valve performance will degrade over time so it is vitally important that procedures are put in place to monitor their condition so that it is possible to determine the optimum time to stop and take maintenance action. The best time to stop will be determined by a combination of technical and economic reasons. Wherever possible monitoring procedures should involve minimum intervention from site personnel and should be able to be carried out with the plant operational.

Performance monitoring can be performed by utilising the diagnostics capabilities of Fisher FIELDVUE® Digital Valve Controllers, a core component of PlantWeb digital automation architecture. FIELDVUE powers PlantWeb by capturing valve diagnostic data and delivering it, via AMS ValveLink® software to those who can act on it. AMS ValveLink software continually monitors FIELDVUE alarms and alerts, under all phases of the process cycle. Should any of the key operating parameters of the control valve change, indicating a potential problem, the operators, maintenance personnel and Emerson diagnostic technicians can be made aware, either by PlantWeb alarm/monitoring system, email, text message or even the production of a works order. Consultants from Emerson can work with site personnel or with Emerson engineers to set the alarms and alerts at suitable levels to ensure they are meaningful.

FIELDVUE instrumentation plays an important role in Emerson's PlantWeb® digital plant architecture. PlantWeb integrates intelligent field devices and modular software such as AMS predictive maintenance software or DeltaV™ digital automation system software. All components are linked by information-rich HART® or FOUNDATION™ fieldbus protocols enabling access to diagnostic information that can be used as part of a predictive maintenance strategy.

On-Line testing, non-intrusive tests that are carried out with the plant operational and remaining under control, can be performed on a routine basis to provide information on friction and deadband; this data can be compared to the initial benchmark and also trended with historical data, so that potential failures can be identified before they become functional failures. Test routines can be automated to minimise the involvement of site technicians. If required, tests can be run from a remote location by Emerson engineers, utilising the communication capabilities of PlantWeb architecture.

The AMS ValveLink software used to perform the monitoring is self documenting and will automatically track and record changes, easing the burden of documenting maintenance information for ISO certification or regulatory compliance reporting.



Retrieve performance to optimal levels

Following the identification of a potential problem it is necessary to identify the specific actions that are necessary to retrieve performance to its original, benchmarked level. Often problems can be resolved with the control valve in line, avoiding the costs of removal and the potential for lengthy shutdowns.

Diagnostic tests can be performed by site personnel, or by Emerson engineers. Tests are performed when the plant is shut down, or the valve bypassed. Diagnostic analysis, which compares the results to the initial benchmark data can be performed on-site by suitably trained and experienced technicians or the information can be emailed to the Emerson European diagnostic centre where experienced engineers can confirm a problem diagnosis or suggest further actions. The analysis identifies a potential cause which enables the correct parts to be purchased and the labour requirements to be identified, prior to the work being carried out.
Parts for Fisher valves are available through the FAST service which can supply 90 per cent of routine parts to European destinations within 24 hours. A further 20,000 items are available within seven days.

Following the maintenance, further diagnostic tests can be performed to ensure performance has been satisfactorily retrieved and to provide new benchmark information for continued monitoring.

Following the identification of a potential problem actions must be taken to **retrieve** *performance to previous levels.*

To **maintain** *optimum loop performance control valve condition should be monitored, on-line while the plant is operational.*

The Cernay Laboratory

The Cernay Laboratory includes a flow loop and a dynamic performance loop both of which are powered by PlantWeb digital plant architecture. PlantWeb uses the digital communications ability of the process instrumentation to control the process and manage the assets.

Both loops utilise the latest technology products and software from Emerson, including Fisher digital valves and FIELDVUE digital valve controllers, Rosemount pressure, temperature flow and radar level transmitters, Micro Motion Coriolis mass flow transmitters, Rosemount Analytical conductivity and PH transmitters, DeltaV digital automation systems and AMS predictive maintenance software.

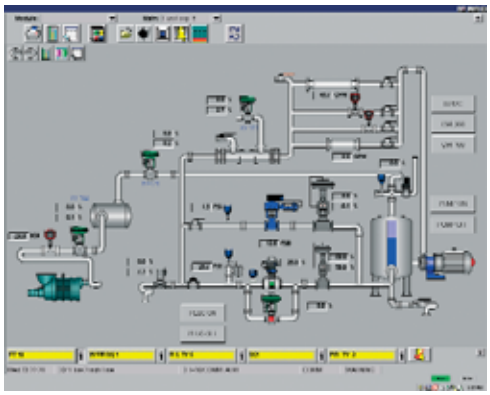
DeltaV work stations are located on each test loop and in the conference room to provide maximum flexibility when testing and proving the capabilities of the architecture and the products. The work stations are networked with other Emerson laboratories located in Asia and the USA to share the extensive amount of data being generated and to further extend the test capabilities of each laboratory. FOUNDATION fieldbus and HART digital communications protocol are used to communicate with the field instrumentation.

To maintain it's laboratory status all of the equipment used to perform tests are routinely calibrated and the results documented. AMS is used to record calibration information as well as automatically keeping records of any configuration changes. DeltaV stores information on any modifications to the control strategy or tuning parameters, as they are made. This provides traceability so that tests can be duplicated as required.

The flow loop is used to experimentally determine or confirm control valve sizing coefficients as well as testing for dynamic torque, stem force and sound levels. Valve sizes from $^1/_2$" to 10" can be tested, on water or air. Tests may be performed to prove a new design, for research, as part of a product audit, to resolve field problems or to satisfy customer requirements.

The PlantWeb dynamic performance loop is used to perform open and closed loop tests on control valves and other instrumentation. Tests can be performed on valve sizes from $^1/_2$" to 4". Open loop step tests determine actual changes in valve position and flow rate following the introduction of a step change in signal. Closed loop tests introduce a standard disturbance to the control loop and determine the ability of the various components to minimise any resultant variability.

Other tests that can be performed in the laboratory include, hydrostatic and stress tests on pressure retaining parts to prove the design, fugitive emissions testing on seals and packing, and accelerated aging tests in the climatic chamber.



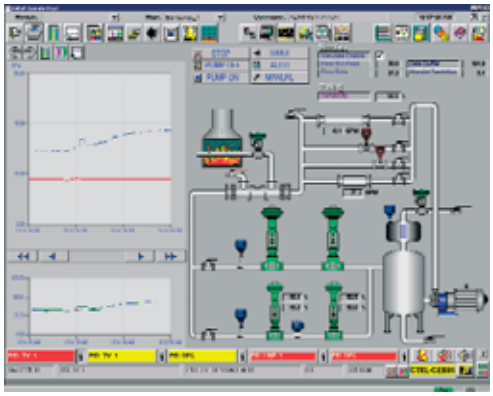
The PlantWeb Dynamic Performance Loop

With its extensive use of the latest digital field devices, systems and software the PlantWeb dynamic performance loop can be used to prove the benefits of PlantWeb digital plant architecture. PlantWeb enables project costs to be reduced due to simplified engineering, easier, faster commissioning and reductions in the quantities of wiring used. Operational benefits include improvements in product quality, increased availability and throughput, reductions in waste and rework and reduced operation and maintenance costs.

Reducing process variability plays a key part in improving loop and plant performance, which in turn provides many of the operational benefits enabled by PlantWeb architecture. The PlantWeb dynamic performance loop has been established to prove the link between process instrumentation performance and loop variability. The predictive maintenance capabilities of the instrumentation can be demonstrated as well as showing how these are used to provide maximum benefit.

A complete range of Emerson FOUNDATION fieldbus and HART instrumentation is installed in the laboratory and is constantly changing as products and technologies develop. A complete up-to-date listing is available on request. The primary function of the dynamic performance loop is to demonstrate control valve performance, however, performance of any of the installed devices can be demonstrated.

Customers are welcome to visit the laboratory to witness at first hand the dynamic performance loop, alternatively presentations can be carried out on-line, from anywhere there is internet access.



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