How to implement advanced combustion control

Combustion controls ensure that burners run safely and efficiently. Adopting advanced combustion control for flow, mass, pressure or temperature can save companies between 5% and 15%.

Advanced control is based on more accurate measuring devices and faster, 'intelligent' digital controllers.

The business case

The cost of the technology varies slightly depending on the specification, but you could recoup your costs within two to three years. The payback time depends, of course, on your energy costs too.

As a rough guide:

- Mass flow meters cost between £3,000 and £10,000.
- HART-compliant (Highway Addressable Remote Transducer) pressure transmitters cost between £500 and £1,000.
- A SCADA (Supervisory Control and Data Acquisition) central computer, with some software installed, could cost around £3,000.
- Wiring costs depend on the length and the route from the central control to the field instruments.

The technology

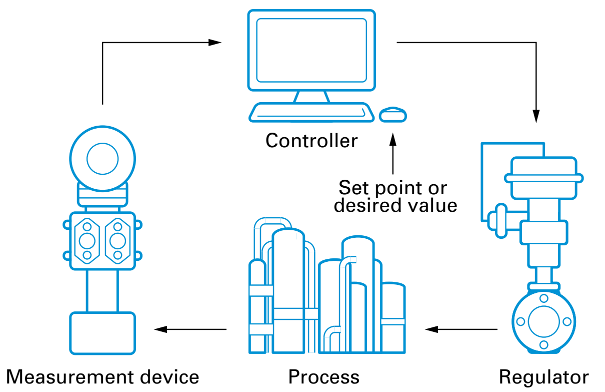
The type of control you need depends, on the process to be controlled, but most controls combine proportional, integral and derivative control actions in one unit. They ensure that, as the process approaches its set-point, the temperature, flow or other variable doesn't overshoot the correct value.

Basic closed-loop control is the building block of any plant control system, and generally includes many hundreds of individual control loops. The task of a control loop is to hold a particular process variable – the temperature of a baking oven, for example – at the desired value or set-point.

The control loop has to be able to make changes quickly, smoothly and efficiently without disturbing the process. It consists of:

- the measurement device
- the controller
- the regulator.

***Figure 1** The main components of a control loop*



[1] You can find a more detailed explanation of this diagram in CTV030 Industrial Process Control, available on www.carbontrust.co.uk.

Measurement device

To control a parameter accurately, the control loop has to be able to measure its value regularly. This is usually done by a sensor that measures a particular physical property, such as temperature or flow rate, and a transmitter that converts the output of the sensor into a standard control signal.

This signal is then sent to the controller, usually located in a protective enclosure in a control room. These signals may be sent to the control room individually or transmitted with other control signals through a dedicated network, known as a fieldbus.

Accurate measurement is at the heart of advanced control, and there is a range of specialised devices for particular parameters.

The controller

The controller compares the measured value to the set-point and, if there is a difference, brings the process back into line. New 'intelligent' controllers fixed to the measuring device have led to faster and more accurate process control.

Controllers are based on a PID loop – a three-term system. The controller measures the difference between the actual measurement and the set-point for the particular instrument. It then uses proportional, integral and derivative functions to correct the difference.

Analogue systems, which are based on hardware rather than software, tend to 'drift' with changes in the environment, such as temperature. This can lead to measurement errors. Direct digital controllers (DDC) use software processes unaffected by external conditions.

More accurate measurement is the main advantage in introducing modern, digital-based control systems. In fact, using these systems is now considered to be best practice.

Table 1 shows typical results for a traditional flow measurement against a DDC controller. This example is for an air system that could be supplying a burner.

Applications

How much you can save depends on the processes you're controlling. Advanced control can be used across a range of industries and applications, including:

- steam and hot water boilers – for fuel and airflow
- process heaters – for flow, temperature and pressure
- gas turbines – for flow, temperature and pressure
- drying processes – for flow, temperature and humidity
- furnaces – for temperature
- cement kilns – for product mass, flow and temperature

Table 1

Flow rate %	**Rate of error – analogue control** Conventional differential pressure transmitter	**Rate of error – DDC control** Advanced process control differential transmitter
100%	0.65%	0.09%
75%	1.16%	0.16%
50%	2.6%	0.37%
25%	10.4%	1.48%

Table 2 Specification checklist

Questions	Comments
What is the parameter you need to measure?	Should one or all of the following be measured: fuel flow, temperatures, airflow, pressures?
Which of these parameters can be measured?	What is the effect of not measuring them?
How is the process controlled at the moment?	How accurate is it, based on the design criteria?
What level of accuracy do you want to achieve?	Specify a 1% variation in the controlled parameter over a 20:1 turndown ratio.
To achieve that accuracy, do you need a complete new system, or just part?	Could you install a new controller only? Or do the measurement device and the regulator need changing as well?
How will you link to SCADA/DCS (Distributed Control System) systems?	
Will existing wiring work with the new system or will you need new?	

Specification checklist

Advanced combustion control is a specialist area. You need expert advice to ensure all aspects are covered.

- Look at your existing system to identify the parameters you need to control.
- Check the operation of existing instruments and regulators.
- Ensure your existing control system is working as designed.
- Identify areas in the control system where improvements might be possible.
- Organise a team of people who have knowledge, not just of the control process but of the day-to-day operation of the plant. Plant operators have detailed knowledge of how the process actually works and should be included at the start of any improvement project. They will be able to identify the areas they have to monitor or make changes to so that the process keeps working correctly.
- Specify the type of controller, measuring device and regulator.
- Decide on who should be responsible for producing documentation, for installation and for commissioning.

The above table lists the questions you need to ask when specifying a control system.

Commissioning checklist

The commissioning process is an important stage for checking that the values you are controlling are kept within the correct range for the process, and that the system is helping you meet your expected savings targets:

- Agree the set-points.
- Check the process and instrumentation diagrams against the actual physical elements of the control system.
- Check all loop diagrams to ensure the wiring matches the design drawings.
- Tag all instruments with the correct reference.
- Document the control system and train staff in how it should work.
- Prepare flow diagrams to show the sequence of control actions.
- Inspect all wiring and piping for faults.
- Calibrate each sensor to the required accuracy, using an external source.
- Commission each control loop without the process being live, possibly using an inert fluid such as nitrogen or water.
- Introduce the fluids to be controlled on each loop and check the control processes.
- Commission the overall process.

Common problems

For efficient operation and to maximise savings, check that:

- you define the process variables correctly at the initial stages
- there is no mismatch between interfaces for new and old plant
- installation and commissioning are done methodically, with all field instruments correctly identified, the right name or number installed on each instrument and calibrations made accurately
- field wiring follows the design drawings
- process conditions haven't changed after the design stage – a change in fluid density, for example
- electronic components haven't failed. This can happen early in their lives, but once through the burn in period, they tend to be reliable.

Finding a supplier

Advanced control is a specialist field and you should always use an expert when considering a process control project. If you are upgrading a system, your existing supplier is usually the first port of call. For a new system, you have a choice of suppliers, some specialising in areas such as steam flow. The Institute of Control and Measurement can recommend suppliers.

Institute of Control and Measurement
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