ENGINEERING TOMORROW

Tehnical paper

Reducing oscillations in a HVAC system

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Reducing oscillations in a HVAC system

In a HVAC system as well as in a process plant, a district heating and district cooling utility, periodical oscillation of the control loop might occur. It has several reasons. Non linearity of the process, excessive amplification of the controller and an oversized system are just few of the reasons. Oscillations will have impact on excessive wear of control components in a system (i.e. motorized control valves) but also on the controlled temperature and energy efficiency of the system.

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The controlled temperature in a building can be affected by uncontrollable changes in and outside. A change of the cooling system load due to a change of ambient temperatures, occupancy or by other heat gains caused by lightning and computer equipment can cause the set temperature in any commercial or industrial building to fluctuate constantly.

How do we control these dynamic changes?

Typically the non-linearity and excessive amplification of the control process are managed by the PID controller. Proportional, integral and derivative control uses a close-loop feedback system to maintain the set point. Variation from the set point is called an offset error and requires continuous corrective actions for a process output to be maintained.

There are several recommended methods on how to tune the HVAC control system (i.e.Zigler Nichols), though they all have a downside in common.

Generally PID control values are being set for the particular system point(s) by building controls engineers at the start of a project. The issue being these are set only once and for maximum design duty. During commissioning very little, if any, consideration is given for partial load operation and the constantly shifting demand that will occur within a typical buildings operational life. Hence we face the situation that although the control system has been tuned, it is very likely that periodical oscillation in the control loop will occur.

Occasionally it gets even worse from the beginning. Copy and paste technology is used. Meaning many controllers for air handling units, boilers, chillers re-use the same PID parameters from the past projects in new projects and this without understanding what is being copied. Then it becomes very likely that the oscillation will have impact on temperature deviation or process instability causing inefficient use of energy and increase the operation costs.

Correct sizing of control components lowers life cycle costs and reduces oscillation. However, during renovation as an example, the building is being insulated thus reducing heat losses and heat gains. Then the HVAC system operates at lower working point. Originally installed control valves become oversized and are prone for oscillation due to an inadequate control range.

Another issue is sizing of control valves in general. Control authority and inherent design of control valve characteristic will be subject to above mentioned uncontrollable changes in practice. Thereby the control characteristic of the valve will be distorted and control valve authority reduced causing control valve hunting at partial loads conditions.

In addition to the above described examples typical causes for oscillation would be:

- Poorly tuned/commissioned PID controllers
- System process non-linearity
- Winter-summer regime

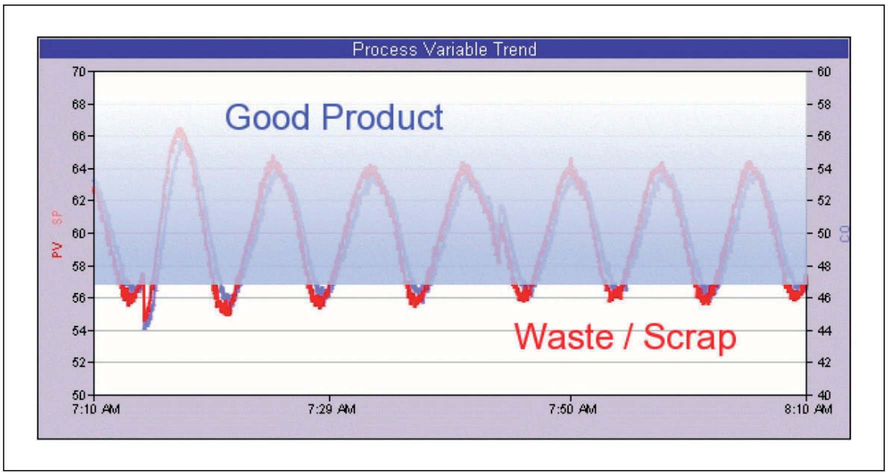

FIGURE 1: Oscillation in a process plant

Often a lot of money is spent for optimization of the energy efficiency in buildings due to periodical oscillations in control systems. The impact of the oscillation in a HVAC system is different compared to the process industry, where process instability would have dramatically consequences – figure 1. Nevertheless in commercial buildings periodical oscillations will have impact on temperature control, which will affect thermal comfort and fluctuation of the controlled temperature. We have to increase set point in heating and decrease set point in cooling to meet designed set point of the building. 1K increased set point in heating equals to 5% to 8% and decrease in cooling for 1K to 10% to 15% of overall HVAC installation energy consumption (incl. chillers, boilers, pumps, fans, cooling towers, etc.) – figure 2.

What is the new intelligent solution for reducing oscillations?

The classic approach for controlling oscillations would be to re-visit site and to do the re-tuning and recommissioning, over and over again. However Danfoss has taken revolutionary new approach. Danfoss has developed a new generation of intelligent motorized control valves (iMCV) with a patented and built-in anti-oscillation feature. Advanced algorithms are installed into the actuator, which ongoing detects tracks and prevents the undesired oscillation in the control loop thus reducing necessary time and money for (re)tuning of a control loop and (re) visiting of the site.

In total the new range of iMCV valves features an intelligent actuator, bubble tight designed valves and simplicity as one actuator is suitable for whole range from DN15 to DN80.

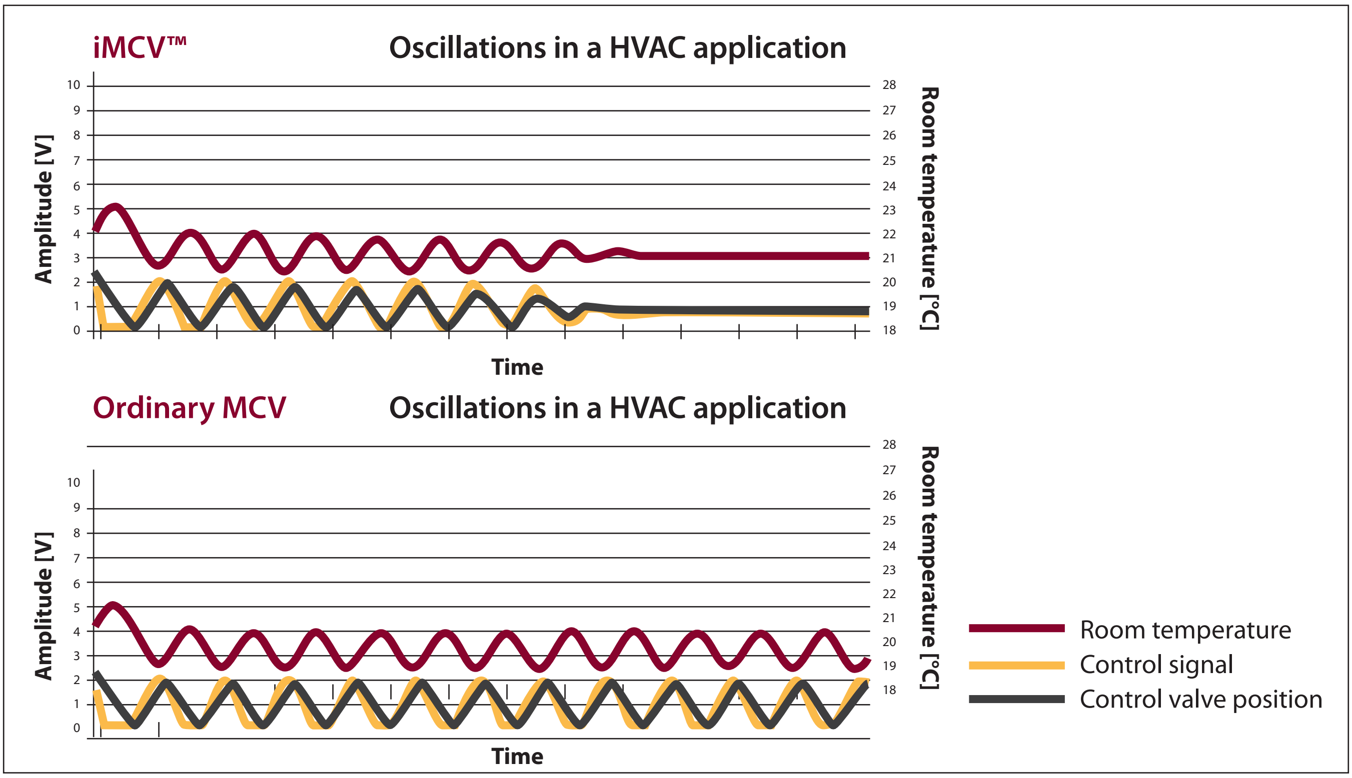

FIGURE 2: Oscillation in a HVAC application

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