LNG Level Control Optimization

This white paper highlights the use of Emerson Variability Management services and the EnTech Toolkit by Emerson's Control Performance specialists to improve level control performance.

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Problem

Many units in the process industries have flow through a series of vessels with level controllers on each vessel. Cycling of the level loops should be avoided because it creates variability in the surrounding processes and can greatly reduce the life of the control valves. In general, cycling of a control loop can be caused by

- Oscillatory tuning of the controller
- Interaction between master (outer) and slave (inner) loops due to inappropriate cascade tuning
- Nonlinearity in the inner loop or control valve
- Oscillations passed to the subject loop from surrounding processes
- Process resonance

The example data in Figure 1 is taken from a Liquefied Natural Gas (LNG) plant that uses the Phillips Optimized Cascade Process engineered by Bechtel Corporation. The plant was replacing the level control valves every few months due to severe wear. Upon arriving at the plant, the Emerson consultant found the large slow cycle shown in Figure 1 and a small fast cycle shown in Figure 2. Figure 2 also illustrates that the high proportional gain, typically required in the level controller, amplifies any PV cycling into large output changes to the control valve. In this case, the small PV cycle caused most of the cumulative travel of the control valve.

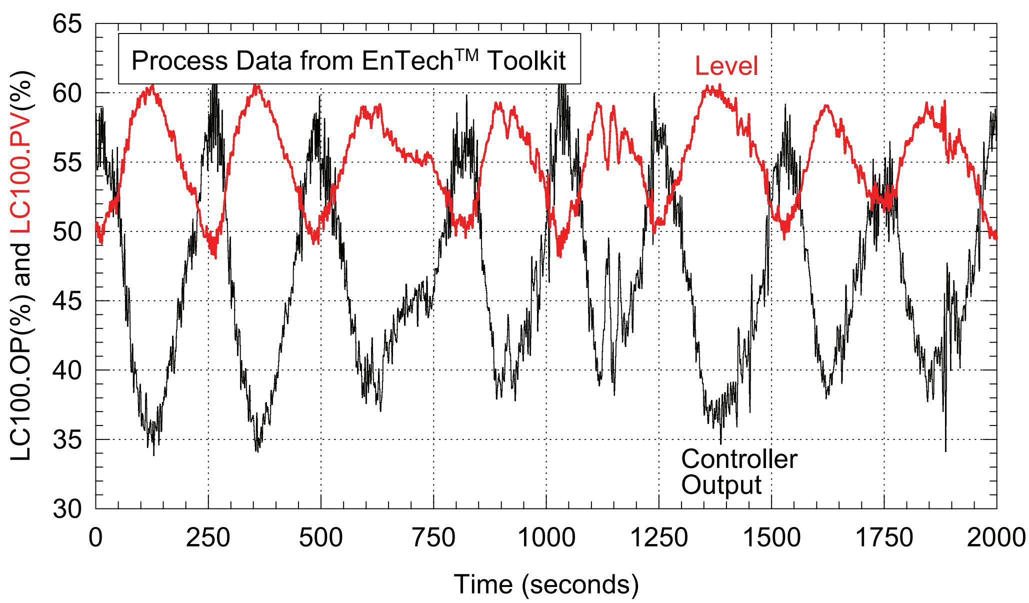

Figure 1 Example of cycling found in the propane ethylene condenser feed chiller of an LNG plant

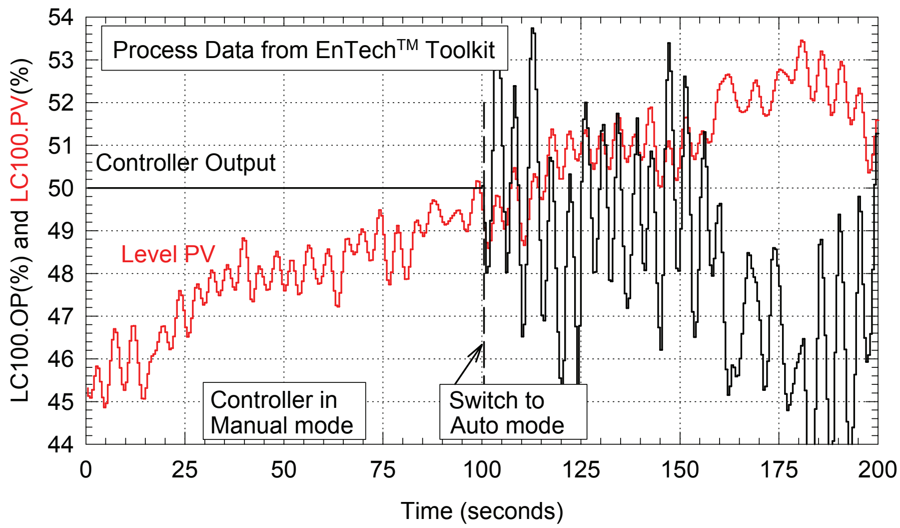

Figure 2 Example of process resonance amplified by the controller structure

Solutions

- The Lambda tuning method used by Emerson's Control Performance group provides critically damped response that will not create an oscillation on the output or a resulting oscillation in neighboring loops. As shown in Figure 3, Lambda (λ) is a user-selected parameter representing the arrest time for a step load disturbance. Emerson offers training on this method in courses 9030 and 9032.
- Lambda tuning also provides an explicit parameter to separate the dynamics of inner and outer loops. For example, one can readily choose Lambda of the level loop much greater than Lambda of an inner flow loop.
- Selection of control valves to minimize installed dead band and other nonlinearities is very important. The Control Performance group has extensive experience and tools in diagnosing control valve problems and specifying the valve, actuator, and positioner components for best performance. The actuator readback and diagnostic information provided by Fieldbus (e.g., PlantWeb®) installations can be helpful in optimizing the installed performance.
- Lambda tuning of the level loops prevents oscillation. Also, Lambda can be chosen to make each vessel absorb disturbances instead of propagating them.
- In level control, resonance of the free surface is common and must be handled properly in the controller structure.

In this case, the Emerson consultant recommended a change in the controller structure to minimize the impact of resonance, a modification to the control valve components to better resist wear, and application of Lambda tuning.

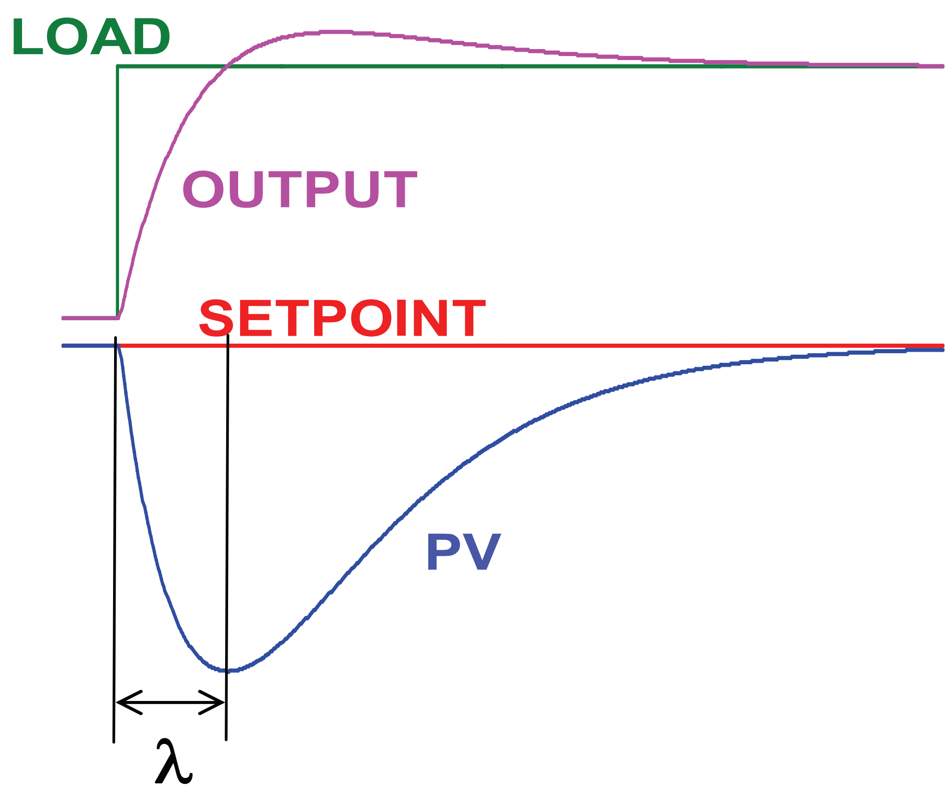

Figure 3 Lambda tuning of the integrating process loop gives a critically damped, non-oscillatory response of the PV and the output.

For Further Information

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