Originally appeared in HYDROCARBON PROCESSING® March 2010, pg 17. Posted with permission.

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Distillation column dual-temperature control—Part 1

This editorial takes issue with a claim by Mr. Greg Shinskey that distillation dual-composition control cannot be done effectively by a multivariable predictive controller (MPC), but can be done effectively by advanced regulatory controllers (ARCs).[1] In fact, the argument is not about MPC versus ARC but about how to set up a workable basic DCS control structure.

Mr. Shinskey's starting point is the dual-temperature control structure shown in Fig. 1, with two temperature controllers: one in the rectifying section manipulating reflux, the other in the stripping section manipulating the reboiler. Mr. Shinskey asserts, and I agree, that "manipulation of reflux and boil-up has almost the same effect on both temperatures. In other words, increasing steam flow will raise the top temperature almost as much as it raises the bottom temperature, and increasing reflux flow will lower both by similar amounts—no amount of clever setpoint adjustment by the MPC can break through that tight coupling."

The real issue is not what manipulates the dual-temperature setpoints, but stability of the basic DCS configuration in Fig. 1. Regardless of what drives the temperature setpoints, MPC or ARC, the basic DCS must provide stable dual-temperature control before any advanced process controls (APC) can begin. Having said that this problem is next to impossible to handle, Shinskey goes through a relative-gain analysis to show that some columns can be stable as configured in Fig. 1, whereas other, high-purity columns must incorporate the mass balance structure of Fig. 2, with drum level control on the reflux and top temperature control on the top product.

Neither strategy works. Why is it then that in my travels I have seen neither the structure of Fig. 1 nor Fig. 2 working? It is because of what Mr. Shinskey so eloquently said about tight coupling. Even if one can manage to tune these temperature loops under one condition, they go unstable the next day under different conditions, and operators quickly turn one of the temperature controllers to manual.

And there is no point squeezing too much mileage out of relative-gain analysis. Relative-gain analysis is a steady-state technique, whereas the complexity of this problem is dynamic. High-purity distillation is not normally controlled by a high-up tray temperature because the temperature profile is flat. The meaningful tray temperature would have to be located many trays below the top, which renders the dynamics between product draw and tray temperature slow and complex, on top of the already disruptive interactions.

I would challenge Mr. Shinskey to write an article showing a real column having stable dual-temperature control, and how such an interactive system can be tuned. Part 2 will be published in our April issue. HP

LITERATURE CITED

[1] Shinskey, F. G., "Multi-variable control of distillation," Parts 1, 2 and 3, *Control Global*, May, June and July 2009.

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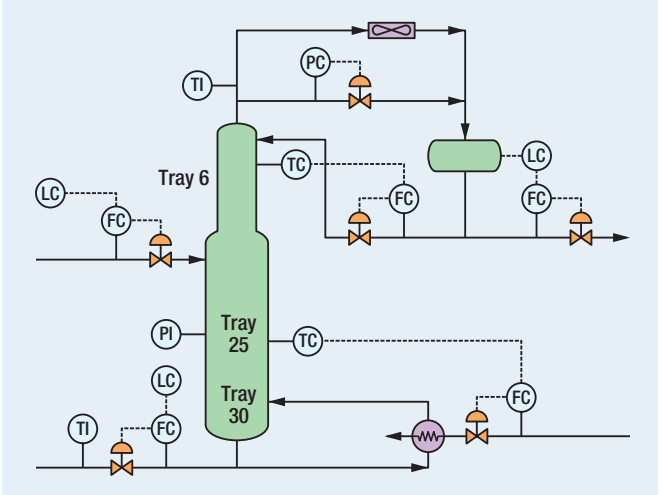

FIG. 1 Dual-temperature control on a heat-balance control structure.

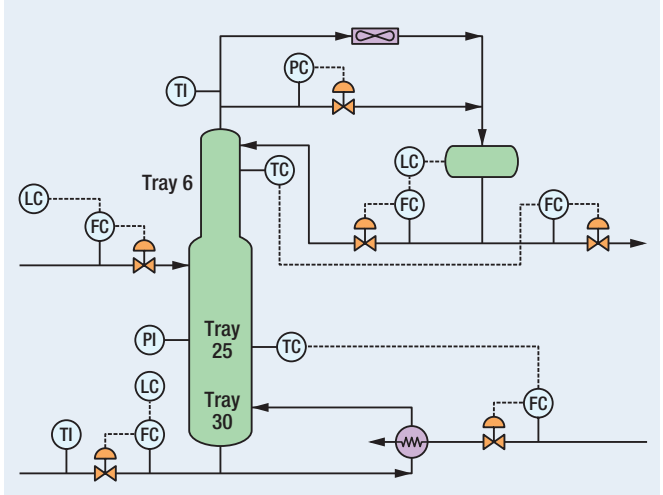

FIG. 2 Dual-temperature control on a mass-balance control structure.