# Distillation column tray temperature control

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A colleague has asked me about distillation column tray temperature control structure. I acknowledge, he said, the advantage of tray temperature control shown in figure 1, with so called heat balance type configuration, where distillate draw is on accumulator level and temperature control on reflux. But what if I have a mass balance configuration as shown in figure 2? Can I use tray temperature control on the distillate to control product quality?

The DCS control strategy of figure 1 works well because a well placed tray temperature provides an approximate product purity inference. Should feed composition or enthalpy change – the tray TC would correct the reflux, and indirectly the distillate draw. Why not then use a similar strategy for mass balanced columns and manipulate distillate draw directly? Let us examine such a strategy.

1. To begin with, mass balance DCS strategy is typically configured on high reflux fractionators with flat temperature profile, and the use of tray temperature as a quality inference is questionable. If indeed there is such a tray whose temperature provides a reasonable inference then why apply a mass balance strategy? Heat balance would do better.
2. At the end of the day the tray in question is cooled by reflux. The DCS strategy of figure 2 depends on the drum LC to respond to distillate flow changes and manipulate the reflux. Only then would the fractionation really change. Depending on LC tuning the temperature response can have difficult dynamics and for such a strategy to work the LC must be tuned tight. Then it must be locked in such a way that no-one can re-tune it without first obtaining permission.
3. And what would happen if the operator turns this LC to manual for unrelated reasons? If the TC is allowed to continue to work it would wind up and fail. This calls for installing a special switch to turn the TC to manual when the LC is not in control, making the strategy more complex.

So can we make the strategy of figure 2 work? Yes we can, with some complexities, but why would we want to?

Alright, said my colleagues, I will not configure figure 2 under normal circumstances, but please tell me, do you see any column configuration where quality control on the draw would be recommended? Initially I responded negatively, but at a later point I thought about figure 3. The column of figure 3 has a pickling section, aiming to remove extra light components, whereas the main distillate product is drawn from a tray. An example of such a column is a benzene toluene separator, where the benzene contains some aliphatic C6. The top product contains about 20% aliphatics and it is recycled back to be reprocessed upstream. Benzene product is drawn from a tray and it is 99.9% pure. The DCS strategy here uses mass balance configuration as shown, but figure 3 is different from figure 2 in an important way. Upon increasing distillate draw, internal reflux is reduced instantly without relying on another LC to work. Hence the tray TC is easy to tune and would not require interlocking logic. Assuming the existence of a meaningful tray temperature, the strategy of figure 3 is a good way to apply quality control at the DCS level.

**Figure 1. Tray temperature control on a heat balance control structure**

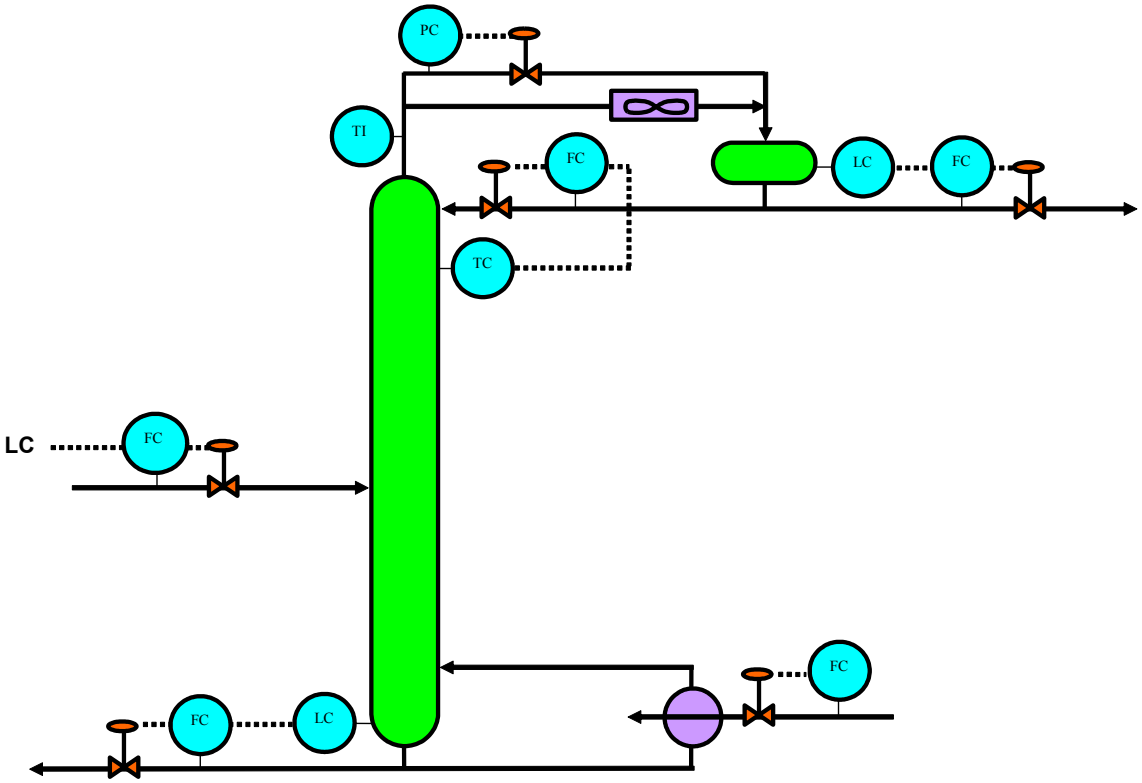

**Figure 2. Tray temperature control on a mass balance control structure**

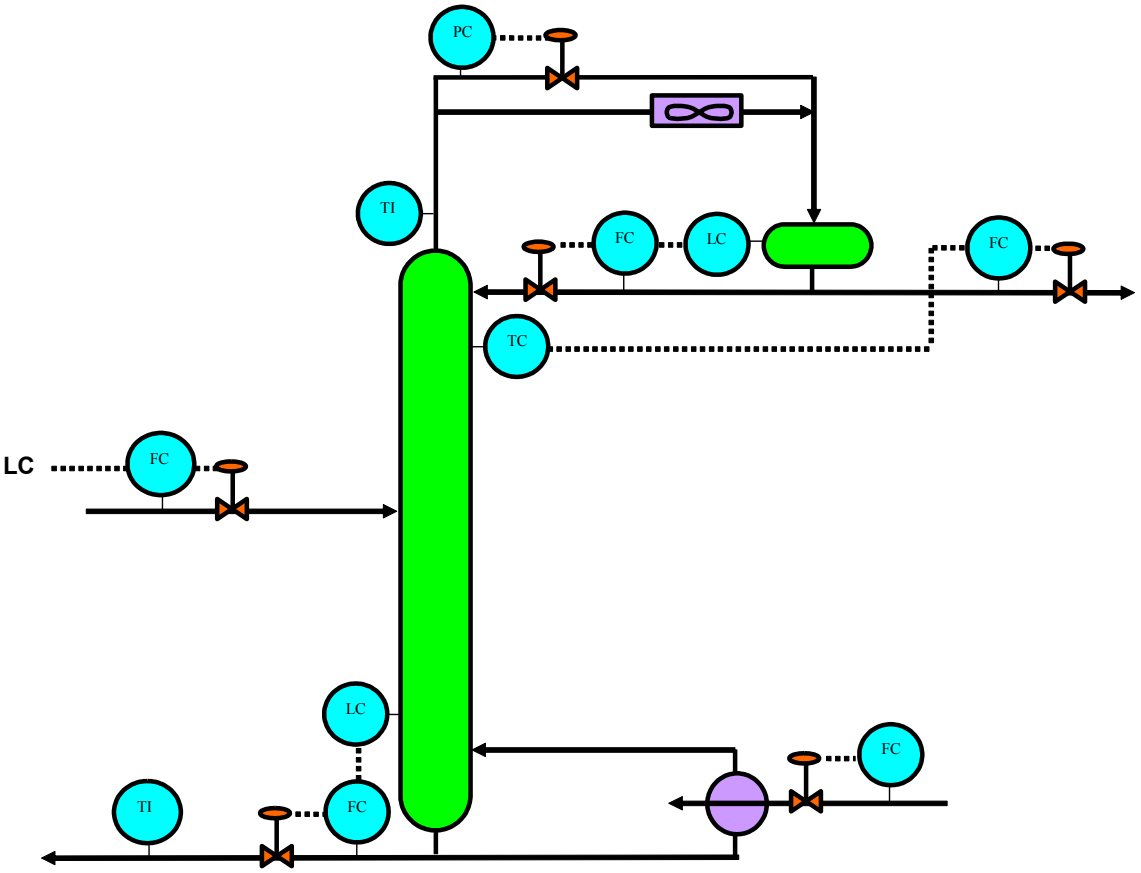

**Figure 3. Tray temperature control on a column with pickling section**