10 Cascade control

Chapters 6 and 7 presented the design of feedback control. Feedback control is the simplest form of automatic process control that compensates for process upsets. However, the disadvantage of feedback control is that it reacts only after the process has been upset. That is, when a disturbance enters the process, it has to propagate through the process and make the controlled variable deviate from set point before feedback takes corrective action. Thus a deviation in the controlled variable is needed to initiate corrective action. Even with this disadvantage, probably 80% of all control strategies used in industrial practice are simple feedback control. In these cases, the control performance provided by feedback is satisfactory for safety, product quality, and production rate.

As the processes requirements tighten, however, and in processes with slow dynamics and processes with too many, or frequently occurring, upsets, the control performance provided by feedback control often becomes unacceptable. It is necessary to use other strategies to provide the required performance. These additional strategies are the subject of this and subsequent chapters. The strategies presented complement feedback control; they do not replace it. Remember that it is always necessary to provide some feedback from the controlled variable.
Cascade control is a strategy that improves, in some applications significantly, the performance provided by feedback control. This strategy has long been well known. Computers provide a simpler, safer, and less costly implementation of cascade control than is obtained by the use of analog instrumentation. Therefore, cascade control is implemented more often now, with computers available, than it was when analog instrumentation alone was used. This chapter explains in detail the fundamentals and benefits of cascade control.

Cascade control is especially useful in reducing the effect of a load disturbance that moves through the control system slowly. The inner loop has the effect of reducing the lag in the outer loop, with the result that the cascade system responds more quickly with a higher frequency of oscillation. Example 18.2 will illustrate this effect of cascade control.