Process Dynamics

PART II

The engineer must understand the dynamic behavior of a physical system in order to design the equipment, select operating conditions, and implement an automation technique properly. The need for understanding dynamics is first illustrated through the discussion of two examples. The first involves the dynamic responses of the bus and bicycle shown in Figure II.1. When the drivers wish to maneuver the vehicles, such as to make a 180° U turn, the bicycle can be easily turned in a small radius, while the bus requires an arc of considerably larger radius. Clearly, the design of the vehicle affects the possible maneuverability, even when the bus has an expert driver. Also, the driver of the bus and the rider of the bicycle must use different rules in steering. This simple example demonstrates that (1) a key aspect of automation is designing and building equipment that can be easily controlled, and (2) the design and implementation of an automation system requires knowledge of the dynamic behavior of the system.

These two important principles can be applied to the chemical reactor example shown in Figure II.2. The reactor operation can be influenced by adjusting the opening of the valve in the coolant pipe, and the outlet concentration is measured by an analyzer located downstream from the reactor outlet. Regarding the first principle (the effect of process design), it seems likely that the delay in measuring the outlet concentration would reduce the effectiveness of feedback control. Regarding the second principle (the effect of automation method), a very aggressive method for adjusting the coolant flow could cause a large overshoot or oscillations in returning the concentration to its desired value; thus, the feedback adjustments should be tailored to the specific process.