

Stability Analysis and Controller Tuning

CHAPTER

10

10.1 ■ INTRODUCTION

To this point, we have developed a control algorithm (the proportional-integral-derivative controller) and a method for tuning its adjustable constants. One might ask, "Isn't this sufficient for designing feedback control systems?" The answer is a resounding "No!", because we do not have a general method for evaluating the effects of elements in the closed-loop system on dynamic stability and performance.

Through various examples and exercises, we have seen how feedback control can change the qualitative behavior of a process, introducing oscillations in an originally overdamped system and potentially causing instability. In fact, we shall see that the stability limit is what prevents the use of a very high controller gain to improve the control performance of the controlled variable. Therefore, a thorough understanding of the stability of dynamic systems is essential, because it provides important relationships among process dynamics, controller tuning, and achievable performance. These relationships are used in a variety of ways, such as selecting controller modes, tuning controllers, and designing processes that are easier to control.

10.2 ■ THE CONCEPT OF STABILITY

In vernacular English, the term "unstable" has a negative connotation. Certainly, no one would want to be described as unstable! This undesirable meaning extends to products of engineering design; we generally want our plants and control systems to be stable. To ensure consistency, we will use a clear and precise definition of