Chapter 22

ADVANCED PROCESS CONTROL

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1. INTRODUCTION

At relatively low cost, model-predictive control improves the capability of process units by increasing throughput, improving fractionator performance, decreasing product quality giveaway, reducing operating costs, and stabilizing operations. Figure 1 presents an overview of the scope of refinery software applications and indicates the frequency at which they typically run.

2. USEFUL DEFINITIONS

A proportional-integral-derivative (PID) controller is a feedback device. A process value (PV) is measured by a field transmitter. A controller compares the PV to its setpoint (SP) and calculates the required change – for example, a new valve opening position (OP) – to bring the PV closer to the SP. The required change is calculated with a PID algorithm. In practice, proportional, integral, and derivative constants are parameters used for tuning.

Advanced process control (APC) applications involve the use of control algorithms to provide improved process control when compared to regulatory PID controllers in loops or cascades.

Traditional Advanced Control (TAC) employs the use of advanced control algorithms combined with regulatory control functions (i.e., lead/lag, ratio, high/low selectors, etc) to implement a control strategy.

A programmable logic controller (PLC) is a small computer used to automate real-world processes. A PLC receives input from various sensors
and responds to changes by manipulating actuator valves according to pre-programmed logic stored in the memory of the PLC.

![Diagram of computer control applications](image)

*Figure 1. Overview of computer control applications. ERP stands for enterprise resource planning, a software solution that integrates planning, manufacturing, sales, and marketing.*

In a **distributed control system** (DCS), process measurements and control functions such as multiple PID loops are connected to application processors, which are networked throughout the plant. A **graphical user interface** (GUI) makes it easier for operators to view data, create plots, change setpoints, and respond to alarms. In addition to process control, modern DCS software includes sophisticated trending and data storage.

**Multivariable process control** (MVPC) applications use one or more independent variables to control two or more dependant variables. If a variable is truly independent, its value is not affected by other process variables. There are two types of independent variables. **Manipulated variables** (MV) can be changed by an operator to control the process. These include setpoints for regulatory PID controllers and valve positions. **Feed-forward** (FF) and **disturbance variables** (DV) affect the process but can’t be manipulated. These include ambient temperature, the quality of an external feed, etc.

The value of a dependent variable can be calculated using the values of independent variables and an appropriate dynamic model. **Controlled variables** (CV) are maintained at a desired steady-state target. Constraint variables are maintained between high and low limits. Many variables are dependent, but not all dependent variables are important enough to be controlled by the APC application.