Output Response from Transfer Functions

Teng-Jui Lin
Department of Chemical Engineering, University of Washington
Process Dynamics and Control

Evaluating nominal steady-state condition

Seborg Ex. 4.5a Given constant liquid density ρ, volume V, mass flow rates w_1, w_2, and w, the governing equation for a continuous blending process is

$$\rho V \frac{dx}{dt} = w_1 x_1 + w_2 x_2 - wx$$

where x are compositions. When output x varies upon change in input x_1 while x_2 is held constant, the transfer function is

$$G(s) = \frac{K_1}{\tau s + 1}, \quad K_1 \equiv \frac{w_1}{w}, \quad \tau \equiv \frac{\rho V}{w}$$

Determine the nominal exit concentration $\overline{x}$, given $w_1 = 600$ kg/min, $w_2 = 2$ kg/min, $x_1 = 0.05$, $x_2 = 1$.

Output response upon step input change can be determined from transfer functions

Seborg Ex. 4.5b Derive an expression of the output response $x(t)$ given the transfer function

$$G(s) = \frac{K_1}{\tau s + 1}, \quad K_1 \equiv \frac{w_1}{w}, \quad \tau \equiv \frac{\rho V}{w}$$

and sudden input change in x_1 from 0.050 to 0.075 at $t = 0$. Assume the process is initially at steady-state. Given $w_1 = 600$ kg/min, $w_2 = 2$ kg/min, $x_1 = 0.05$, $x_2 = 1$, $V = 2\ \mathrm{m}^3$, $\rho = 900\ \mathrm{kg/m}^3$.