Experimental estimations of the model parameters

Problem: estimating the time constants for the first order and overdamped second order dynamic models based on the measured output response to a step input change of magnitude M.

Transfer function	Step response
$\frac{Y(s)}{U(s)} = \frac{K}{\tau s + 1}$	$y(t) = KM(1 - e^{-t/\tau})$
$\frac{Y(s)}{U(s)} = \frac{K}{(\tau_1 s + 1)(\tau_2 s + 1)}$	$y(t) = KM(1 - \frac{\tau_1 e^{-t/\tau_1} - \tau_2 e^{-t/\tau_2}}{\tau_1 - \tau_2})$

Some times a variable transformation can be employed to transform nonlinear model so that linear regression can be used.

$$\ln(1 - \frac{y(t)}{KM}) = -\frac{t}{\tau} \tag{1}$$

Because $\ln(1 - y(t)/KM)$ can be evaluated at each time t_k, this model is linear in the parameter $1/\tau$.

5.1 Concentration process

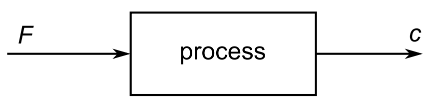

Figure 1: Mixing process

In order to estimate process parameters the next experiment was carry out. At 13:00 operator changed the initial inflow up-to $\Delta F = 0.5\ l/min$. During first 7 min concentration of the product was the same $c = 75$ %. At 13:20 measurement of the concentration shows the next value $c = 70$ %. After that operator was destructed by other process, so the next time he could measure the concentration of the product time was 16:30 and concentration value $c = 65$ %.

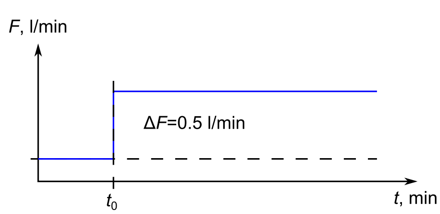

Figure 2: Input change

1. Provide FOPDT model of the process. What are the gain K_p, time constant τ and the delay θ values?