Modelling and control summaries

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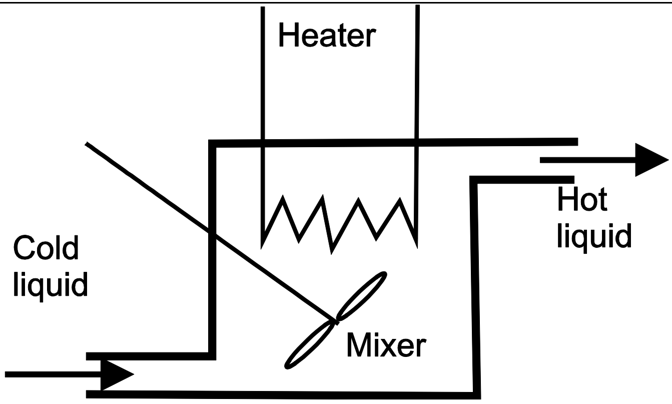
MATLAB GUIs – heat exchanger with disturbance

ASSUMPTION: Students should understand the context of a simple heat exchanger.
In this example cold liquid is heated up by condensing steam (the heater) in a tank of volume V m^3. Assume perfect mixing.
Fluid (water) enters at one temperature (T_{in}) and leaves at another (T) and has constant flow rate F m^3/s. It is assumed that the only heat supply is the latent heat $\lambda=2.3\times10^6$ J/kg from the condensing steam which has flow rate Q kg/s. C_p=4200J/degree is specific heat of fluid and ρ=1000kgm^{-3} the density.



An approximate model for such a heat exchanger is given as:

$$\lambda Q + \rho F C_p T_{in} = \rho V C_p \frac{dT}{dt} + \rho F C_p T \quad \Rightarrow \quad \left(\frac{\lambda}{\rho F C_p}\right) Q + T_{in} = \left(\frac{V}{F}\right)\frac{dT}{dt} + T$$

One purpose of this GUI is to allow students to investigate the impact on behaviour of changes in:

1. Tank volume ***V*** (effects dynamics through time constant).
2. Flow rate of fluid ***F*** (effects dynamics through time constant and gain from steam flow).
3. Flow rate of steam (input 1) ***Q***.
4. Input temperature of fluid (input 2) T_{in}.

To investigate these effects put the GUI in manual mode and then open-loop behaviours will be observed. *Turn uncertainty off to see nominal behaviour*.

IMPACT OF UNCERTAINTY: **The main purpose of this GUI is to understand the challenges of handling uncertainty in the real world.**

Two types of uncertainty are included:

1. The fluid flow rate ***F*** is continuously disturbed ($F=F_{ex}+F_{pert}$), so slightly different from that expected. (It changes, randomly, every 60 seconds and by a small amount F_{pert}.)
2. The inlet temperature T_{in} is also disturbed continuously (again it takes a value $T_{in}=T_{in,ex}+T_{in,pert}$ which is a random deviation about an 'expected' value $T_{in,ex}$, every 60 sec.).

THE CHALLENGE

1. Can the user manually select the steam flow rate ***Q*** and maintain the outlet temperature at the desired value?
2. What happens if you run true open-loop, which is estimate ***Q*** from the expected condition and system parameters and simply see what follows?

FILENAMES are heatexchanger.p, heatexchanger.fig . Both are needed!
Type >> heatexchanger to run

1. As soon as the use changes the values in the sliders (or edit text boxes next to them), then this change is incorporated immediately and the plots will change.
2. The tank changes colour to give a pictorial view of the temperature – dark blue for cold and light purple for hot.
3. The heater changes thickness to give a view of the heat supply ***Q***.