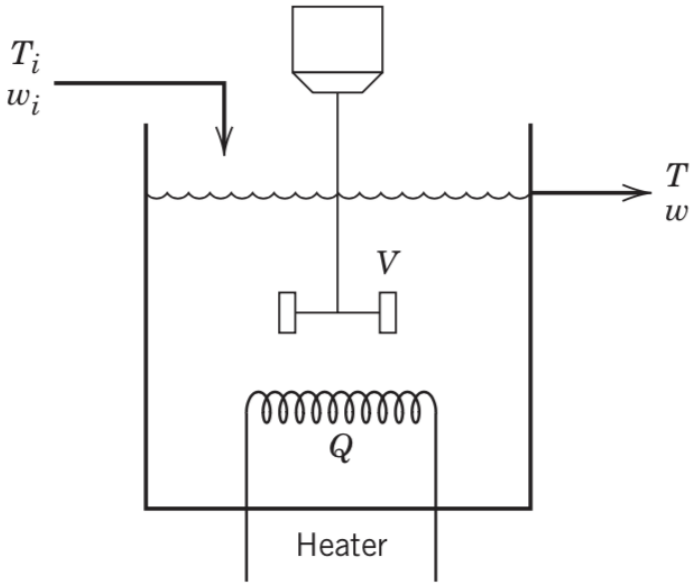
CHEM-E7190/2021: Exercise I - Modelling + simulation (Euler)

Task 1. Consider the stirred-tank heating system. The liquid inlet stream consists of a single component with a mass flow rate w_i and an inlet temperature T_i. The tank contents are agitated and heated using an electrical heater that provides a heating rate, Q. A dynamic model will be developed based on the following assumptions:



1. Perfect mixing; thus, the exit temperature T is also the temperature of the tank contents.
2. The density ρ and heat capacity C of the liquid are assumed to be constant. Thus, their temperature dependence is neglected.
3. Heat losses are negligible.
4. The flow rate exiting the tank is through an orifice, and the overall rate is dictated by hydrostatic forces.

Study the process diagram, then write the total mass balance equations.

Familiarise with programs `stirredTank_main_template.m` and `stirredTank_template.m`. Experiment on how to simulate the system from different initial conditions $x(t=0) = \begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix}$ and varying inputs $u(t) = \begin{bmatrix} u_1(t) \\ u_2(t) \end{bmatrix}$. Then implement your stirred tank model with programs named, for example, `stirredTankNonLin_main.m` and `stirredTankNonLin.m`.

1. Simulate the system from initial condition $V = 1$ and $T = 1$ for a constant input $w_i = 0$, $T_i = 0$ and $Q = 0$. Constants are $\rho = 1$, $C_v = 1$, $A = 1$ and $C = 1$
2. Simulate the system from initial condition $V = 1$ and $T = 1$ for a constant input $w_i = 1$, $T_i = 0.1$ and $Q = 0.1$.

3. Simulate the system from initial condition $V = 1$ and $T = 1$ for an input defined as follows

   - $w_i(t) = 1$ for $t \in [0, 2.5]$, $w_i(t) = 2$ for $t \in [2.5, 5]$, $w_i(t) = 1$ for $t \in [5, 7.5]$, $w_i(t) = 3$ for $t \in [7.5, 10]$
   - $T_i(t) = 2$ for $t \in [0, 2.5]$, $T_i(t) = 0$ for $t \in [2.5, 5]$, $T_i(t) = 2$ for $t \in [5, 7.5]$, $T_i(t) = 1$ for $t \in [7.5, 10]$
   - $Q(t) = 2$ for $t \in [0, 2.5]$, $Q(t) = 0$ for $t \in [2.5, 5]$, $Q(t) = 2$ for $t \in [5, 7.5]$, $Q(t) = 1$ for $t \in [7.5, 10]$

You can use program `plotStirredTank_template.m` to plot your results. You can also modify it to suit your needs.