A single tank with cross-sectional area \( A \) \( \text{ft}^2 \) receives an inflow of \( f_1(t) \) in \( \text{ft}^3/\text{min} \) at a temperature of \( T_1(t) \), measured in deg F. Outflow \( f_0(t) \) is in \( \text{ft}^3/\text{min} \) and at temperature \( T(t) \), in deg F. The liquid level and temperature in the tank at time \( t \) is \( H(t) \) and \( T(t) \), respectively.

The tank is modeled by the following differential and algebraic equations:

\[
A \frac{dH}{dt} + f_0 = f_1
\]

\[
f_0 = \alpha H^{1/2}
\]

\[
c f_1 T_1 - c f_0 T = c \frac{d}{dt}(AHT)
\]

The last equation reflects a conservation of energy, i.e.

Rate of energy in \( \rightarrow \) rate of energy leaving \( \rightarrow \) rate of accumulation of energy

where \( c \) is the specific heat of the liquid measured in \( \text{Btu} / \text{degF} \) per \( \text{ft}^3 \).

\[
\frac{Btu}{\text{ft}^3 - \text{degF}} \cdot \frac{\text{ft}^3}{\text{min}} \cdot \frac{\text{degF}}{\text{min}} = \frac{Btu}{\text{ft}^3 - \text{degF}} \cdot \frac{\text{ft}^3}{\text{min}} \cdot \frac{\text{degF}}{\text{min}} = \frac{Btu}{\text{min}} \cdot \frac{1}{\text{min}} \cdot \left( \frac{\text{ft}^2 \cdot \text{ft} \cdot \text{degF}}{\text{min}} \right)
\]

\[
\frac{Btu}{\text{min}} - \frac{Btu}{\text{min}} = \frac{Btu}{\text{min}}
\]

The right hand side of the last equation is expanded to

\[
c f_1 T_1 - c f_0 T = c A \frac{d}{dt}(HT) = c A \left( H \frac{dT}{dt} + T \frac{dH}{dt} \right)
\]
After solving for $\frac{dT}{dt}$ in the last equation, the Simulink diagram is obtained as shown.

% class_demo_3A.m
% example of a tank with two inputs, flow and temperature
clc, close all, clear all
A=10; % tank area
F1=12; % amplitude of step flow in
alpha=4; % discharge flow constant
H_init=10;
T_init=70;
delta_T=50; % change in temp step flow in above T_init
step_size=0.025; % RK-4 integration step size
tfinal=500;
estop=0.01; % stop condition for |dH/dt| and |dT/dt|
sim('class_demo_3A')
t=t_H(:,1);
H=t_H(:,2);
T=t_T(:,2);
subplot(2,1,1)
plot(t,H)
ylabel('H (ft)')
title('H vs t')
subplot(2,1,2)
plot(t,T)
xlabel('t (min)')
ylabel('T (deg F)')
title('T vs t')