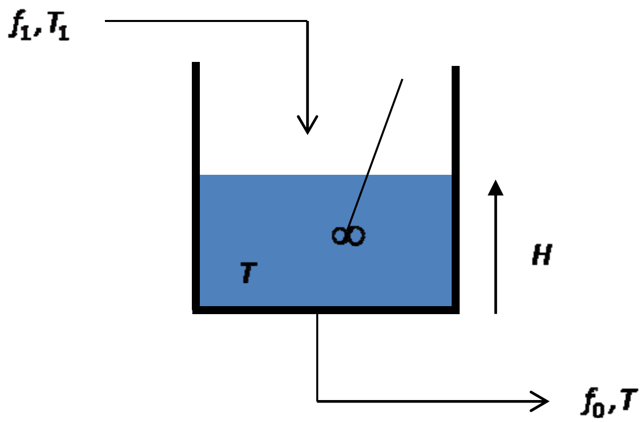
A single tank with cross-sectional area A ft^2 receives an inflow of $f_1(t)$ in ft^3/min at a temperature of $T_1(t)$, measured in deg F. Outflow $f_0(t)$ is in ft^3/min and at temperature $T(t)$, in deg F. The liquid level and temperature in the tank at time t is $H(t)$ and $T(t)$, respectively.



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

$$A\frac{dH}{dt} + f_0 = f_1$$

$$f_0 = \alpha H^{1/2}$$

$$cf_1T_1 - cf_0T = c\frac{d}{dt}(AHT)$$

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

Rate of energy in − rate of energy leaving = rate of accumulation of energy

where c is the specific heat of the liquid measured in $Btu / \deg F$ per ft^3.

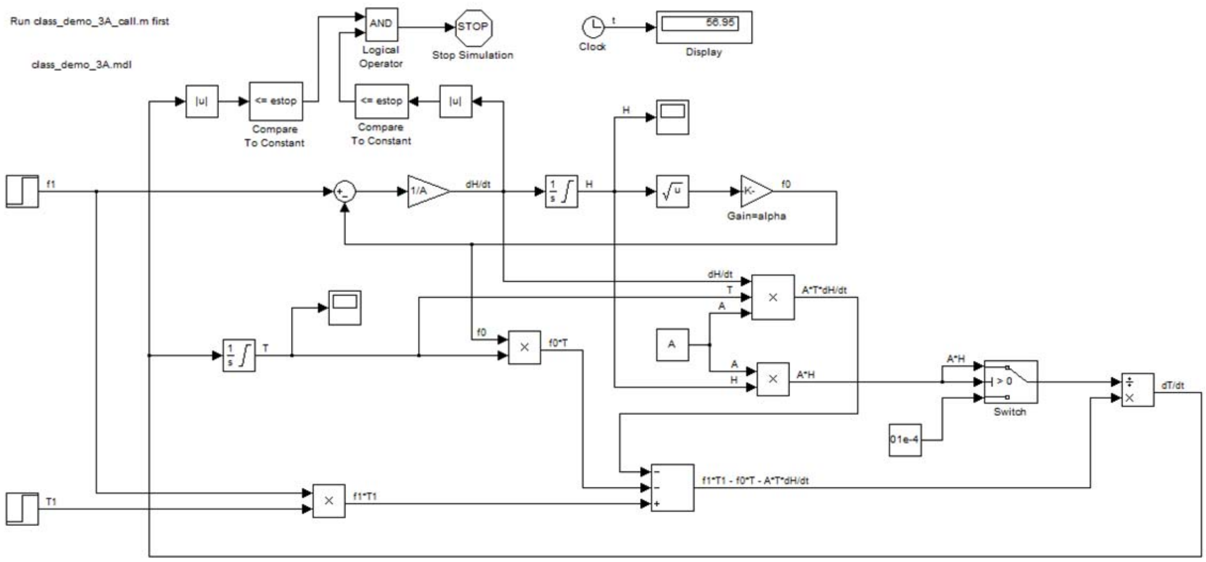
$$\frac{Btu}{ft^3 - \deg F}\cdot\frac{ft^3}{\min}\cdot\deg F - \frac{Btu}{ft^3 - \deg F}\cdot\frac{ft^3}{\min}\cdot\deg F = \frac{Btu}{ft^3 - \deg F}\cdot\frac{1}{\min}\cdot\left(ft^2\cdot ft\cdot\deg F\right)$$

$$\frac{Btu}{\min} - \frac{Btu}{\min} = \frac{Btu}{\min}$$

The right hand side of the last equation is expanded to

$$cf_1T_1 - cf_0T = cA\frac{d}{dt}(HT) = cA\left(H\frac{dT}{dt} + T\frac{dH}{dt}\right)$$

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')
```