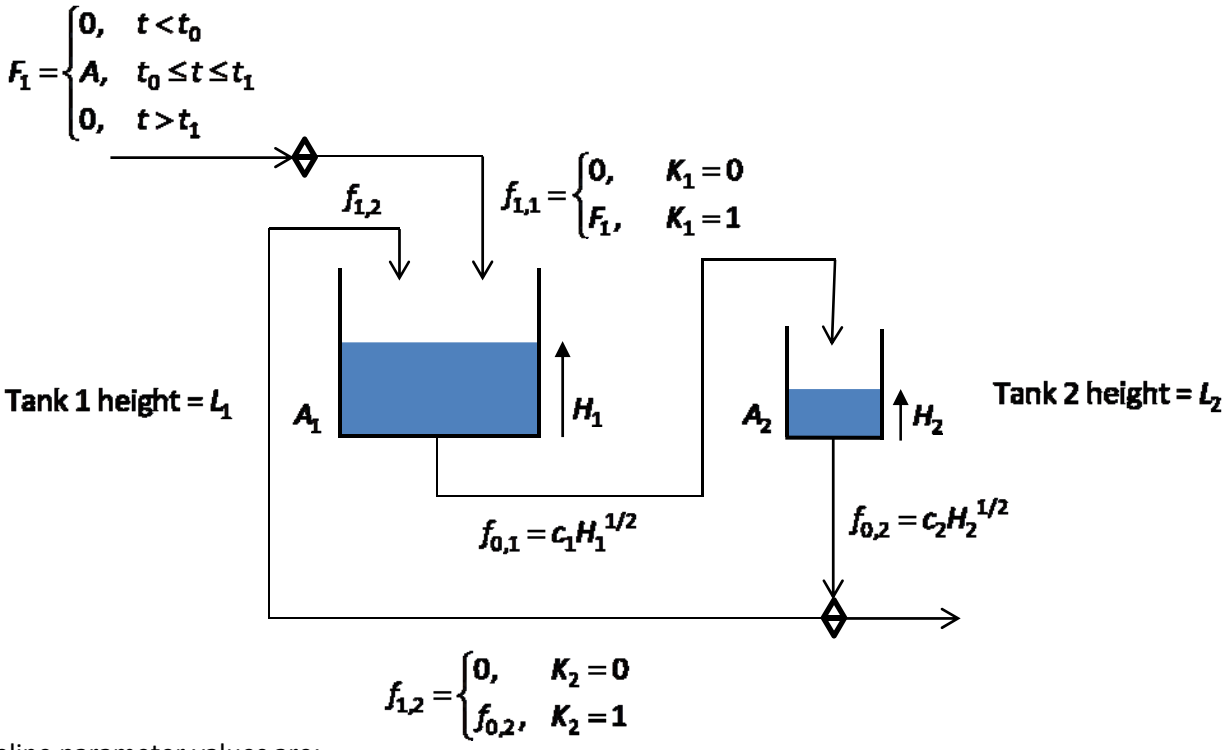
Two tanks are arranged in series as shown.



Baseline parameter values are:

$A_1 = 4 \text{ ft}^2,\ A_2 = 4 \text{ ft}^2$

$L_1 = 20 \text{ ft},\ L_2 = 10 \text{ ft}$

$c_1 = 2 \text{ ft}^3/\text{min per ft}^{1/2},\ c_2 = 2 \text{ ft}^3/\text{min per ft}^{1/2}$

$H_1(0) = 0 \text{ ft},\ H_2(0) = 0 \text{ ft}$

$t_0 = 0 \text{ min},\ t_1 = 20 \text{ min}$

$A = 15 \text{ ft}^3/\text{min}$

$K_1 = 1,\ K_2 = 0$

The overflow from each tank (not shown in figure) is

$$f_{1,s} = \begin{cases} 0, & H_1 < L_1 \\ (f_{1,1} + f_{1,2}) - (f_1)_{\max}, & H_1 = L_1 \end{cases} \quad \text{where} \quad (f_1)_{\max} = c_1 L_1^{1/2}$$

$$f_{2,s} = \begin{cases} 0, & H_2 < L_2 \\ f_{0,1} - (f_2)_{\max}, & H_2 = L_2 \end{cases} \quad \text{where} \quad (f_2)_{\max} = c_2 L_2^{1/2}$$

1) Prepare a Simulink diagram for simulating the two-tank system dynamics. Include scopes for viewing the following variables:

$f_{1,1}, f_{1,2}, f_{0,1}, f_{0,2}, f_{1,s}, f_{2,s}, H_1, H_2$

In addition, include blocks and scopes for viewing:

i) $V_{1,in}$, the cumulative flow (in cu ft) into Tank 1 from the external source from $t = 0$ to $t = t_{final}$.

ii) $V_{1,spill}$, the cumulative overflow (in cu ft) from Tank 1 from $t = 0$ to $t = t_{final}$.

iii) $V_{2,spill}$, the cumulative overflow (in cu ft) from Tank 2 from $t = 0$ to $t = t_{final}$.

iv) $V_{2,out}$, the cumulative flow (in cu ft) out of Tank 2 not returned to Tank 1 from $t = 0$ to $t = t_{final}$.

Configure the scopes or include "To Workspace" blocks so that the cumulative flows in i) thru iv) are saved in the Matlab Workspace.

2) Call the Simulink model from Matlab using the baseline parameter values and plot

i) $H_1(t)$ and $H_2(t)$ on the same graph.

ii) $f_{1,1}(t)$, $f_{0,1}(t)$ and $H_1(t)$ on the same graph.

iii) $f_{0,1}(t)$, $f_{0,2}(t)$ and $H_2(t)$ on the same graph.

Use the 'ode4' integrator with a step size of 0.005 sec. Run the simulation for 30 sec.

3) Call the Simulink model from Matlab using the values:

Case I:

$A_1 = 4$ ft^2, $L_1 = 20$ ft, $c_1 = 2$ ft^3/min per ft$^{1/2}$, $H_1(0) = 0$ ft,

$A_2 = 4$ ft^2, $L_2 = 10$ ft, $c_2 = 2$ ft^3/min per ft$^{1/2}$, $H_2(0) = 0$ ft

$t_0 = 0$ min, $t_1 = 20$ min, $A = 8$ ft^3/min

$K_1 = 1$, $K_2 = 0$

Case II:

$A_1 = 4$ ft^2, $L_1 = 20$ ft, $c_1 = 2$ ft^3/min per ft$^{1/2}$, $H_1(0) = 0$ ft,

$A_2 = 4$ ft^2, $L_2 = 10$ ft, $c_2 = 2$ ft^3/min per ft$^{1/2}$, $H_2(0) = 0$ ft

$t_0 = 0$ min, $t_1 = 20$ min, $A = 20$ ft^3/min

$K_1 = 1$, $K_2 = 0$

Case III:

$A_1 = 5$ ft^2, $L_1 = 20$ ft, $c_1 = 2$ ft^3 / min per ft$^{1/2}$, $H_1(0) = 10$ ft,

$A_2 = 3$ ft^2, $L_2 = 10$ ft, $c_2 = 2$ ft^3 / min per ft$^{1/2}$, $H_2(0) = 5$ ft

$t_0 = 0$ min, $t_1 = 20$ min, $A = 20$ ft^3 / min

$K_1 = 1$, $K_2 = 0$

Case IV:

$A_1 = 4$ ft^2, $L_1 = 20$ ft, $c_1 = 2.25$ ft^3 / min per ft$^{1/2}$, $H_1(0) = 0$ ft,

$A_2 = 4$ ft^2, $L_2 = 10$ ft, $c_2 = 1.5$ ft^3 / min per ft$^{1/2}$, $H_2(0) = 0$ ft

$t_0 = 0$ min, $t_1 = 20$ min, $A = 25$ ft^3 / min

$K_1 = 1$, $K_2 = 0$

Case V:

$A_1 = 4$ ft^2, $L_1 = 20$ ft, $c_1 = 2$ ft^3 / min per ft$^{1/2}$, $H_1(0) = 0$ ft,

$A_2 = 4$ ft^2, $L_2 = 10$ ft, $c_2 = 2$ ft^3 / min per ft$^{1/2}$, $H_2(0) = 0$ ft

$t_0 = 0$ min, $t_1 = 20$ min, $A = 30$ ft^3 / min

$K_1 = 1$, $K_2 = 1$

For each case, find

a) $V_1(0)$, the initial volume of fluid in Tank 1 (in cu ft).

b) $V_2(0)$, the initial volume of fluid in Tank 2 (in cu ft).

c) $V_{1,in}$, the cumulative flow (in cu ft) into Tank 1 from the external source from $t = 0$ to $t = t_{final}$.

d) $V_1(\infty)$, the final volume of fluid in Tank 1 (in cu ft)

e) $V_2(\infty)$, the final volume of fluid in Tank 2 (in cu ft)

f) $V_{2,out}$, the cumulative flow (in cu ft) out of Tank 2 not returned to Tank 1 from $t = 0$ to $t = t_{final}$.

g) $V_{1,spill}$, the cumulative overflow (in cu ft) from Tank 1 from $t = 0$ to $t = t_{final}$.

h) $V_{2,spill}$, the cumulative overflow (in cu ft) from Tank 1 from $t = 0$ to $t = t_{final}$.

and fill in the table.

Case	$V_1(0)$ a)	$V_2(0)$ b)	$V_{1,in}$ c)	a)+b)+c)	$V_1(\infty)$ d)	$V_2(\infty)$ e)	$V_{2,out}$ f)	$V_{1,spill}$ g)	$V_{2,spill}$ h)	d)+e)+f)+g)+h)
I										
II										
III										
IV										
V										