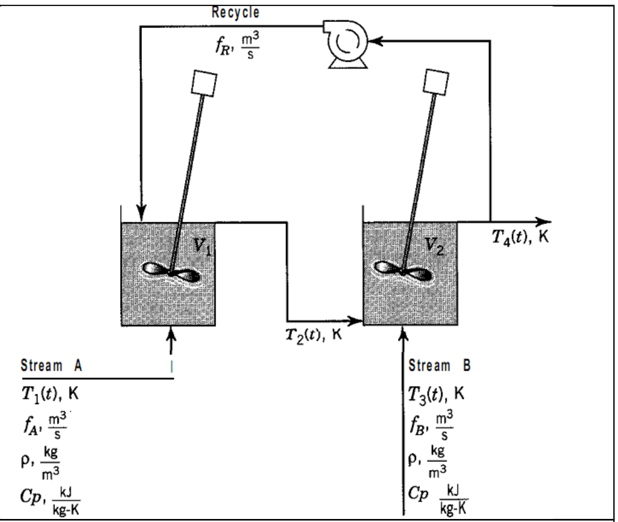
## 4-2.2 Thermal Tanks with Recycle

Consider the process shown in Fig. 4-2.4. This process is essentially the same one described in Section 4-1.2 except that a recycle stream to the first tank has been added.
Let us suppose that this recycle stream is a constant 20% of the total flow out from the process. In addition, let us accept the same assumptions as in Section 4-1.2.

$$f_R = 0.2\left(f_A + f_B\right)$$

$$f_A + f_R - f_C = f_{o-tq1}$$

$$\left[\frac{m^3}{s}\right]\left[\frac{kg}{m^3}\right]\left[\frac{kJ}{kgK}\right]\left[K\right] = \left[\frac{kJ}{s}\right]$$




Lets write an unsteady-state energy balance on the contents of the first tank:

$$f_A \rho C_P T_1(t) + 0.2\left(f_A + f_B\right)\rho C_P T_4(t) - \left[f_A + 0.2\left(f_A + f_B\right)\right]\rho C_P T_2(t) = V_1 \rho C_P \frac{dT_2(t)}{dt}$$

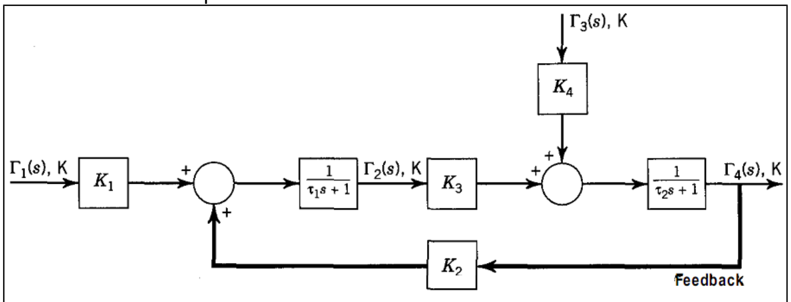
$$\left[f_A + 0.2\left(f_A + f_B\right)\right]\rho C_P T_2(t) + f_B \rho C_P T_3(t) - 1.2\left(f_A + f_B\right)\rho C_P T_4(t) = V_2 \rho C_P \frac{dT_4(t)}{dt}$$

$$\Gamma_4(s) = \frac{K_3 K_1}{\left(\tau_1 s + 1\right)\left(\tau_2 s + 1\right) - K_2 K_3}\Gamma_1(s) + \frac{K_4\left(\tau_1 s + 1\right)}{\left(\tau_1 s + 1\right)\left(\tau_2 s + 1\right) - K_2 K_2}\Gamma_3(s)$$

$$\frac{\Gamma_4(s)}{\Gamma_1(s)} = \frac{K_3 K_1}{\left(\tau_1 s + 1\right)\left(\tau_2 s + 1\right) - K_2 K_3}$$

$$\frac{\Gamma_4(s)}{\Gamma_3(s)} = \frac{K_4\left(\tau_1 s + 1\right)}{\left(\tau_1 s + 1\right)\left(\tau_2 s + 1\right) - K_2 K_3}$$

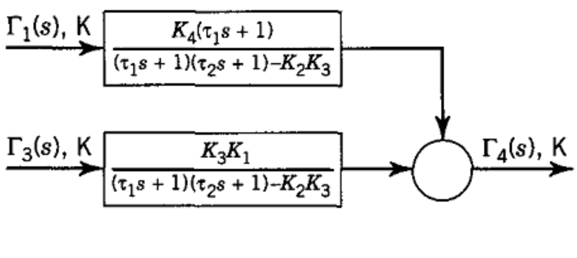
Figure 4-2.5 shows two different ways to draw the block diagram. Figure 4-2.5a is developed by chaining Eqs. 4-2.14 and 4-2.15. Figure 4-2.5b is the graphical representation of Eq. 4-2.16. The feedback path in Fig. 4-2.5a shows graphically the interactive nature of this process.




(a)

El termino que tiene un derivador, (un termino en el numerador) responde mas rapido que el de abajo.

$\Gamma_1(s)$ : responde mas rapido que $\Gamma_3(s)$, debido al termino derivativo en el numerador.




(b)