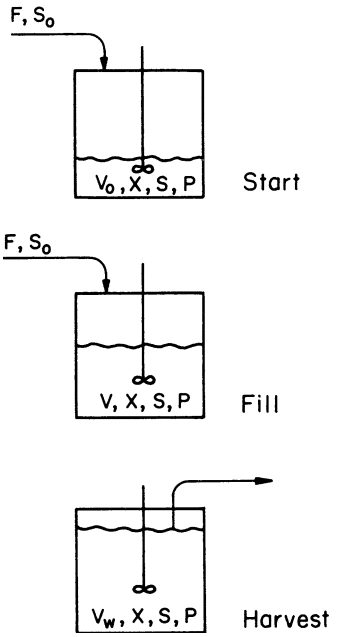

Figure 9.8. Schematic of a fed-batch culture.

The rate of change in biomass concentration is

$$\frac{dX}{dt} = \frac{V(dX^t/dt) - X^t(dV/dt)}{V^2} \tag{9.31}$$

Since $dX^t/dt = \mu_{net}X^t$, $dV/dt = F$, and $F/V = D$, eq. 9.31 becomes

$$\frac{dX}{dt} = (\mu_{net} - D)X \tag{9.32}$$

When the substrate is totally consumed, $S \approx 0$ and $X = X_m = Y^M_{X/S}S_0$. Furthermore, since nearly all the substrate in a unit volume is consumed, then $dX/dt = 0$. This is an example of a quasi-steady state. A fed-batch system operates at quasi-steady state when nutrient consumption rate is nearly equal to nutrient feed rate. Since $dX/dt = 0$ at quasi-steady state, then

$$\mu_{net} = D \tag{9.33}$$

If maintenance energy can be neglected,

$$\mu_{net} = \mu_m \frac{S}{K_s + S}$$

then

$$S \cong \frac{K_s D}{\mu_m - D} \tag{9.34}$$