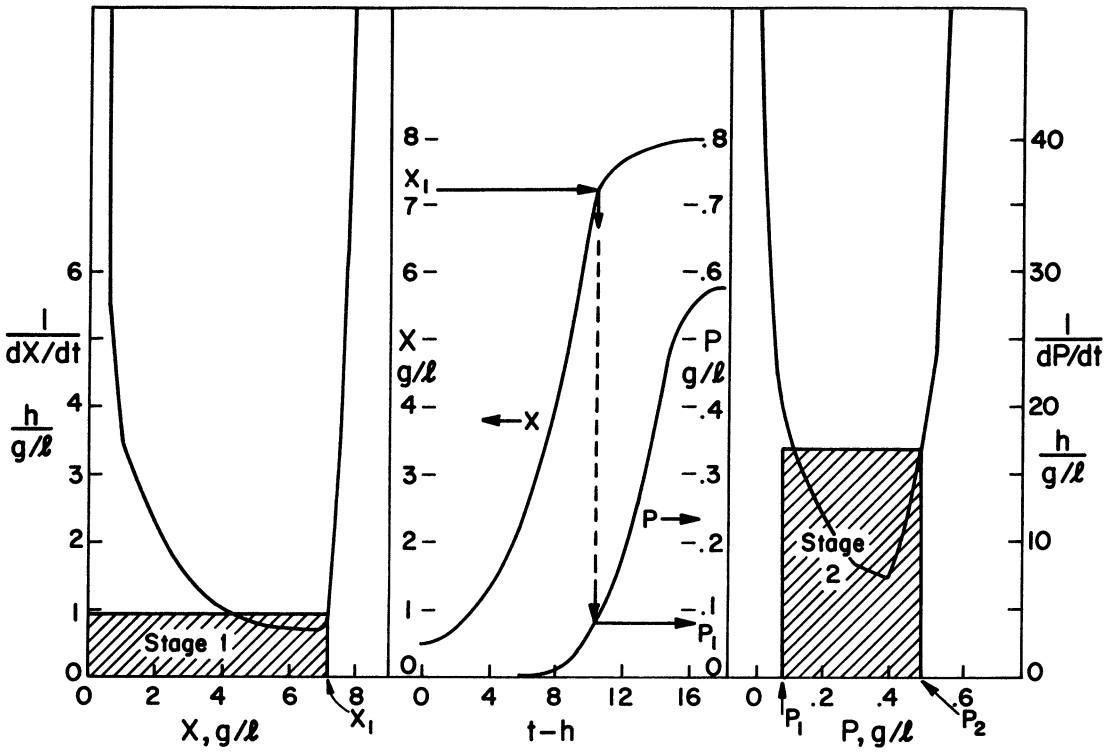

Figure 9.5. Solution of Example 9.2 for two-stage system, each with $\theta = 7$ h.

$$\theta_2 = 7 \text{ h} = (P_2 - P_1)\frac{1}{dP_1/dt}$$

By trial and error, we find that at $P_2 = 0.49$ g/l

$$\begin{aligned}\theta_2 &= (0.49 \text{ g/l} - 0.08 \text{ g/l})(17 \text{ h/g/l}) \\ &= 6.97 \text{ h}\end{aligned}$$

which corresponds reasonably closely to 7 h.

In this solution the reader should note that for the first stage, only solutions that exist for X_1 greater than the value of X for which $1/(dX/dt)$ is a minimum are practically obtainable. Washout occurs if θ_1 is too small.

We can compare the result to a single-stage system with the same total volume as the two-stage system (Fig. 9.6). Here the trial-and-error approach indicates for $X_1 = 7.35$ g/l that

$$7.35 \text{ g/l} \cdot 1.9 \text{ h/g/l} = 13.97 \text{ h} \approx 14 \text{ h}$$

The value of P_1 that corresponds to $X_1 = 7.35$ g/l is 0.10 g/l. Thus, the use of the two-stage system in this case increased product concentration from 0.10 to 0.49 g/l.

An alternative graphical approach that eliminates the trial-and-error aspect of the first approach is shown in Fig. 9.7. Here eqs. 9.24a and 9.26a have been used. $D_1 = 1/\theta_1 =$