1.1 Find the rate of reaction defined as

$$r_{O_2} = \frac{\text{mol } O_2 \text{ used}}{\text{sec} \cdot m^3 \text{ of tank}}$$

Evaluate terms

$$\bar{t} = \frac{V}{v} \quad \text{or} \quad V = \bar{t} v$$

or

$$\begin{pmatrix} \text{Volume of} \\ \text{treatment tanks} \end{pmatrix} = \left(\frac{1}{3}\text{day}\right)\left(32000 \frac{m^3}{\text{day}}\right) = 10667\ m^3$$

O_2 used

$$\left(200 \frac{mg}{lit}\right)\left(\frac{1\ gm}{1000\ mg}\right)\left(\frac{mol}{32\ gm}\right)\left(\frac{1000\ lit}{m^3}\right)\left(\frac{32000\ m^3}{day}\right) = 2 \times 10^5 \frac{mol\ O_2}{day}$$

Thus the rate of reaction

$$\frac{2.0 \times 10^5 \text{ mol } O_2/\text{day}}{10667 m^3} = 18.75 \text{ mol}/m^3 \cdot \text{day}$$
$$= 2.17 \times 10^{-4} \text{ mol}/m^3 \cdot s$$

1.3 Find $-r'_{C_{20}H_{42}}$ and $-r'''_{C_{20}H_{42}}$ --- evaluate terms

$$V_{cat} = \frac{50000\ kg}{800\ kg/m^3} = 62.5\ m^3 \text{ of catalyst}$$

$$W_{cat} = 50000\ kg$$

$$mw_{C_{20}H_{42}} = \left[20(12) + 42(1)\right]\frac{1}{1000} = 0.282\ kg/mol$$

$$F_{feed} = (6000\ m^3/day)(900\ kg/m^3) = 5400000\ kg/day$$

So

$$-\frac{dN_{C_{20}H_{42}}}{dt} = \left(\frac{5\,400\,000\ kg/day}{0.282\ kg/day}\right)\left(\frac{day}{24(3600)s}\right)(0.6) = 133 \text{ mol reacted}/s$$

Thus the rate of disappearance of $C_{20}H_{42}$

$$-r' = \frac{1}{W_{cat}}\frac{dN}{dt} = \frac{1}{50000}(133) = 0.0027 \text{ mol}/\text{kg cat} \cdot s$$

$$-r''' = \frac{1}{V_{cat}}\frac{dN}{dt} = \frac{1}{62.5}(133) = 2.13 \text{ mol}/m^3 \text{cat} \cdot s$$
