$$CH_3CHO \xrightarrow{k_1} CH_3\cdot + CHO\cdot$$

$$CH_3\cdot + CH_3CHO \xrightarrow{k_2} CH_3\cdot + CO + CH_4$$

$$CHO\cdot + CH_3CHO \xrightarrow{k_3} CH_3\cdot + 2CO + H_2$$

$$2CH_3\cdot \xrightarrow{k_4} C_2H_6$$

$$-r_{AC} = r_1 + r_2 + r_3$$

$$= k_1 C_{AC} + k_2 C_{AC} C_{CH_3\cdot} + k_3 C_{AC} C_{CHO\cdot}$$

$$= C_{AC}\left[k_1 + k_2 C_{CH_3\cdot} + k_3 C_{CHO\cdot}\right] \quad ——①$$

Active Intermediate

$$CH_3\cdot \;,\quad CHO\cdot$$

$$\cancel{-r\cdot}$$

$$-r_{CH_3\cdot} = -r_1 + \cancel{r_2} - \cancel{r_2} - r_3 + \frac{1}{2}r_4$$

$$0 = -k_1 C_{AC} - k_3 C_{CHO\cdot} C_{AC} + \frac{1}{2}k_4 C_{CH_3\cdot}^2 \quad ——②$$

$$-r_{CHO\cdot} = -r_1 + r_3$$

$$0 = -k_1 C_{AC} + k_3 C_{CHO\cdot} C_{AC}$$

$$\Rightarrow \quad C_{CHO\cdot} = \frac{k_1}{k_3} \quad ——③$$

substituting ③ in ②

$$0 = -k_1 C_{Ac} - k_3 C_{Ac} \frac{k_1}{k_3} + \frac{1}{2} k_4 C_{CH_3}^2$$

$$\Rightarrow \frac{1}{2} k_4 C_{CH_3}^2 = C_{Ac} \left[2k_1 \right]$$

$$C_{CH_3} = 2 C_{Ac}^{1/2} \left(\frac{k_1}{k_4} \right)^{1/2} \qquad \text{④}$$

substitute ③ and ④ in ①

$$-r_{Ac} = C_{Ac} \left[k_1 + 2k_2 \left(\frac{k_1}{k_4} \right)^{1/2} C_{Ac}^{1/2} + \cancel{k_3} \frac{k_1^2}{k_3} \right]$$

$$\boxed{-r_{Ac} = k_1 C_{Ac} \left[1 + \frac{2k_2}{\sqrt{k_1 k_4}} \sqrt{C_{Ac}} + \frac{k_1}{k_3} \right]}$$

(b) For

$$-r_{AC} = k \, C_{CH_3 CHO}^{3/2}$$

$$\Rightarrow C_{AC} \gg 1 \qquad \text{or}$$

$$\frac{k_2}{\sqrt{k_1 k_4}} \gg 1$$

(c)

$CH_3CHO \cdot$

$CHO \cdot$

$CH_3 \cdot$

C_2H_6

H_2O

CO

CH_4