Autocatalytic Rxn

A reaction in which one of the product of rxn act as a catalyst is called an autocatalytic rxn.

ex. $A + R \xrightarrow{K} R + R$

∵ A formed R, and R remain constant in product (cat.)

$$-r_A = -\frac{dC_A}{dt} = K C_A C_R \quad \text{—①}$$

Here, sum of moles remain constant.

$$C_{A0} + C_{R0} = C_A + C_R = C_0 \quad \text{—②}$$

(constant)

Note: $C_{A0} \neq C_A$, $C_{R0} \neq C_R$ (only sum will be same)

from eq ②

$$C_R = C_0 - C_A$$

$$-r_A = K C_A (C_0 - C_A)$$

$$-\int_{C_{A0}}^{C_A} \frac{dC_A}{C_A (C_0 - C_A)} = K \int_0^t dt = Kt$$

$$\Rightarrow \frac{1}{C_A (C_0 - C_A)} = \frac{A}{C_A} + \frac{B}{C_0 - C_A} \Rightarrow 1 = A(C_0 - C_A) + B C_A$$

$$-\int_{C_{A0}}^{C_A} \left(\frac{1}{C_0} \cdot \frac{1}{C_A} + \frac{1}{C_0} \cdot \frac{1}{C_0 - C_A} \right) dC_A = Kt$$

$$-\frac{1}{C_0}\ln\frac{C_A}{C_{A0}} + \frac{1}{C_0}\left[\ln(C_0 - C_A)\right]_{C_{A0}}^{C_A} = kt$$

$$-\frac{1}{C_0}\ln\frac{C_A}{C_{A0}} + \frac{1}{C_0}\ln\left[\frac{C_0 - C_A}{C_0 - C_{A0}}\right] = kt$$

$$-\ln\frac{C_A}{C_{A0}} + \ln\left(\frac{C_0 - C_A}{C_0 - C_{A0}}\right) = C_0 kt$$

$$\ln\left[\frac{(C_0 - C_A)}{C_0 - C_{A0}} \times \frac{C_{A0}}{C_A}\right] = C_0 kt$$

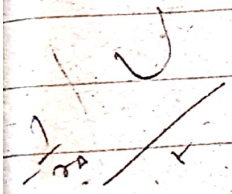
$$C_R + C_A = C_{R0} + C_{A0} = C_0$$

$$\boxed{\ln\left[\frac{C_R \cdot C_{A0}}{C_{R0} C_A}\right] = C_0 kt}$$

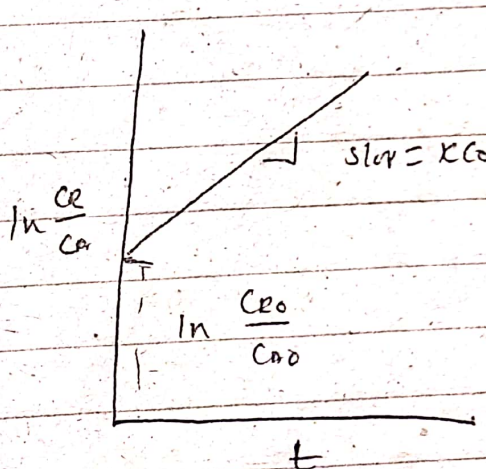
or

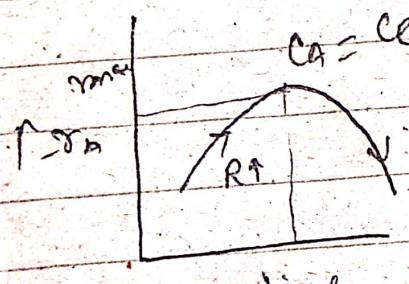
$$\ln\left(\frac{C_R}{C_A}\right) + \ln\frac{C_{A0}}{C_{R0}} = C_0 kt$$

$$\ln\frac{C_R}{C_A} = \ln\frac{C_{R0}}{C_{A0}} + kC_0 t$$



Curve b/w $(-r_A)$ vs (t)





⇒ In autocatalytic reaction product help in increasing ROR

i) $C_R \uparrow$ the $-r_A \uparrow$

ii) $C_A = C_R$ the $r_A = -r_{max}$

iii) When $C_R \downarrow$ then $-r_A \downarrow$

Space Time & space velocity

- These term is used only flow reactors to measure their performance [PFR & MFR]

- space time (τ) :- It is define as the time necessary to process one reactor volume of feed at specified condition.
- denoted by τ
- unit, — hr, minute, second
- Also define reciprocal of space velocity.

Example:- A space time of 5 minute means that every 5 minute one reactor volume of feed at specified condition is being treated by the reactor

space velocity; (s)

It is define as the no. of the reactor volume of feed at specified condition which can be treated in unit time.

- denoted by, s.
- $s = 1/\tau$ unit = $time^{-1}$

Example:- A space velocity of $2\ min^{-1}$ mean that two reactor volume of feed at specified condition are being fed two the reactor per minut.