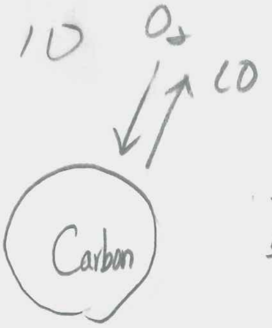
25-10



$O_{2(g)} + 2C_{(s)} \rightarrow 2CO_{(g)}$

$O_{2(g)} + C_{(s)} \rightarrow CO_{2}(g)$

Differential eq'n of mass transfer

0. S.S. 0. no reaction in the diffusion domaind.

$$\vec{\nabla}\vec{N}_A + \frac{\partial C_A}{\partial t} - R_A = 0$$

$$\Rightarrow \vec{\nabla}\vec{N}_A = 0$$

$$\Rightarrow \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 N_{A,r}) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(N_{A,\theta}\sin\theta) + \frac{1}{r\sin\theta}\frac{\partial N_{A,\phi}}{\partial\phi} = 0$$

for mass flux in r direction only $\Rightarrow N_{A,\theta}.\ N_{A,\phi} = 0$

$$\Rightarrow \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 N_{A,r}) = 0$$

$$\Rightarrow \frac{\partial}{\partial r}(r^2 N_{A,r}) = 0$$

$\Rightarrow r^2 N_{A,r}$ in not a funtion of r in diffusion domaind.

a. $\underset{A}{O_{2(g)}} + 2C_{(s)} \rightarrow 2\underset{B}{CO_{(g)}}$, $N_A = -2N_B$

From Fick's 1st eq'n

$$\vec{N}_A = -cD_{AB}\vec{\nabla}y_A + y_A\sum_{i=1}^{n}(\vec{N}_i)$$

$$= -cD_{AB}\vec{\nabla}y_A + y_A(\vec{N}_A + \vec{N}_B)$$

for mass flux in r direction only , & $N_{A,r} = -2N_{B}$

$$N_{A\cdot r} = -CD_{AB}\frac{\partial y_A}{\partial r} + y_A(-N_{A\cdot r})$$

$$\Rightarrow N_{Ar} = \frac{-CD_{AB}}{1+y_A}\frac{\partial y_A}{\partial r}.$$

b. $\underset{A}{O_{2(g)}} + C_{(s)} \rightarrow \underset{C}{CO_{2(g)}}$ $\quad N_A = -N_C.$

$$\vec{N}_A = -CD_{AC}\vec{\nabla}y_A + y_A(\vec{N}_A + \vec{N}_C)$$

mass flux in r direction only & $N_{A\cdot r} = -N_{C\cdot r}$

$$\Rightarrow N_{A\cdot r} = -CD_{AC}\frac{\partial y_A}{\partial r}.$$

for reaction at the surface is instantenous, the radius of carbon is constant

B.C.s $\begin{cases} r = r_1, & y_A = 0. \\ r = \infty, & y_A = 1 \end{cases}$

補充 ③

a' $O_2 + 2C \rightarrow 2CO$

$$N_{A \cdot r} = -CD_{AB}\frac{\partial y_A}{\partial r} + y_A(-N_{A \cdot r})$$

$$\Rightarrow (1+y_A)N_{A \cdot r} = -CD_{AB}\frac{\partial y_A}{\partial r}.$$

$$\Rightarrow N_{Ar}\, dr = -\frac{CD_{AB}}{1+y_A}\, dy_A$$

$$\Rightarrow r^2 \cdot N_{Ar}\frac{1}{r^2}\, dr = \frac{-CD_{AB}}{1+y_A}\, dy_A$$

$$\Rightarrow \int_{r_1}^{r_2} \underbrace{r^2 \cdot N_{Ar}}_{\text{constant}} \frac{1}{r^2}\, dr = \int_{y_{A1}}^{y_{A2}} \frac{-CD_{AB}}{1+y_A}\, dy_A$$

$$\Rightarrow r^2 N_{Ar}\left(\frac{-1}{r_2} - \frac{-1}{r_1}\right) = -CD_{AB}\ln\left(\frac{1+y_{A2}}{1+y_{A1}}\right).$$

$$\Rightarrow N_{Ar} = \frac{1}{r^2}\frac{CD_{AB}\ln\left(\frac{1+y_{A2}}{1+y_{A1}}\right)}{\frac{1}{r_2} - \frac{1}{r_1}}$$