Q) Use the Hirschfelder et al. equation to calculate diffusion coefficient of CO_2 in N_2 at 298 K & 100 KPa. (1/2)

Solution :-

eqv. 24.33 $$D_{AB} = \frac{0.001858\, T^{3/2} \left[\frac{1}{M_A} + \frac{1}{M_B}\right]^{1/2}}{P\, \delta_{AB}^2\, \Omega_D}$$

$T = 298$ K , $P = 100$ KPa $= 1$ atm

$M_A = M_{CO_2} = 44$, $M_B = M_{N_2} = 28$

eqv. 24.40 $$\epsilon_{AB} = \sqrt{\epsilon_A \epsilon_B}$$

Appendix K 2

$\delta_A = \delta_{CO_2} = 3.996$ °A , $\delta_B = \delta_{N_2} = 3.681$ °A

$$\delta_{AB} = \frac{3.681 + 3.996}{2} = 3.8385$$

$\frac{\epsilon_B}{K} = 91.5$ (N_2) , $\frac{\epsilon_A}{K} = 190$ (CO_2)

where $K = 1.38 \times 10^{-16}$ ergs / K

$$\epsilon_{AB} = \sqrt{\frac{91.5 * 190}{K^2}} = \frac{131.85}{K}$$

$$\therefore \frac{KT}{\epsilon} = \frac{298}{131.85} = 2.26$$

From Appendix K1 at $KT/\epsilon = 2.26$

$$\Omega_D = \frac{1.026 + 1.012}{2} = 1.019$$

$\therefore$

$$D_{AB} = \frac{0.001858\,(298)^{3/2}\left[\frac{1}{44} + \frac{1}{28}\right]^{1/2}}{(1)\,(3.8385)^2\,(1.019)}$$

$$\boxed{D_{AB} = 0.154\ cm^2/s}$$