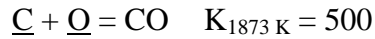


### Sparging Fe to Remove O as CO gas



$$\frac{n_{\text{CO}}}{n_{\text{Ar}}} = \frac{P_{\text{CO}}}{P_{\text{Ar}}} = \frac{V_{\text{CO}}}{V_{\text{Ar}}}$$

$$\frac{n_{\text{CO}}}{n_{\text{Ar}}} = \frac{P_{\text{CO}}}{P_T - P_{\text{CO}}}$$

$$n_{\text{CO}} = \frac{P_{\text{CO}}}{P - P_{\text{CO}}} n_{\text{Ar}} \quad PV = nRT$$

$$n_{\text{Ar}} = \frac{PV}{RT} = \frac{P_T V_{\text{Ar}}}{RT}$$

$$n_{\text{CO}} = \left( \frac{P_{\text{CO}}}{P - P_{\text{CO}}} \right) \frac{P_T V_{\text{Ar}}}{RT}$$

$$dn_{\text{CO}} = \frac{P_{\text{CO}}}{P_T P_{\text{CO}}} \frac{P_T dV_{\text{Ar}}}{RT} = -M \frac{d(\text{wt}\% \text{O})}{(100\%)(16)}$$

$$dV_{\text{Ar}} = -\frac{RTM(P_T - P_{\text{CO}})}{P_T P_{\text{CO}}(1600)} d(\text{wt}\% \text{O})$$

$$dV_{\text{Ar}} = \frac{RTM(P_{\text{CO}} - P_T)}{P_T P_{\text{CO}}(1600)} d(\text{wt}\% \text{O})$$

$$\int_0^V dV_{\text{Ar}} = \frac{RTM}{P_T 1600} \int_{O_i}^{O_f} \left( 1 - \frac{P_T}{P_{\text{CO}}} \right) d(\text{wt}\% \text{O})$$

$$V_{\text{Ar}} = \frac{RTM}{P_T 1600} \left[ (\text{wt}\% O_f - \text{wt}\% O_i) + \frac{P_T}{(k)(\text{wt}\% C)} \ln \left( \frac{\text{wt}\% O_i}{\text{wt}\% O_f} \right) \right]$$

For 1 MT of 1040 Steel at 1873 K initially in equilibrium with  $P_{\text{CO}} = 1 \text{ atm}$ :

$V_{\text{Ar}}$  1.48 L 90.0% [O] removal

$V_{\text{Ar}}$  60.0 L 99.0% [O] removal

$V_{\text{Ar}}$  123 L 99.9% [O] removal

