Lec1: Batteries

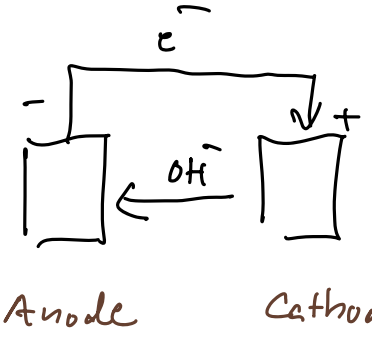
p 19

Anode: $Cd + 2OH^- \rightarrow Cd(OH)_2 + 2e^-$

Cathode: $2(NiO(OH) + H_2O + e^- \rightarrow OH^- + Ni(OH)_2)$

Cell: $Cd + 2OH^- + 2NiO(OH) + 2H_2O + 2e^- \rightarrow$

$Cd(OH)_2 + 2e^- + 2OH^- + 2Ni(OH)_2$



p 25 Ex: Compute OCV for a ZnCu-cell:

$Zn^{2+} + 2e^- \rightarrow Zn$: $U_-^\circ = -0,76\,V$ (negative electrode)

$Cu^{2+} + 2e^- \rightarrow Cu$: $U_+^\circ = 0.34\,V$ (positive electrode)

$U_{cell} = U_+^\circ - U_-^\circ = 0.34 - (-0.76) = 1.1V$

Discharge cell reaction:

reverse neg. electrode reaction: $Zn \rightarrow Zn^{2+} + 2e^-$

Cell reaction: $Zn + Cu^{2+} \rightarrow Cu + Zn^{2+}$

p 29 Ex: Given: $Zn \rightarrow Zn^{2+} + 2e^-$

$t = 2h$

$I = 12A$

Find: Moles n_{Zn}, mass m_{Zn}

Solution: Charge $Q = I \cdot t = 24\,Ah \cdot 3600\,\frac{s}{h} =$

$= 86\,400\,[As = C]$

Mole electrons:

$$n_{e^-} = \frac{Q}{F}\left[\frac{Ah}{\frac{Ah}{mol\,e^-}}\right] = \frac{24\,Ah}{26.8\,Ah/mol\,e^-} = 0.895\ mol$$

$1\,Zn \Leftrightarrow 2e^-$: $n_{Zn} = \frac{1}{2} n_{e^-} = 0.448\ mol$

Mass Zn: $m_{Zn} = n_{Zn} \cdot M_{Zn}$

$= 0.448 \cdot mol \cdot 65.38\,g/mol = 29.3\,g$

p 30 Faraday's law of electrolysis

Mass of substance m_i generated by electric charge Q:

$$n = \frac{n_{e^-}}{n_i} \Leftrightarrow n_i = \frac{n_{e^-}}{n}$$

$$m_i = n_i \cdot M_i = \frac{n_{e^-}}{n} \cdot M_i = \frac{Q}{F}\frac{M_i}{n}$$

Charge density:

$$\frac{Q}{m_i} = F\frac{n}{M_i}\left[\frac{Ah}{g}\right]$$

p31 Ex: Charge density of Zn in $Zn \rightarrow Zn^{2+} + 2e^-$:

$$F \cdot \frac{n}{M_{Zn}} = 26.8 \frac{Ah}{\cancel{mole^-}} \cdot \frac{2 \frac{\cancel{mole^-}}{\cancel{mol\,Zn}}}{65.38 \frac{g}{\cancel{mol\,Zn}}} = 0.82 \frac{Ah}{g}$$

p32 Charge density for considering both electrodes:

$$\frac{g}{Ah}\Big|_{cell} = \frac{g}{Ah}\Big|_{cathode} + \frac{g}{Ah}\Big|_{anode}$$

$$\frac{Ah}{g}\Big|_{cell} = \left(\frac{g}{Ah}\Big|_{cell}\right)^{-1} = \left(\frac{g}{Ah}\Big|_{cathode} + \frac{g}{Ah}\Big|_{anode}\right)^{-1}$$

$$Cu^{2+} + Zn \longrightarrow Cu + Zn^{2+}$$

p33 The charge density for Cu: $Cu = \frac{F \cdot n}{M_{Cu}} = \frac{26.8 \cdot 2}{63.5} \frac{Ah}{g} = 0.84 \frac{Ah}{g}$

Charge density for anode + cathode:

$$\frac{Ah}{g}\Big|_{cell} = \left(\frac{g}{Ah}\Big|_{Zn} + \frac{g}{Ah}\Big|_{Cu}\right)^{-1} =$$

$$= \left(\frac{1}{0.82} + \frac{1}{0.84}\right)^{-1} = 0.42 \frac{Ah}{g}$$

Energy density:

$$\frac{Wh}{g} = U^0 \cdot \frac{Ah}{g} = 1.1V \cdot 0.42\,Ah/g = 0.46\,Wh/g$$

$$= 460\,Wh/kg$$