



ENGINEERING CHEMISTRY

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Energy storage devices - Batteries



Class content:

- *Battery characteristics*
- *Voltage*
- *Current*
- *Capacity*
- *Electricity storage density*
- *Cycle life*

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Battery characteristics

Voltage:

Emf of the cell $\rightarrow \Delta G \rightarrow$ reaction \rightarrow choice of electrodes

$$E_{cell} = E^{\circ}_{cell} - \frac{2.303RT}{nF} \log Q$$

Factors affecting voltage of a battery:

- **E°_{cell}** ; higher the difference between $E^{\circ}_{cathode}$ and E°_{anode} , higher is the voltage of the cell
- **Temperature (T)** ; with increase in temperature voltage of the cell decreases
- **Reaction quotient (Q)** ; as the value of Q increases, the voltage of the cell changes marginally

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Current:

- Measure of the **rate** at which battery is discharging
- Amperes, milliamperes
- Depends on **rapid electron transfer reaction**
 - Amount of electroactive species
 - Conductivity of electrolyte
 - Inter-electrode distance

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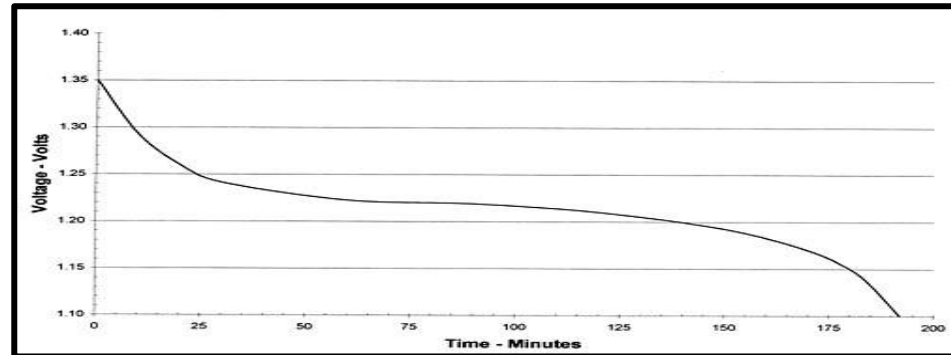
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Capacity:

- Charge or amount of electricity that may be obtained from the battery and is given in **Ah**
- Faraday's relation $C = \frac{wnF}{M}$ C is the capacity , w is the mass and M is the molar mass of active material
- Capacity depends on : **Size of the battery**

• $C = It$

- The time period, t, for which the battery will last when a constant current, I, is drawn depends on a) Discharge conditions of the battery b) Capacity of the battery
- **Longer the flat portion** of the curve better is the capacity



http://www.hangtimes.com/robert_hoff_on_esv_s.html

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Electricity Storage density:

- Amount of charge or electricity per unit weight which the battery can hold

$$\text{ESD} = \text{Capacity} / \text{Weight of the battery}$$

- Weight includes weight of **all the components** of the battery - electrodes, electrolyte, case, current collectors, terminals etc
 - To get high electricity storage density, use of right kind of material for all the components is important
- e.g., **7g of Li** is required at anode to give **1F** of charge whereas **104g of Pb** is required for the same amount of charge

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Cycle life :

- Number of charge/discharge cycles that are possible before failure occurs
- Applicable only to **secondary batteries**
- **Reasons for limited cycle life:**
 - Corrosion at contact points
 - Shedding of active material from the plates
 - Shorting between electrodes due to irregular crystal growth and changes in morphology



THANK YOU
