19CH201 - ENGINEERING CHEMISTRY

UNIT-2 - ENERGY STORAGE DEVICES

CHARACTERISTICS OF BATTERY

1) Type

primary and secondary batteries

2) Voltage

The theoretical standard cell voltage can be determined from the electrochemical series using E^o values:

E^o (cathodic) – E^o (anodic) = E^o (cell)

This is the standard theoretical voltage. The theoretical cell voltage is modified by the Nernst equation, which takes into account the non-standard state of the reacting component. The Nernstian potential will change with time either because of use or self-discharge by which the activity (or concentration) of the electro-active component in the cell is modified. Thus the nominal voltage is determined by the cell chemistry at any given point of time.

The actual voltage produce will always be lower than the theoretical voltage due to polarisation and the resistance losses (IR drop) of the battery and is dependent upon the load current and the internal impedance of the cell. These factors are dependent upon electrode kinetics and thus vary with temperature, state of charge, and with the age of the cell. The actual voltage appearing at the terminal needs to be sufficient for the intended application.

Typical values of voltage range from 1.2 V for a Ni/Cd battery to 3.7 V for a Li/ion battery.

3) Discharge Curve

The discharge curve is a plot of voltage against percentage of capacity discharged. A flat discharge curve is desirable as this means that the voltage remains constant as the battery is used up.

4) Capacity

The theoretical capacity of a battery is the quantity of electricity involved in the electro-chemical reaction. It is denoted Q and is given by:

Q=xnF

where x = number of moles of reaction, n = number of electrons transferred per mole of reaction and F = Faraday's constant

The capacity is usually given in terms of mass, not the number of moles:

Q=nFMr

where M_r = Molecular Mass. This gives the capacity in units of Ampere-hours per gram (Ah/g).

In practice, the full battery capacity could never be realised, as there is a significant weight contribution from non-reactive components such as binders & conducting particles, separators & electrolytes and current collectors & substrates as well as packaging. Typical values range from 0.26 Ah/g for Pb to 26.59 Ah/g for H_2.

5) Energy density

The energy density is the energy that can be derived peer unit volume of the weight of the cell.

6) Specific energy density

The specific energy density is the energy that can be derived per unit weight of the cell (or sometimes per unit weight of the active electrode material). It is the product of the specific capacity and the operating voltage in one full discharge cycle. Both the current and the voltage may vary within a discharge cycle and thus the specific energy derived is calculated by integrating the product of current and voltage over time.

The discharge time is related to the maximum and minimum voltage threshold and is dependent upon the state of availability of the active materials and/or the avoidance of an irreversible state for a rechargeable battery.

7) Power density

The power density is the power that can be derived per unit weight of the cell (W/kg).

8) Temperature dependence

The rate of the reaction in the cell will be temperature dependant according to theories of kinetics. The internal resistance also varies with temperature; low temperatures give higher internal resistance. At very low temperatures the electrolyte may freeze giving a lower voltage as ion movement is impeded. At very high temperatures the chemicals may decompose, or there may be enough energy available to activate unwanted, reversible reactions, reducing the capacity.