Commercial cells

Commercial Cells Galvanic Cell A Galvanic cell is also known as a Voltaic cell. It was named after Luigi Galvani and Alessandro Volta. A galvanic cell is capable of producing an electric current from a redox reaction that occurs within it and consists of two half cells. Each half cell consists of an electrode and electrolyte and a salt bridge. In a galvanic cell one metal can undergo reduction and the other oxidation. A typical galvanic cell is based on the spontaneous redox reaction: Net Ionic Equation Zn(s) + Cu2+(aq) > Zn2+(aq) + Cu(s)

Half Equations Zn(s) > Zn2+(aq) + 2e– Cu2+(aq) + 2e– > Cu(s) The anode will undergo reduction (Zinc) and the cathode will undergo oxidation (Copper) The two half cells must be physically separated so that the solutions do not mix together. A salt bridge is used to separate the two solutions yet keep the respective charges in the solution from separating which would cease the chemical reaction. Electrons released during an oxidation half-equation must flow through a wire or other external circuit before they can be accepted in a reduction half-equation.

Consequently an electrical current is made to flow. Construction of galvanic cells Anode Half-cell where oxidation occurs Anode Half-cell where oxidation occurs The more reactive metal will undergo oxidation which is a loss of electrons. These electrons will flow from the anode (negative terminal) to the cathode (positive terminal) which will then undergo reduction which is the gain in electrons. This flow of electrons creates electricity. The salt bridge allows total charge in each half cell to become neutral.

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Metal Ion + electrons Metal atom Example Cu2+(aq) + 2e– > Cu(s) Typical Cathode Reaction Metal Ion + electrons Metal atom Example Cu2+(aq) + 2e– > Cu(s) Typical Anode Reaction Metal atom Metal Ion + electrons Example Zn(s) > Zn2+(aq) + 2e– Typical Anode Reaction Metal atom Metal Ion + electrons Example Zn(s) > Zn2+(aq) + 2e– Definitions * Anode – The negative electrode in a galvanic cell, it is found in the half cell where it undergoes oxidation. Cathode – The positive electrode in a galvanic cell, it is found in the half cell where it undergoes reduction * Electrode – A conducting material placed in each half cell to pick up or release electrons in the redox reaction, e. g. in a galvanic cell there are two electrodes which pick up or release electrons * Electrolyte – A substance which will conduct electricity when molten or in solution, generally, it refers to ionic solutions Dry Cell The most common type of battery used today is the dry cell battery. Invented by Sakizou Yai in 1885, the dry cell battery was improved and patented by Dr.

Carl Gassner, a German scientist in 1887. A " dry-cell" battery is essentially made of a metal electrode or graphite rod (elemental carbon) surrounded by a moist electrolyte paste enclosed in a metal cylinder. The dry cell is made of two half cells. The anode is a zinc shell which also acts as the reductant at the negative electrode (anode) and it is where oxidation occurs. The cathode is made of manganese dioxide which is the oxidant, the reduction occurs at this terminal where it gains electrons, the manganese dioxide also surrounds a carbon rod which acts as the positive terminal to increase its conductivity.

The electrolyte is an aqueous paste made of ammonium chloride and a mixture of powdered Manganese dioxide, carbon, and ammonium chloride because the hydrogen ions are require for the reduction process. Oxidation Reaction Zn(s) Zn2+ + 2e- Reduction Reaction 2MnO2(s) + 2H+ (aq) + 2e- Mn2O3(s) + H2O (l) Overall Reaction Zn(s) + 2MnO2(s) + 2NH+4(aq) Mn2O3(s) + Zn(NH3)22+(aq) + H2O(l) The standard dry cell has e. m. f. between 1. 25 to 1. 48V Alkaline dry cells are another common dry cell that has a long life and the there is no voltage drop.

It uses exactly the same components as the zinc-carbon cell, the only difference is the anode is made of powdered zinc and the electrolyte used is potassium hydroxide. Cost and Practicality Cost * The most inexpensive type of battery * Material for construction is cheap and the cell is easy to manufacture * Alkaline batteries cost slightly more than the zinc-carbon cell * Cheapest due to their short shelf life, deterioration etc. Practicality Advantages * Zinc anode also forms the container The most common batteries and are used for general purposes * Produced in range of sizes (AA, AAA, etc.) * Easy to transport energy source * Smaller than lead acid cells Disadvantages * Short life * Cannot be recharged * Bulky * Zinc casing is used up so eventually the battery may leak * Continuous use may cause cell to expand and burst due to the production of ammonia * The consumption of a dry cell battery is extremely dangerous and poisoning Impact on Society

Widely used as it is suitable for common low drain appliances such as torches, toys, and portable radios * Short shelf life due to the acidic paste attacking the zinc container (older batteries may leak) * All users of the dry cell batteries need to be aware that there can be problems associated to leakages and deterioration * Zinc- carbon batteries are now gradually being replaced by the alkaline dry- cell battery, which works exactly the same but it has a longer life and the voltage doesn't drop. The consumption of a dry cell battery is extremely dangerous and poisoning Environmental Impact * Weak acidic paste and reaction products are non-toxic and pose little problem for dumps * They produce major waste because they are not rechargeable * Materials needed for manufacturing are still available and the extraction of these minerals won't affect the environment * The batteries contain small amounts of zinc which is harmless to the environment and graphite and ammonium salts which cause little damage * The only major environmental impact in regard to the use of dry cells is the amount f landfill produced from the disposed batteries Button Cell (Silver Oxide Cell) Button cell batteries are small, thin energy cells that are commonly used in watches, hearing aids, and other electronic devices requiring a thin profile. In many ways it is similar to the dry cell because it cannot be recharged but the other characteristics that make it useful. The silver- oxide button cell also consists of an anode, cathode and an electrolyte which functions the battery much like the dry cell.

Similar to the dry cell, the anode is made of powdered zinc which undergoes oxidation, therefore zinc loses electrons. Oxidation Reaction Zn + 2OH- ZnO + H2O + 2e- The cathode is a bit different to the dry cell, it is made of silver oxide which undergoes reduction, therefore gaining electrons. Reduction Reaction $Ag_2O + H_2O + 2e^-$ $2Ag + 2OH^-$ The electrolyte used in the button cell is the alkaline paste of potassium hydroxide. Overall Equation

$Zn(s) + 2OH^-(aq) + Ag_2O + H_2O (l)$ $ZnO(s) + H_2O (l) + 2Ags) + 2OH^-(aq)$ Silver- oxide button cells can produce a maximum e. m. f. of 1. 5V. The mercury- oxide produces 1. 3V and the lithium – iodine cell produces a cell voltage up to 2. 8V. Cost and Practicality Cost * More expensive than dry cells * Silver is an expensive metal and makes the button cell more expensive Practicality * Not rechargeable * Longer life span than the normal dry cell * They supply constant voltage Compact and small which allows it to fit into small places and operate smaller objects Impact on Society The small size, light weight and stable voltage over a long period makes it useful in small appliances such as cameras, calculators and watches. Silver- oxide cells and the latest development of the lithium- iodine cell has made the previous mercury- oxide button cell obsolete because of the detrimental environmental impact associated to the mercury waste, another reason is because other button cells have more beneficial characteristics.

Environmental Impact * Expensive silver needs to be recycled * KOH electrolyte is caustic * No highly toxic materials that will harm the environment * Button cells are comprised of many heavy metals so they need to be carefully disposed and recycled * Silver is another metal that needs to be recycled, it is an expensive and by recycling it can minimise the need to excavate and extract it from mines, recycling is an ecologically sustainable method of conserving scarce minerals

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