Sai Surya Molugoori
Project Advisor: Xiaoli Ma
Team Name: 1961C

Mobile Power Supplies for Electronics

Introduction

Mobile power supplies are portable power sources that can range in size from as small as a dime to larger than a PC. These power supplies also have a wide spectrum of specifications, suitable for many applications. While there are many different types of portable power sources available, batteries are the most mature technology in use today. This paper is a review of the common battery types, their chemical makeup, and their commercial applications.

Battery Chemistry

Batteries, series of electrochemical cells, have two types: primary and secondary. Primary batteries are disposable, non-rechargeable, and used mainly for common household purposes such as remotes, alarms, toys, etc. Examples of primary batteries are AA, AAA, D-cell, 9V, etc. Secondary batteries are rechargeable batteries used in laptops, phones, and other devices. The parts of a battery consist of an anode, a cathode, positive electrode, and the electrolyte. The anode, the negative electrode, builds up with an excess of electrons which travel to the cathode, the positive electrode with the help of an inductive path [1]. The anode is where oxidation occurs, and the cathode is where reduction occurs. Batteries produce electrical energy from oxidation-reduction reactions. There are also wet cells and dry cells. Wet cells and dry cells can be used in both primary and secondary batteries. The main difference between the two is that wet cells have a liquid electrolyte while the dry cell contains no liquids. Car batteries are examples of wet cells while flashlights are examples of dry cells. The preferred choice for mobile power supplies are secondary batteries. Examples of these batteries include sealed lead acid and lithium ion. For lead acid batteries, the electrodes contain lead and sulfuric acid [2]. For lithium ion batteries, the cathode is material is changed with the most common types being: Lithium Cobalt Oxide, Lithium Manganate, Lithium Iron Phosphate, Lithium Nickel Manganese Cobalt, and Lithium Nickel Cobalt Aluminum Oxide [3].

Common Battery Types

Sealed Lead Acid

The oldest type of battery currently in common use is the sealed lead acid (SLA) battery. SLA batteries are used in three categories: automotive starter batteries, motive power batteries (e.g. for motorized wheelchairs, golf carts), and batteries for uninterruptible power supplies (UPS) [4]. SLA batteries have an

energy density of less than 50 Wh/kg, and a cost per capacity of approximately $150/kWh [5]. The average SLA battery supports a discharge rate of approximately 0.25C, and between 200 and 750 cycles before reaching 80% state-of-health. The main advantage of this type of battery is the low manufacturing cost, which translates directly into a low price point. The disadvantages of SLA technology include size and weight, potential need for regular maintenance, slow discharge, toxic electrodes, and limited life span. The reason SLA's are not more popular is because of the toxic electrodes that are hazardous and require the batteries to be legally disposed.

Lithium Ion

Lithium battery technology refers to a group of battery technologies based on the lithium ion. These include Lithium Cobalt Oxide (LCO), Lithium Manganese Oxide (LMO), Lithium Nickel Manganese Cobalt Oxide (NMC), Lithium Iron Phosphate (LFP), Lithium Nickel Cobalt Aluminum Oxide (NCA), and Lithium Titanate (LTO) [3]. These battery technologies span a wide range of capacity, discharge rate, life span, and cost. Li-ion batteries are used in applications where high energy density is needed, from smartphones to electric vehicles [6]. They have an energy density varying from 50 to more than 250 Wh/kg, depending on the underlying technology. Li-ion batteries have high discharge rates: all technologies can support up to 1C, with some technologies supporting rates as high as 30C. They also have a wide range of cost per capacity: from $350/kWh for NCA batteries to approximately $1000/kWh for LTO batteries. An example of a commercial application of Li-ion batteries is the Powerwall by Tesla: a rechargeable lithium-ion battery used for home energy storage. It features a 14 kWh storage capacity and a peak power output of 7 kW, specifications that could not be easily achieved using SLA batteries [7].

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