Charge-Discharge Studies of Lithium Iron Phosphate Batteries

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Abstract

A lithium-ion battery comprises of two intercalating electrodes separated by a lithium-ion conducting matrix, sandwiched between aluminum and a copper current collecting plates. In recent years, demonstration of lithium iron phosphate (LiFePO4) as a cathode material for Li+-insertion has generated considerable interest among researchers. The material has many advantages: a) It is inexpensive and less toxic compared to cobalt, nickel or manganese cathode materials. b) The operating voltage of the electrode (about 3.4 V vs. Li) is high enough for the battery to hold significant amount of energy. c) The side reactions due to electrolyte decomposition are minimal. d) The theoretical specific energy density of ~580 Wh/kg is very attractive. All these features of the cathode material have resulted in lithium-ion technology being offered as a technical and economic solution for increased electrical energy storage capacities, efficiency and security.

Today, several industries are interested in putting these energy storage devices in their products. However, the OEM refrains from giving details of the working of the devices in order to protect IP rights.

In order to assist an industry to decide upon the suitability of an energy storage device among several lithium ion batteries available off-the-shelf, which are based on lithium iron phosphate (LiFePO4) as a cathode material and carbon as anode, we modeled a 3.2 V, 200 Ah device using COMSOL Multiphysics Lithium-Ion Battery Interface for studying the charge-discharge characteristics of the device. The battery performance generally depends upon several parameters, such as, charge-discharge current, active material particle radius, temperature, volume fraction of active mass in the electrodes, reaction rates at the electrodes, separator thickness, electrode thickness etc. So, it is important to know the cell performance by varying these parameters.

In our model we looked into the parameters which affect the performance of the cell. We varied thickness of electrodes, binder concentration, operating temperature and discharge rates. The discharge curves for discharge rates of 0.5 C and 1 C at temperatures 10oC, 30oC and 45oC obtained from our model has been validated with the experimental results performed in our laboratory. The studies could help in development of analytics for the products where the lithium ion battery will be used as a component. The details will be discussed in the poster.