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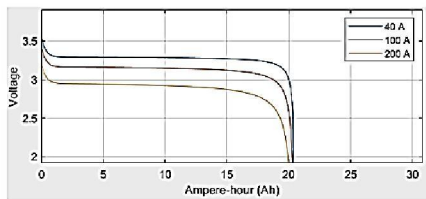
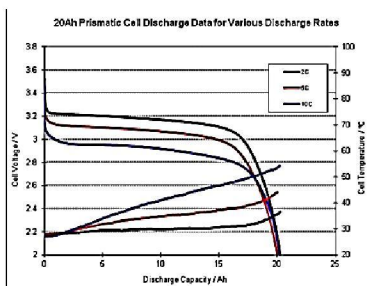
GENERAL LI-ION BATTERY MODEL WITH OVERCHARGE PROTECTION

Nowadays lithium-ion batteries are considered as the most advanced batteries technology. These batteries can be designed for high energy or high power storage system. However, it is impossible to manufacture identical battery cells due to fabrication process. If not to take some preventive measures, it would cause a big difference between cells, which in its turn, to less lifecycle of battery or completely fail the battery. Without an appropriate battery management system, it is impossible to make a variation between cells as small as possible [1].

In the first step of battery management system (BMS) development the general battery model is needed. Matlab subsystem Simulink provides us with the general battery model [2]. This model represents general dynamic model of the most popular battery types: Lead-acid, Ni-MH, Ni-Ca and Li-ion. It may be useful for checking the general discharge characteristic and aging or / and temperature depended discharge characteristics. To validate this model the real data of Li-ion battery cell LiFePo₄ A123 System AMP20m1HD-A was insert [3]. As a result, we received the discharge characteristics that are almost the same with real ones, despite the fact that real one use temperature dependent model. (Fig. 1). The figures shows us discharging characteristics at 2C, 5C, 10C discharge. According to them AMP20m1HD-A battery has good performance, the power drops are at acceptable level and the power will be almost constant until 90% discharge even at high current.

But, how to check the charging characteristic? It is needed to implement equivalent circuit model (figure 2). This circuit represents general battery model, the ideal energy source for charging battery cell, wires resistance and overcharge protection. The charging characteristics is shown of the figure 3.

The charging characteristics show us exponential voltage increase when a battery is charging and if compare it with discharging characteristic – they are reversal. Moreover, these characteristics shows us correct operation of overcharging protection. The charging process stopped at 100% state of charge. If it would not stop, the battery cell voltage will grow to the power source level, but in real life, it will damage the cell or cause overheating and self-firing.



a – real discharge characteristics; b – simulated discharge characteristics
Figure 1 – LiFePO_4 discharge characteristics

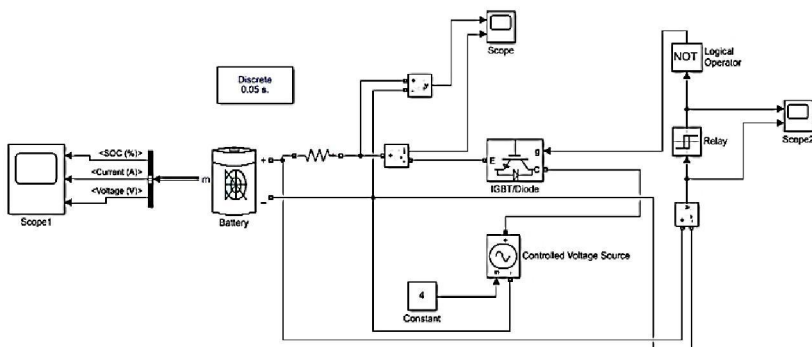


Figure 2 – Equivalent circuit model for battery cell charging

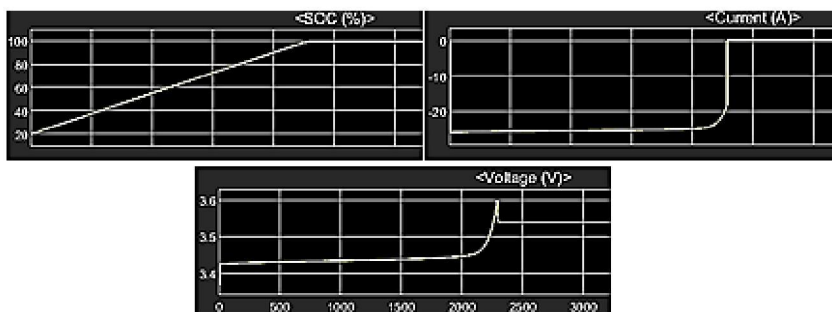


Figure 3 – Charging characteristics

The proposed equivalent circuit for battery cell charging with protection device may be used as a part of battery cell pack and battery managements system.

LIST OF REFERENCES

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