Study of Battery Management System with analysis of Ni-mh, lithium-ion Batteries

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ABSTRACT

The conventional flooded-type lead acid battery is being replaced by the sealed-type VRLA (Valve-Regulated Lead- Acid) battery, which is superior from the standpoints of economy, reliability, safety, ease of maintenance and construction. The work on the new battery management system which automatically determines the level of deterioration of the batteries using battery parameters like voltage, charging, discharging current and temperature, and additionally, indicates the approximate charge stored and indicates time to replace a defective battery. It makes a reliable maintenance free batteries of power-supply units for telecommunication equipment and Electric vehicle or the like applications. However battery maintenance work has some difficulties and another problem is how to manage battery for equipment such as an Electric vehicle more efficiently. So we have worked on the battery management system with higher efficiency, which monitor a state of battery and then integrates its data from battery-management unit and in future scope the battery deterioration unit will be controlled through wireless lines.

***Keywords*--** Battery Management System, SOC, SOCV, Charging and Discharging Current, Ageing, Life Cycle Analysis, Trickle Charge, Integrator

I. INTRODUCTION

The flooded-type lead-acid batteries are used for backup of power-supply unit for various applications. This type of battery requires periodic addition of water and its specific gravity measurements. Moreover, it discharges inflammable gas, which is undesirable from the viewpoint of safety. The conventional flooded-type lead acid battery is being replaced by the sealed-type battery, which is superior from the standpoints of economy, reliability, safety, ease of maintenance and construction [1].

The sealed battery, which does not require regular maintenance and does not discharge inflammable gas, was developed to overcome these problems; but it is difficult to determine the discharge level of these types of battery because its specific gravity cannot be measured from outside. These sealed batteries are installed in various ways, usually in a cubicle structure. The increasing number of cells in battery makes it difficult to carry out voltage measurement as a part of maintenance operations. These sealed batteries for engine starters, telecommunication equipment and for security device terminals have to be used and manually discharged on a regular basis. The battery-management system is a system which automatically determines the level of discharge of the batteries, and additionally, indicates the a defective battery.[2] It makes maintenance task of batteries reliable as the maintenance job has become difficult and the problem is how to manage a battery for equipment such as an engine generator more efficiently. So the battery-management system will monitor a state of battery and then integrates its data from battery-management unit and battery-deterioration unit.

II. BATTERY MANAGEMENT SYSTEM

Battery management system provides accurate measurements for battery conditions and the battery-deterioration judgment unit automatically determines the level of deterioration of the batteries and indicates the defects in battery for the battery replacement[2]. By calculating accurate charge level present in the battery, it can determine remaining discharge time. It makes maintenance-free and reliable operation of sealed batteries for telecommunication systems, UPS and for engine generator starters. The device will monitor a battery voltage and automatically determines the level of deterioration of the batteries also indicates the proper time to replace the battery. The work is basically to monitor the battery and to provide indications for over voltage; faulty battery and battery life [1] . Charge Measurement Circuit for Electric Vehicle Batteries,and related work is concentrated towards the charge calculation. Experiments performed by them on charge measurement circuit includes the SOC state of charge calculation of a battery. Based on these parameters remaining discharge time for a battery can be calculated[2].

Battery management system is a system which will perform both operations of monitoring of the battery and to provide SOC measurement of battery; along with a battery deterioration unit to indicate appropriate time to replace battery[5].

As per the study of above theories the accurate measurements of state of charge (SOC) for electric vehicle (EV) battery packs continue to be a problem. Some of the errors that occur are inherent to the characteristics of the battery itself and do not depend in the accuracy of the charge measurement circuit. During typical operation of an electric vehicle, the battery is alternately being charged and discharged over a wide range of currents. Since the battery has losses, the net change in the SOC cannot be determined by simple integration of the current because the change in the stored charge is always less than the difference between charge in and charge out.[9]

Basically these losses are highly dependent on the current amplitude, temperature, age of the battery, and its operating history. It is a critical task to calculate net charge flow. It also should be recognized that since charge measurement errors are cumulative, even errors that seem small will eventually lead to unacceptable results.

This means that any SOC calculation process must be reset to an accurate value periodically; to collect the accurate SOC values periodically. Certain types of batteries can be overcharged at a low current periodically to an SOC of 100%. Since this study is concerned only with the charge measurement circuit, it does not provide information about degradation of battery and battery life. The present study for these type of circuits includes not only charge calculation; but also the monitoring various parameters of battery like remaining battery discharge time and battery life indications.

III. DESIGN METHODOLOGY

The objective of the paper is to study calculations of the state of charge (SOC) of battery accurately to monitor the battery health based on parameters like temprature, voltage and current.[7]

The energy contained in an electric charge is measured in Coulombs and is equal to the integral over time of the current which delivered the charge. The remaining capacity in a cell can be calculated by measuring the current entering (charging) or leaving (discharging) the cells and integrating this over time.[6] The charge transferred in or out of the cell is obtained by accumulating the current drain over time. The calibration reference point is a fully charged cell, not an empty cell, and the SOC is obtained by subtracting the net charge flow from the charge in a fully charged cell. This method, known as Coulomb counting, provides higher accuracy than most other SOC measurements since it measures the charge flow directly.

The SOC value for lead acid can be calculated by recharging the pack to an SOC = 100%. This can be done by charging at a high current until a certain voltage is reached and then charging at a low current of 1 or 2 A (trickle charge) until cell gets full charged. Some batteries in the series pack will reach a full charge before others and will then overcharge. The excess energy during overcharge is safely dissipated in the form of heat.[10]

The charge Q is calculated by integrating the battery current over a discrete time increment Δt.

$\Delta Q = \int i_b \, dt$
Where, i= time varying battery current
ΔQ= incremental charge
Accumulated charge Q for n periods is
$Q = \sum \Delta Q_i$ ………… I = 0,1,2,3…n

In addition to measuring Q, the battery management system usually performs several other tasks during the Δt period. These tasks typically include several voltage and temperature measurements plus calculations based on this data.

As shown in figure 1. The charge measurement circuit will contain integrator, V/F convertor and a counter. The time between measurements Δt can be in the range of 2s.I_b battery current can actually vary considerably over this period, but it is not measured at one point. Because of this variation it is necessary to integrate $I_b$to find ΔQ instead of simply measured $I_b \times \Delta t$. Battery management unit includes voltage measurement and temperature measurement of battery to determine the state of battery. Also battery management unit consist of charging and discharging unit to provide information of charging and discharging current. Based on the discharging current information charge remained in battery can be measured in Charge measurement circuit. ΔQ measuring integrator would be standard analog integrator that is reset to zero at the start of each Δt period. The V/F converter and a counter can be used to perform integration. Thus the value of ΔQ for each Δt=2s interval can be obtained by counting number of pulses during Δt.

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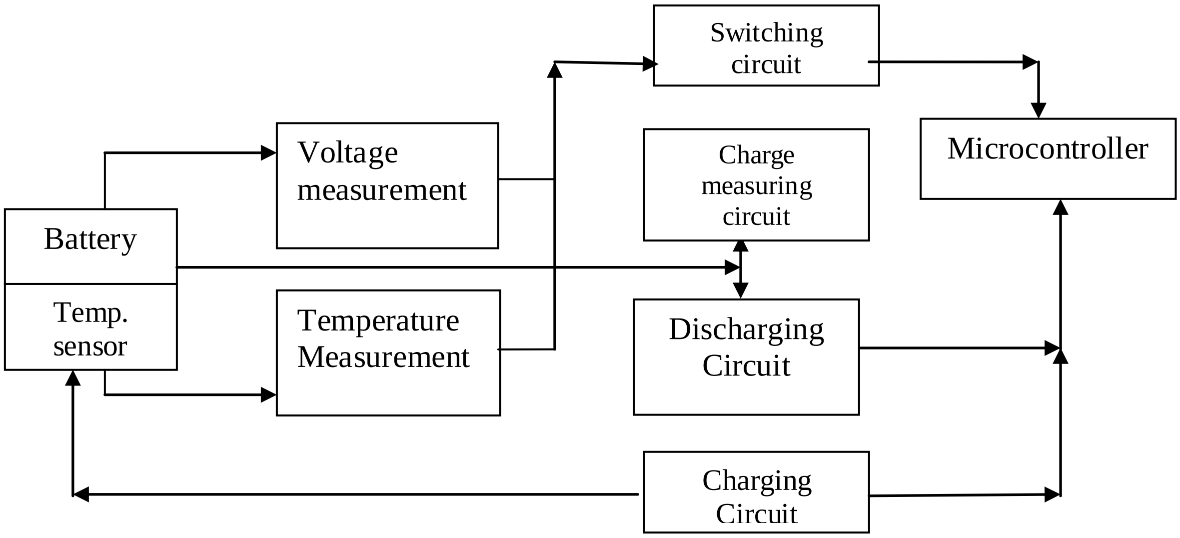
Figure 1: Block diagram of Battery management system



The number of pulses during time Δt at the output of the V/F converter is directly proportional to charge Q which is the change in Q during t. Since current measurement is for battery protection, the I_b value is considered adequate for this purpose. Since only the current (I_b) component is of interest, no attempt is made to measure the instantaneous value of i_b , The method chosen here is to use a V/F converter and a counter to perform the integration.

IV. CONCLUSIONS

The Battery Management System design will help to save the energy by calculating remaining stored charge in battery. Accurate calculation of stored charge is not possible as the battery current is continuously discharging though it is applied a load or not. So regular reset of charge calculation circuit is necessary. The amount of energy stored in battery can be used for some of the emergency situations . As user can get prediction about how long it can be used in next few hours. The battery management system will also help to find our defective battery and time to replace the battery.

FUTURE SCOPE

In Future development the system can be operated remotely from any place using wireless connections. It will help to control the Battery maintenance activities from remote locations.
It can be further improved by analyzing the system parameters dataset using an algorithm in machine learning process, to predict the behavior of battery and to avoid accidents.

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