BATTERY MANAGEMENT BASICS

After Voltage and Current the most useful measurement available from a battery condition monitor is state of charge of the battery. However the estimation of state of charge of lead acid or AGM batteries is never exact. The problem of making accurate estimates results from the characteristics of the cells, the electrolyte, and history of current drawn from (discharge) and supplied to (charge) the battery.

The basis for the best capacity estimates is that the starting condition is known. The only well-established “known” state of a battery is when it is fully charged after a long period of trickle or float charging, usually with a smart charger or regulated alternator-driven charging system. Discharging a new battery at a current 1/20 of the manufactures stated capacity will discharge it fully in 20 hours. This is known as the “20 hour rate”.

For example, if a battery has a stated capacity of 100 Ahr, then the 20 hour rate for that battery is 5 amps (because 100/20 = 5) likewise a 40 Ahr battery would have a 20 hour rate of 2 Amps (because 40/20 = 2.

If higher current than the 20 hour rate is drawn from the battery, the available capacity is reduced. For example, if it is steadily discharged at 10 times the 20 hour rate (50 Amps from 100 Ahr battery), the available capacity falls to about half of the stated capacity. The battery will be flat after about 1 hour instead of the expected 2 hours. (However if the battery is left to recover with the heavy load removed , most of its remaining capacity will return after perhaps 20 hours resting or at a discharge rate close to the 20 hour rate). The NASA BM-1 make allowance for these effects when estimating the battery state of charge and the expected time to discharge the battery fully.

When the battery is being charged, the voltage is no longer a reliable estimate of the state of charge, and so the BM-1 integrates the Ampere hours added to the last know capacity to estimate the battery state of charge on a continuous basis. Allowance for charge efficiency (not all charging current results in useful charge in the battery) is also computed.

Available battery capacity is significantly reduced at temperatures significantly below 20C. The value quoted by the manufacturers is valid at 20C. However, at 0C the capacity may be only 90 % and at -20C may be only 70% of the stated value. A small increase in capacity is achieved at temperatures above 20C, rising to about 105% of the nominal value at 40C.

The effect of cell deterioration on the available capacity are significant. If the battery is charged for long periods, gassing takes place. The gasses are Hydrogen and Oxygen, derived from water in the battery acid. Loss of this water needs to be made up by topping up the cells if possible, or by avoiding lengthy overcharges in sealed cells.

Other irretrievable effects include sulphation (encouraged by leaving the battery flat for long periods), and deterioration of the cell plates. If the battery voltage falls below 10.7 volts (for a normal 12 volt battery), and charging is not started, sulphation on the plates can begin.

The NASA BM-1 has an alarm which flashes and alarms when the voltage falls below 10.7 volts. If the alarm is triggered, its important to reduce the current being drawn immediately and if possible place the battery on charge, to avoid permanent damage to the cells. If the alarm is ignored, the total number of charges/discharge cycles which the battery will survive before it loses a substantial fraction of its nominal capacity may be substantially reduced.

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