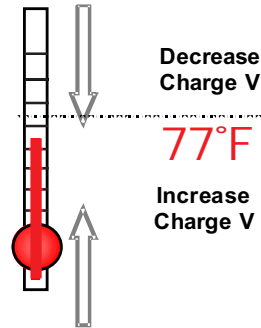


Temperature Compensated Battery Charging

Battery banks are the single most important component of a UPS system, representing a very large capital investment. Both the reliability and longevity of a battery bank depend heavily on the operating conditions most important of which is the charging voltage of the cells. The optimal charge voltage of batteries is not constant but rather varies with the ambient temperature. While most manufacturers specifications list the nominal float charge voltage at 77°F, in reality batteries operate in range of ambient temperatures, and consequently require a dynamic charging voltage to match the temperature. This is why MGE employs temperature compensated charging as part of its Advanced Battery Management system.

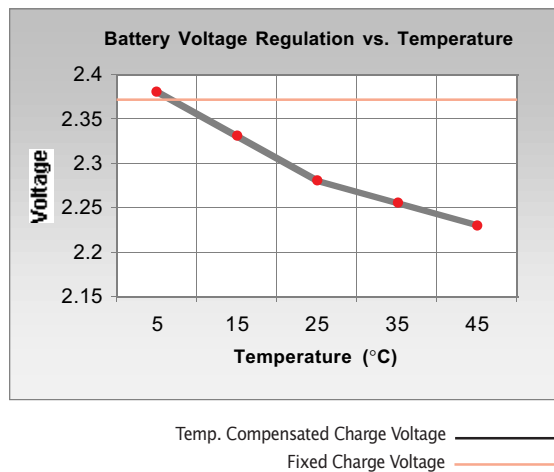


Temperature compensated charging ensures that batteries are charged to maximum capacity in cool environments and are well protected from overcharging in warm environments, features not available with fixed charge voltage systems.

Temperature compensated charging operates on a negative temperature co-efficient centered on a temperature of 77°F (25°C). The charging / temperature co-efficient is $-3\text{mV}/^\circ\text{C}$ per battery cell. As a result the battery charge voltage is reduced by 3mV / per cell for every degree above 25°C (77°F) and increased by 3mV per cell for every degree below 25°C (77°F).

EX: A 480 VDC battery bank (240 x 2V cells) at 20°C will have a temperature compensated charge voltage 3.6 V lower than it would operating at 25°C (77°F).

Risks of Non-Temperature Compensated Charging in Warm Environments: Batteries charged at fixed charge voltages in warm environments risk permanent damage or drastically reduced life spans, especially in the case of sealed batteries. As battery charging is chemical reaction, it has an optimal effective temperature (typically 77°F). By compensating (reducing) the charge voltage for the higher temperatures, the charging reaction is optimized.



Ignoring the compensation factor in warm environments, may cause the battery to overcharge, producing excess hydrogen and causing pressure to form inside of the battery. At higher temperatures non-compensated charge voltages may produce enough pressure to vent a sealed battery. Most sealed battery vents open at around 4 psi, not a lot of pressure. Once vented, a sealed battery discharges hydrogen (and in severe conditions, electrolyte) unbalancing its delicate chemical equilibrium. This can cause permanent damage to the cell, which may not be detectable until the cells are discharged, revealing their deficient capacity. Hydrogen discharge from improperly charged sealed batteries may also pose a safety risk.

In the cases of flooded cells the rate of electrolyte evaporation is greatly accelerated with out temperature compensated charging in warm environments. This radically increases the required maintenance levels.

Temperature Compensated Charging in Cool Environments: In cool environments a battery requires a higher charge voltage to compensate the chemical reaction for the lower temperature. A non-compensated charge voltage will undercharge the battery, limiting the available capacity, which means fewer precious minutes when the UPS is supporting a critical load. As most UPSs are kept in controlled environments where the temperature is around 68°F - 74°F, the compensated charge voltage increases over the nominal voltage. This allows the batteries to attain 100% maximum charge capacity ensuring that the battery provides the rated discharge/backup time.

Maximizing Battery Life: Even under float charging conditions batteries have a finite life and will naturally deteriorate. By keeping the float voltage optimized for the ambient temperature, the chemical equilibrium of the battery is kept stable. This aids in prolonging the life of the battery bank, the single most expensive component of many UPS systems.

Temperature Compensated Charging Benefits

- ▶ Prolongs battery life by limiting natural self deterioration in float charging applications
- ▶ Reduces risk of venting and permanent damage to cells in warm environments
- ▶ Limits electrolyte maintenance on flooded cells
- ▶ Ensures 100% charge capacity and maximizes UPS run time in cooler environments

NOTE: While temperature compensated charging will benefit batteries in warm environments it is best not to expose batteries to hot temperatures (88°F) for any prolonged duration.