WHITE PAPER

Deep-Cycle Battery Storage

Introduction

Each year, seasonal changes bring renewed concerns about the proper storage procedure for deep-cycle, lead-acid batteries. Since lead-acid batteries are electrochemical systems, temperature affects a variety of their characteristics, such as electrical performance and life. Proper storage of deep-cycle batteries helps achieve better performance and longer life, while increasing reliability and value.

Product Design Influences on Storage

All batteries, regardless of their chemical make up, undergo a process called local action or self-discharge. The rate or speed at which this process occurs is dependent upon the chemical reactants in the battery's composition. The chemical reactants in a lead-acid battery consist of lead dioxide or lead peroxide in the positive electrode, sponge lead in the negative electrode and sulfuric acid in a dilute solution, called electrolyte.

One basic principal in chemistry states that as the quantity of reactants increases, the rate of reaction increases. The number of plates in each cell, the density of the active material, and the concentration of pure sulfuric acid in the electrolyte solution all play a part in the rate at which the battery self-discharges during storage.

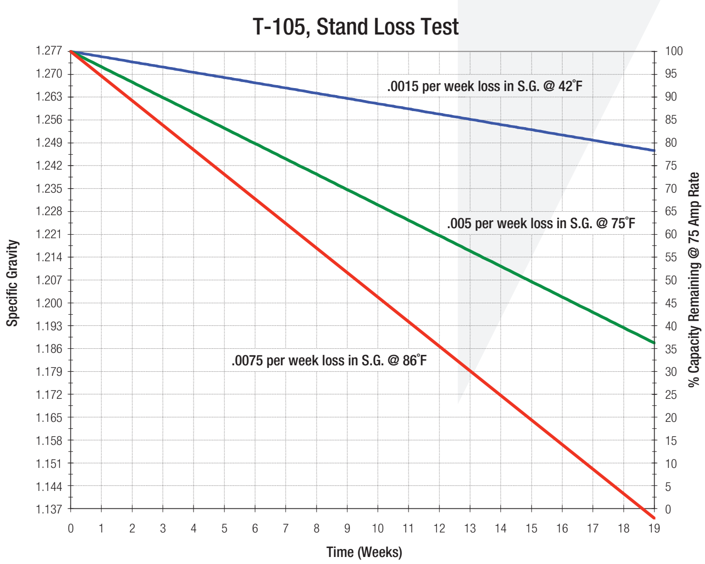

Figure 1

Effects of Temperature

Temperature plays a critical role in the performance of a battery. At higher temperatures, battery capacity generally increases, usually at the cost of battery life.

As the temperature increases, the rate of reaction increases. A general rule of thumb is that every 10°F increase in temperature results in a two to three fold increase in reaction rate. Therefore, storing batteries in a hot environment accelerates the self-discharge characteristic.

At lower temperatures, the battery capacity generally decreases. Furthermore, as the temperature decreases, the rate of reaction decreases, slowing the self-discharge characteristic. Figure 1 shows the standing losses of a Trojan T-105 deep-cycle battery at various temperatures.

In extremely cold climates, batteries stored outdoors may be subjected to freezing. Freezing usually results in irreparable damage to the plates and containers. It is therefore imperative that batteries that are subjected to freezing temperatures be stored fully charged or at a high state of charge. Table 1 shows freezing points of electrolyte at various states of charge.

Table 1

Electrolyte Freezing Point at Various States of Charge

Specific Gravity	State of Charge	Freezing Temperature
1.280	100	-92.0°F
1.265	92	-71.3°F
1.250	85	-62.0°F
1.200	62	-16.0°F
1.150	40	+ 5.0°F
1.100	20	+19.0°F
Source: BCI Battery Service Manual © 1995		

Recommended Storage Practices

1. Batteries should be stored in a cool, dry location, protected from the elements. Wind chill factors have been known to freeze batteries which would not freeze at normal ambient temperatures. Direct exposure to heat sources, such as radiators or space heaters, will accelerate the rate of self-discharge and increase the frequency of required boost charging. Exposure to direct sunlight may result in fading of colored cases and covers.
2. According to Battery Council International, batteries in storage should be given a boost or freshening charge when the specific gravity value drops .040 points. When hydrometer readings are not accessible, open circuit voltage readings may be used. While in storage, a freshening charge should be given when the battery voltage drops below 12.4 volts for a 12 volt battery, or 6.2 volts for a 6 volt battery. Table 2 shows open circuit voltage values at various states of charge and recommended recharge times at various charge current rates.
3. If the batteries have been in service prior to storage, they should be given a boost charge before being placed in storage and immediately prior to returning to service.

Proper storage of Trojan deep-cycle, lead-acid batteries will help achieve better performance and longer life, while increasing reliability and value to the end user.

Table 2

Recharge Time vs. State of Charge

Percentage of Charge	Specific Gravity Corrected to 80°F	Open Circuit Voltage per Cell	Hours Charge @ 5 Amps.	Hours Charge @ 10 Amps.	Hours Charge @ 20 Amps.
100	1.277	2.122	0	0	0
90	1.258	2.103	5	3	1
80	1.238	2.083	10	5	3
70	1.217	2.062	16	8	4
60	1.195	2.040	21	10	5
50	1.172	2.017	26	13	6
40	1.148	1.993	31	16	8
30	1.124	1.969	36	18	9
20	1.098	1.943	41	21	10
10	1.073	1.918	47	23	12

Notes: 1 - Multiply by 3 for 6 volt batteries or 6 for 12 volt batteries to determine unit voltage.

TECHNICAL SUPPORT

800-423-6569 Ext. 3045 / +1-562-236-3045

technical@trojanbattery.com

Please check the Trojan Battery website (www.trojanbattery.com) for the most up-to-date information.

10375 SLUSHER DRIVE, SANTA FE SPRINGS, CA 90670

TROJAN BATTERY COMPANY

800.423.6569 +1.562.236.3000

TROJANBATTERY.COM

99% RECYCLABLE