Battery Tech Tips and Help

Because we are in the battery charging business, we find the informed consumer is a better customer. We hope that the information here will be helpful to you in understanding batteries, electrical systems, and charging.

AMP-HOUR RATINGS OF VARIOUS BATTERIES

There are several different ways to rate batteries, one of which is amp-hours. Simply defined, amp-hours is *current* multiplied by time. One amp-hour is equal to one amp of current for a period of one hour. In other words, a 105 amp-hour group 27 battery can deliver 5.25 amps for 20 hours before the battery voltage drops to 10.50 volts, at which point the battery is dead. The same battery will also deliver approximately 10.5 amps for 10 hours, and so on.

For typical RV batteries, the amp-hour rating is determined at what is termed a *20 hour rate*. That is, a constant current is consumed from the battery that will cause battery voltage to drop to 10.50 volts in 20 hours. The actual available amp-hours from a particular battery will be somewhat more if less current is delivered over a longer period, and somewhat less if more current is delivered over a shorter period.

The typical amp-hour ratings of batteries used in RVs is shown in Table 1. Note that golf cart batteries are 6 volt. Two golf cart batteries are connected in series to produce the 12 volts required by RVs. Placing batteries in series increases the total voltage to the sum of the batteries (6V+6V=12V), but does not increase amp-hour capacity. Two golf cart batteries still deliver 220 amp-hours. Placing batteries in parallel increases the total amp-hour capacity to the sum of the batteries, but does not increase voltage. For example, a popular combination is two Group 27 batteries in parallel which will deliver a total capacity of 210 amp-hours (2x105AH=210AH).

Table 1: Typical Amp-Hour Capacity of RV Batteries

BATTERY SIZE	TYPICAL AMP-HOURS
GROUP 24	85 Amp-Hours
GROUP 27	105 Amp-Hours
4D	160 Amp-Hours
8D	220 Amp-Hours
6 VOLT GOLF CART	220 Amp-Hours

BATTERY VOLTAGE AND SPECIFIC GRAVITY

There are two possible ways to determine the remaining capacity of a battery, specific gravity of the electrolyte, and battery voltage. Since access to the electrolyte in a gel type battery is not possible, the voltage method must be used. If the battery is not being charged or discharged, battery voltage will be *open circuit* voltage, and remaining capacity can be determined from Table 2. If this method is used, the readings should be taken after the battery voltage has stabilized for a period of at least 24 hours after charge or discharge.

Table 2: OPEN CIRCUIT VOLTAGE AND SPECIFIC GRAVITY

	BATTERY TYPE			
REMAINING	LIQUID ELECTROLYTE		GEL ELECTROLYTE	
BATTERY CAPACITY	OPEN CIRCUIT VOLTAGE	SPECIFIC GRAVITY	OPEN CIRCUIT VOLTAGE	SPECIFIC GRAVITY
100%	≥12.68 V	1.265	≥12.95 V	N/A
75%	12.44 V	1.225	12.71 V	N/A
50%	12.23 V	1.190	12.50 V	N/A
25%	12.02 V	1.155	12.29 V	N/A
0%	11.80 V	1.120	12.07 V	N/A

HOW LEAD-ACID BATTERIES WORK

The electrolyte of a liquid type battery consists of 36% sulfuric acid by weight in water. As the battery is discharged, sulfate in the electrolyte combines with the lead plates of the battery to form lead sulfate. As the plates take up sulfate, the electrolyte becomes more like water and less like sulfuric acid. As the electrolyte becomes more like water, its specific gravity also gets closer to that of water (SG of water =1), as shown in Table 2. The reverse occurs as the battery is charged. As charging current flows through the battery, the battery plates revert back to their original condition and the electrolyte reverts back to its original sulfuric acid content. Batteries are not 100% efficient at converting charging amp-hours back onto stored amp-hours. Replacing 100 amp-hours of consumed capacity will take approximately 110 amp-hours of charge.

WHY BATTERY VOLTAGE CHANGES

Open circuit voltage of a battery is a direct function of the specific gravity of the electrolyte at the place in the battery where the chemical reaction occurs. This chemical reaction takes place inside the pores of the active material on the lead plates. If the battery has just been charged, the local electrolyte in the pores of the plates is very rich in sulfuric acid and the battery voltage will be high, perhaps 13 to 14 volts. As the battery rests following charge, voltage slowly drops and stabilizes as the electrolyte mixes.

A similar change in battery voltage occurs during discharge. While a fully charged battery may read 12.68 volts open circuit, the voltage will drop and then stabilize at a somewhat lower value as a load is applied to the battery. The change in voltage occurs even though the state of charge of the battery has not significantly changed. This is due to the local electrolyte in the pores of the plates becoming less rich in sulfuric acid as the battery supplies current. As the battery discharges, electrolyte more like sulfuric acid enters the pores while electrolyte more like water exits the pores. As discharge continues, the electrolyte in the pores eventually stabilizes at a specific gravity somewhat lower than the average value in the battery, producing the slightly lower battery voltage.

MAXIMUM CHARGING CURRENT

All batteries have a maximum current at which they can be safely charged. Charging a battery at a current greater than this maximum value will shorten battery life, and in cases of extreme over current could result in a hazardous condition due to battery overheating. Our model 6210 has a fully adjustable charge current limit feature which is used to provide the maximum charging current possible yet stay within the limits of your particular battery.

Consult the battery manufacturer to determine the maximum suitable charging current for your battery bank. Maximum charging current generally varies based on the battery type (liquid or gel electrolyte) and the total amp-hour rating of the battery bank. Maximum charging values are expressed in terms of "C", where "C" is the total amp-hour rating at a 20 hour rate. Typical maximum charging current values are C÷ 3 for a flooded liquid electrolyte battery, or C÷ 5 for a gel battery. For example, the maximum charging current for one 8D liquid electrolyte battery rated at 220 amp-hours would be 220÷ 3 ˜ 73 amps. Using these charge current limit values, the typical maximum charging current limit for various batteries is shown in Table 3.

Table 3: TYPICAL MAXIMUM CHARGING CURRENT FOR RV BATTERIES

BATTERY	TYPICAL AMP-HOURS	MAXIMUM CURRENT
ONE GROUP 24, = LIQUID	85 Amp-Hours	28 AMPS
ONE GROUP 27, = LIQUID	105 Amp-Hours	35 AMPS
ONE 8D, LIQUID	220 Amp-Hours	73 AMPS
ONE 8D, GEL	200 Amp-Hours	40 AMPS
TWO 6 VOLT GOLF CART, = LIQUID	220 Amp-Hours	73 AMPS

There are four key criteria for proper battery charging:

1. **Charging current** must be no more than C/3 for flooded liquid batteries and C/5 for gel batteries, where "C" is the AH rating @ 20 hour rate.

   Two Group 27's maximum current = 2x(105AH)/3 = 210AH/3 ? 70A.

2. **The battery must be charged** at a *temperature compensated* acceptance voltage of ??14.2V @ 80°F, temperature compensated at -16.7mV/°F.

   As temperature increases, voltage decreases.

3. **The acceptance voltage** must be applied until battery current decreases to the critical value of 1.0A per 100AH of battery capacity.

   1A/100AH is the *key indicator of full charge* without over charge.

4. **Once the battery is charged**, voltage must decrease to a *temperature compensated* float voltage of ??13.3 V @ 80°F.

   A healthy battery that is fully charged will draw a float charge current of 1/500 to 1/1000 of the C rating, or 0.2-0.4A for 2 Group 27's.

DESIRABLE THREE STAGE CHARGE REQUIREMENTS

1. Temperature compensation: Optimizes float and acceptance voltages based on battery temperature.
2. Some units offer user selectable voltage or temperature -- fully automatic is best.
3. Full charge determination based on actual charging current.
4. Charge current is the best indicator, not time.
5. Must be actual "charging current", not charger output current.
6. Changes with battery size (1.0A/100AH) -- selectable current is best.
7. Selectable battery electrolyte type.
8. Selects the proper acceptance and float voltages for liquid or gel electrolyte.
9. Remote sensing and control of battery current and voltage.
   - Voltage sensing eliminates the effect of cabling voltage drop.
   - Current sensing allows for proper charge termination, and bulk charge limiting.

TEMPERATURE COMPENSATED CHARGING

Temperature compensation: The primary reason for temperature compensated charging is that the required charging voltage for batteries is based on temperature. With out temperature compensated charging batteries the proper charge voltage can't be employed. As temperature increases, voltage decreases. Where climate temperatures can be extreme during certain times of the year or in certain parts of the country it is easy to see why temperature compensated charging is necessary.

ABOUT INVERTERS

Inverters are designed to allow you to operate appliances from your 12 volt battery system without shore power or your generator. Inverters are not chargers. Some inverters will have a built in charger to help compensate for what the inverter will draw out of the battery(s) when operating an appliance. An inverter can be handy when you want that pot of coffee and it is before or after generator hours and/or you don't have a generator. Keep in mind what you take out the battery has to be put back. An investment in a good charging system makes sense if you want to use a large inverter.

When selecting an inverter, determine what you want it for as it is easy to get carried away or talked into buying a larger inverter than you really need. You can save yourself money by buying an inverter that meets with your lifestyle choices.

WHAT SIZE INVERTER DO YOU NEED?

The average RV'er usually only needs one of two types. The first is to operate TV's, satellite dishes, and laptop computers or similar products. A 500 or 600 watt inverter is great and inexpensive for these tasks. The next step up is for those customers who want to use a microwave, coffeepot or other larger power hungry device. A 1500 to 2500 watt inverter will work for these. Remember a larger bank of batteries will allow you to last longer but still what you take out needs to be put back.