

ROLLS BATTERY ENGINEERING

Salem, Massachusetts, USA Ph 1-800-681-9914 (902) 597 – 3767 Fax (902) 597-8447
Mail: P.O. Box 2020, Springhill, Nova Scotia, Canada B0M 1X0



The positive power choice

Bulletin 609, Voltages, Specific Gravity and State of Charge

This bulletin describes how to correctly use and interpret both specific gravity and voltages readings and how to determine when your battery bank requires charging.

Specific Gravity Readings – “True” State of Charge

The specific gravity (SG) of the battery acid or electrolyte is the truest and most absolute measure of a battery’s state of charge. The SG reading is not affected by the load on the battery. Basically if a battery is 50% charged, it will read a specific gravity of 1.200 (see Table 1), regardless of whether the battery is on charge, being discharge or being stored. This is not the case for voltage readings.

Table 1. SG vs. State of Charge

<u>% Charged</u>	<u>Specific Gravity</u>	<u>% Charged</u>	<u>Specific Gravity</u>
100%	1.255 – 1.275	25%	1.165–1.155
75%	1.215 – 1.235	0%	1.130-1.110
50%	1.200 – 1.180		

Voltage Readings

Voltage readings will vary and are greatly affected and dependent on whether the battery is being charged, discharged or in storage (rest or “open cell” voltage). There are two terms for voltage readings:

- 1) Load voltage (voltage under load or on charge)
- 2) Open cell voltage.

Charge Voltage: When a battery is charged the plates will polarize and develop a resistance to the charge (surface charge). This resistance will add to the battery voltage and therefore using this voltage reading will not reflect the true state of charge. All the so-called “surface charge” will be removed when the battery is being discharged. In general, the battery voltage will recover or increase when the load is removed. This is especially true if the load is very high.

Open Cell Voltage is determined by taking all the loads off of the battery and letting the battery stand for at least 4 hours before taking a reading. This allows the surface charge to dissipate. To get around this problem either use table 2 or determine the 50% state of charge as described.

Determining the 50% state of charge Voltage Reading

Most three steps chargers or inverters monitor the voltage and have an adjustable set point that determines when the batteries are low (50% discharged) and should be charged. Once this set-point is reached the inverter will either sound an alarm or start a generator or tie the battery bank back into to grid power. The voltage set-point maybe factory set but could require verification. Consult your inverter manual for the section on “Cut-off voltage” or “Over discharge protection”. Since the voltage will change depending on whether or not the bank is on load the set point can be determined by a specific gravity reading. A gravity reading of 1.220 is equal to 50% discharged.

Battery cable lengths, system set-up and other variables can affect the voltage readings as well. Below is a procedure to verify the 50% mark and table 2 gives approximate cut-off voltages at various state of charge. Notice 100% is given as an open cell voltage and all other as under load.

When using a generator with a low voltage cut-off, set the generator to start at the 50% mark given by table 2 and put the bank into service (11.6 V for a 12V system). When the generator starts-up measure the specific gravity of one cell in the bank. Compare this to the table 1, Specific gravity versus state of charge. If the measured specific gravity indicates the state of charge is more than 50%, decrease the low voltage cut-off setting. Similarly if the specific gravity indicates the state of charge is lower than 50%, increase the low voltage cut-off setting. Note: 50% is the desired depth of discharge but it does not have to be exactly 50%. For practical purposes a range of 45-55% is acceptable. The actual battery voltage corresponding to 50% will change with a change in load. In general, the higher the discharge amperage, the lower the corresponding voltage.

To determine or verify the 50% voltage set point:

1. Put all or as many loads as possible on the battery. Disconnect any in coming current inputs such as panels / windmills and grid power. Contact your dealer for specifics.
2. Take the specific gravity of one cell.
3. Take another reading 15 minutes and ½ hr later this should give you an indication of how fast the batteries are dropping.
4. Continue to take readings until 50-55% state of charge is reached according to the specific gravity readings.
5. Take and record voltage readings (when on load) of any meters to be used for monitoring the state of charge and take a voltage reading across the terminals of one battery.
6. Compare to table 2.
7. These readings will then give you a very accurate voltage reading which can be used in the future either as a set point for the inverter or as a day to day monitoring parameter.

Table 2.

% Charged	Single Cell	12V	24V	32V	48V	
100%	2.10	12.60	25.20	33.60	50.40	OPEN CELL
75%	2.01	12.06	24.12	32.16	48.24	UNDER LOAD
50%	1.93	11.58	23.16	30.88	46.32	UNDER LOAD
25%	1.84	11.04	22.08	29.44	44.16	UNDER LOAD
0%	1.75	10.50	21.00	28.00	42.00	UNDER LOAD

Note: This will give you a very good idea on how your battery bank will behave and how long it will last with no power inputs. New batteries will give about 75% of the specified capacity until the battery has been cycled 40-60 times (1-3 months of service).