Batteries
- frequently asked questions about choosing and caring for batteries on miniature locomotives.

Dave Giles - Ikon Loco Works

Q1. How do I decide on the correct size battery for my battery powered locomotive?
A1. Most DC motors that are suitable for powering miniature locomotives operate on 24 volts and have permanent field magnets. Let's assume that the motors are 24 Volt. This requires two 12-volt batteries in series to make up a 24-volt system. Four six volt batteries in series can also be used.
A typical battery electric locomotive with 2 - 600-watt DC motors (3/4HPea.) geared to a maximum speed of 12 km / hour will haul 10 adults on grades of 1.5% - 2% with ease. The total current draw from the batteries on a typical journey will be about 20 amps on the level sections and about 60 amps on the gradients. Most miniature railway tracks are a loop so the uphill section can not be more than 50% of the journey. On the downhill section there is virtually no power being consumed and in some cases a very small amount of power is returned to the batteries from the dynamic braking effect of making the motors into generators.
While passengers are being loaded the loco is usually stopped for about the same time as the trip takes so the average current draw per hour is only about 1/3 of the maximum amps being consumed on the upgrade section of the trip. The average current usage in this example would equate to 20 amps.
If 80 amp/hour batteries in series are powering the locomotive you could expect to run the locomotive for 4 hours before the power would start to drop off. ie: total battery voltage down to 23 volts. Eg: 80 amp/hour battery divided by 20 amps = 4 hr expected running time. If 100 amp/hour batteries were being used, 5 hours running time could be expected.
The general rule with batteries is 'Bigger is always best' if they will fit in the available space.

Q2. What voltage is a fully charged battery?
A2. For a 24 volt system this is 25.6 - 25.8 volts when the batteries are not connected to the battery charger.

Q3. How far can I draw the battery voltage down before I start to permanently damage the cells?
A3 23 volts is considered the minimum voltage that the batteries should be drawn down to if permanent damage to the cells is to be avoided.

Q4. Can a battery be left in a discharged condition for a few days without damaging it?
A4. No, after your run for the day put your batteries on charge as soon as you can. Chemical changes take place when batteries are left in a discharged state for any length of time. This may mean that the plates start to sulphate and they will never fully return to a 'fully charged' state.

Q5. Are sealed GELL CELLS better than WET CELLS? (With removable top up caps)
A5. In general the sealed type of GELL CELLS do not last as long on cyclic use as the wet cells that you can top up with electrolyte. The GELL CELLS do have certain safety advantages in that they do not vent explosive hydrogen fumes when being charged or spill acid in the event of a roll over.

Q6. Are TRACTION or DEEP CYCLE BATTERIES of different construction than the sealed GELL CELL type of battery.
A6. Yes, Traction batteries have thicker plates, the plates are fastened in the case more securely to cope with vibration. The battery case is also deeper which allows more space at the bottom of each cell for debris to collect before it starts to short across the bottom of the positive and negative plates causing the cell to fail.

Q7. Are there any viable alternatives to LEAD ACID type batteries?
A7. Yes there are several different types but the cost of the exotic types is out of all proportion to the cost and performance of a conventional Lead Acid battery. The Lead acid battery is still the only viable choice at present.

Q8. What is the best type of battery charger, Single-stage or Two-stage?
A8. The single-stage battery charger gives a compromise charge. If left on for too long after the batteries reach their fully charged state the cells can overheat and boil the electrolyte, which then evaporates. The single-stage charger is reasonably cheap to purchase and it is best suited to supervised use. ie: It must be turned off as soon as the battery comes up to full float voltage.
The two-stage charger is easily the best for batteries that are on intermittent use. This charger starts charging on a boost voltage of 29 - 30 volts for two or three hours and gets things moving inside the cells. It then cuts off and comes in on a much lower float maintenance charge voltage level of 27.2 - 27.4 volts. This type of charger can be left turned on without overcharging or heating the batteries and shortening their life. It is the type recommended for the sealed types of GELL CELL batteries as it does not cause the electrolyte to 'gas'. It costs considerably more than the single stage charger but the sealed batteries have a much longer useful life.

Q9. How do I know what amperage battery charger to use for my 80 amp/hour batteries?
A9. The battery manufacturers recommend that to obtain the longest life from your batteries the charger should be sized to give a full charge over a period of 10 - 12 hours. The maximum charging current amps that a battery can accept is its rated Amp/hours divided by 4. In this example the maximum charge rate that a 80 amp/hour battery could accept is 20 amps. This is not recommended as the high charge rate severely overheats the plates and they buckle

and start to disintegrate. The battery life will be very short if it is charged at this high rate. If your loco has 80 amp/hour batteries, an 8 amp charger will take 10 hours to fully recharge them. ie: 8 amp X 10 hr = 80 amp hour. An 8 amp charger is perfect for 80 /100 amp/hour batteries.

Q10. Can parallel /series /parallel stacks of batteries be charged together or does each bank have to be charged separately?
A10. The industry opinion is that it is not satisfactory to charge strings of series / parallel batteries with a common charger. The variation in resistance between batteries in parallel causes uneven current flows. If this lash up has to be used, it is better to charge the series strings separately.

Q11. Does the Amp/Hour capacity of a battery reduce with short heavy usage and then long periods of inactivity?
A11. As long as the batteries are stored fully charged they last fairly well. This however needs to be taken in context that the life of a battery is never more than 4 years even if it is properly charged and cared for. The internal plates 'sulphate' over time and they eventually fail at around 3-4 years. If a single stage charger is used the batteries should be put on charge for two hours every month to keep them fully charged. If a two-stage charger is used they can be left on float charge.

Q12. How long do you expect batteries last in a miniature locomotive used one day per month?
A12. Three to four years is the usual life of a battery however some only last one year if they are discharged and charged every day. In our business of manufacturing and servicing battery powered vehicles we have had the odd case of premature failure with all brands of battery but in general they should last three - four years in miniature locomotive usage. Makers of the Sealed types claim a cycle life of 300 - 350 cycles, ie: full - flat - recharged. The makers of the Trojan Deep Cycle wet batteries that are often used in Golf Karts claim a typical battery life of 600 - 700 cycles. These cycle/ life predictions are assuming the battery is used and charged on a daily basis. To obtain the best life from a battery it must never be discharged below 11.5 volts on a 12 Volt system, or never discharged below 23 volts on a 24 V system.

The information on batteries and chargers has been gained from practical experience gained from many years of building more than 600 battery electric vehicles ranging from single seat Mobility scooters weighing 100 kg up to 48 seat people movers weighing up to 5000 kg. Many variations of battery electric railway locomotives and two race winning solar/ battery powered racing cars have also been designed and manufactured by the author over the past 20 years. **Dave Giles - Ikon Loco Works** *www. ikoneng. com*

Gaston Planté *(1834–1889) was the French physicist who invented the lead-acid battery in 1859.*
Planté was born on April 22, 1834, in Orthez, France. In 1854, he began work as an assistant lecturer in physics at the Conservatory of Arts and Crafts in Paris, and in 1860, rose to the post of Professor of Physics at the Polytechnic Association for the Development of Popular Instruction.
In 1859, he invented the lead-acid cell, the first rechargeable battery. His early model consisted of a spiral roll of two sheets of pure lead separated by a linen cloth, immersed in a glass jar of sulfuric-acid solution. The following year, he presented a nine-cell lead-acid battery to the Academy of Sciences. In 1881, Camille Alphonse Faure would develop a more efficient and reliable model that saw great success in early electric cars.
In 1989, the Bulgarian Academy of Sciences established the Gaston Planté Medal, which is awarded every few years to scientists who have made significant contributions to the development of lead-acid battery technology.