

WHY IS IT BAD MIXING OLD & NEW BATTERIES

Most of the batteries used in a UPS systems or DC power systems, work with progressive dynamics. Since most of the time, we wire them in series, each cell adds its contribution to the total bank voltage. When one eventually fails, perhaps owing to sulfation or other reasons, this voltage drops. The battery industry does not replace individual lead-acid cells in such cases, because these would be out of balance with the older ones. It is said whenever there is a need to replace old cells with the new ones in a particular bank, one should maintain the dancing tune of those batteries. They must charge & discharge in synchronism!

Why Mixing Old and New Batteries is a Bad Idea

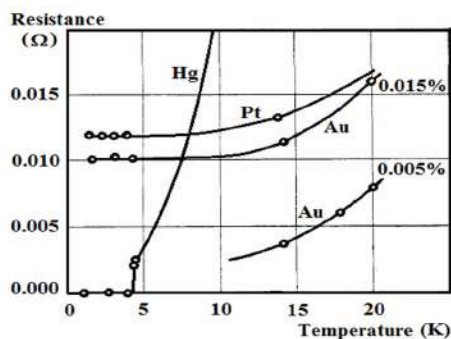


Let's assume we are doing a barbecue in the garden in the dark. We need an electric torch to see how the food is doing, but find the three batteries in it are almost flat.

We borrow two from the bathroom radio and replace two in the torch. The light is brighter and we can soon enjoy our meal cooked to perfection. The next time we use the torch, it is back to its old habits.

Mixing old and new batteries has let us down. That's because the two batteries from the bathroom radio have been working harder than the manufacturer intended. Moreover, they have been forcing more electricity through the weak one than they should. This has caused the weak one to overheat. It could even leak and ruin our torch.

The Chemistry behind the Overheating Problem



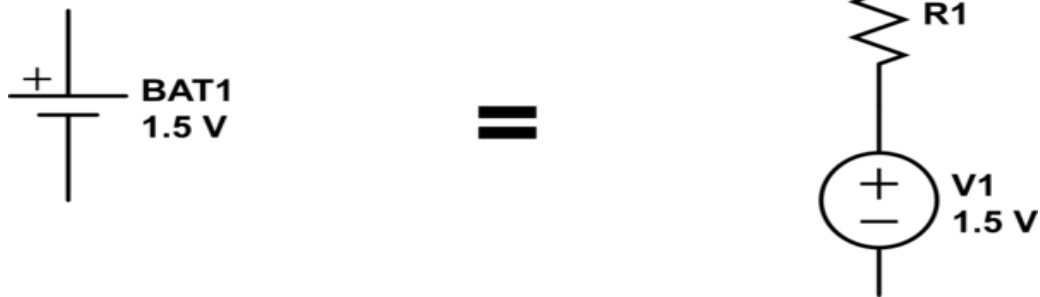
Resistance v Temperature

Batteries are chemical reactions producing constant voltage. The speed at which this happens depends on their internal resistance. A fresh battery has a low resistance, but this increases as it wears out. Joule's law dictates that thermal gain accompanies loss of electrical energy.

Thus, mixing old and new batteries forces an excessive amount of energy through an abnormally high resistance. The new batteries run out sooner, while the old battery overheats. By mixing old and new, we are wasting good money. This applies to mixing older and newer fresh batteries to a lesser extent.

The Electricals

A simple model of a battery is a chemical reaction which produces a constant voltage. But, this chemical reaction takes time. A simple model of the limited speed of that reaction in electrical terms is a series resistance:



When the battery is fresh, R_1 is small. As the chemical energy is depleted, R_1 gets bigger. Why this happens is complicated, and I'm not a chemist, so I can't tell you in detail, but it has to do with the reactants being used up, and the battery plates getting covered in crud, and so on.

This resistance, even though it's a combination of electrical and chemical effects, isn't exempt from the laws of physics. It still experiences a loss according to Joule's law:

$$P=I^2R \text{ or } P=I^2R$$

This loss of electrical energy must be accompanied by a gain of thermal energy.

If you aren't mixing batteries, then as the batteries become dead, all their resistances rise about the same, so while R goes up, the increasing R also limits the maximum current I that the batteries can supply. Most batteries¹ are designed to be safe under any of these conditions.

However, if you mix fresh and old/dead batteries, then you have the fresh battery which can deliver a large current, into a dead battery which has a high resistance. This results in excessive heat in the old/dead battery, which may then be damaged or fail, perhaps spectacularly.

The worst thing you can do to just about any kind of battery, whether rechargeable or not, is to push an amount of current through it which is large relative to its short-circuit current. As a battery gets depleted, its short-circuit current--and thus the level of current which it can safely handle--will diminish. If all batteries in a stack get depleted at the same time, the amount of current flowing in the system will remain below the amount of current that the weakest battery can safely handle. If, however, one of the batteries in the stack is depleted while other batteries remain strong, the strong batteries may manage to push significant current through the weak one even when its short-circuit current has diminished to basically nothing. Such abuse will severely degrade the useful life of rechargeable batteries, and may cause non-rechargeable batteries (or even rechargeable ones) to release corrosive gunk.



Conclusions

Q. **Can I mix old and new batteries?** A. Do not mix old and new batteries. Doing so will reduce overall performance and may cause battery leakage or rupture. We recommend replacing all batteries within a device.

Q. **Can I mix different battery types?** A. No, different batteries are designed for different purposes. Mixing a lithium battery with an alkaline battery will not improve device performance. In fact, it will reduce performance and may even damage your device or cause battery leakage or rupture.

As well, do not mix different battery brands within a device. Doing so will reduce overall performance and may also cause battery leakage or rupture. We recommend using the same type of batteries within a device.

Q. Do I have to change all the batteries at the same time? A. We do recommend changing all batteries in a unit at the same time. A partially used battery will drain energy from a new one, reducing the total amount of battery power available.