

BoatWorks

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The hybrid-propulsion battery bank installed on my boat *Nada*. Note how the batteries are spaced so air can circulate between them

Tech Notes with Nigel Calder

Can't Stand the Heat

Some hot tips on how to help your batteries keep their cool

Traditional lead-acid batteries are inefficient energy storage devices. As a general rule of thumb, about 15 percent of the energy pumped in by a battery charger or alternator is lost, and there are similar losses on the way back out to power a load. Of course, you don't actually "lose" the energy (I believe we have Einstein to thank for that insight). It just gets changed into something else, and in this case that something else is heat.

Let's say you have a 12-volt electrical system and you've upgraded your alternator

to 150 amps. In practice, the alternator will never run at this rate for more than a minute or two, after which it too will heat up (alternators are at best 50 percent efficient—see "Too Hot to Handle," Tech Notes, May), resulting in a drop in its output. We'll be optimistic and assume it puts out a steady 120 amps. The charging voltage will be around 14.0 volts. So 120 amps x 14.0 volts = 1,680 watts, and 15 percent of this, around 250 watts, is being turned into heat inside the battery. Over time, that's quite a bit of heat. Or maybe you have a 3kW in-

verter/charger that you plug into a 30-amp shorepower supply. It will have similar charging and heating capabilities.

THERMAL RUNAWAY

Normally, as a battery comes up to charge, its charge acceptance rate—the amperage it will absorb at a given charging voltage—decreases and is just a trickle of amps once the battery gets to an 80 percent to 90 percent state of charge. This is why it takes many hours to fully recharge a battery. But when batteries warm up, their charge acceptance rate at a given voltage increases. If a battery steadily gets hotter as it comes up to charge, instead of its charge acceptance rate tapering off, it instead accepts a higher-than-normal rate of charge. But now even less of this energy is put to useful work, and even more of it is converted to heat. You can probably see where this is going—you get into a vicious circle where the battery accepts more and more charging current and gets hotter and hotter.

At some point the excess charging current begins to break down the water in the battery's electrolyte into its constituent parts of hydrogen and oxygen. If it is a wet-cell battery (the type that need topping up from time to time), you will hear it boiling away like a tea kettle. If it is a sealed battery, the internal pressure will rise, pushing out the sides of the case like a partially inflated balloon, until the vent caps blow. Regardless of their construction, all batteries at this point will give off highly explosive hydrogen gas, the same stuff that blew the lid off the nuclear power plant in Japan. This is known as a "thermal runaway." A single small spark inside the battery—from an internal short, for example—or from outside can set off a considerable explosion.

Fortunately, this sort of thing doesn't happen very often. But as we put ever larger battery banks, heavier electrical loads and more powerful charging devices on our