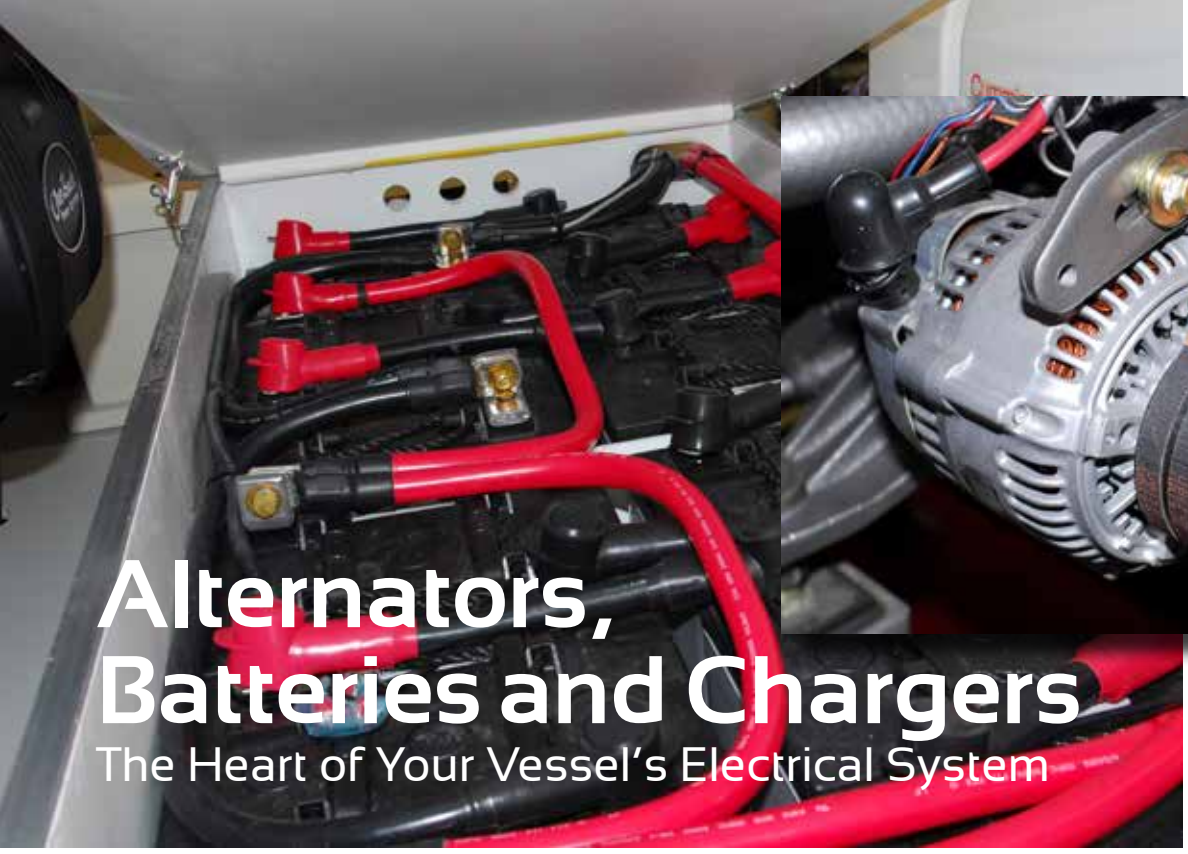

Alternators, Batteries and Chargers

The Heart of Your Vessel's Electrical System

Large, deep cycle house battery banks have special needs where charging is concerned, particularly if they are of the AGM variety, like the ones shown here.

Using stock, internally regulated alternators, regardless of their output, often leads to inefficient, and incomplete charge cycles, as well as charge profiles that promote premature failure, especially in the case of AGM and gel batteries.

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While the future of marine charging systems promises to be bright, with lightning fast charging lithium ion batteries that weigh a fraction of their lead cousins, ultra-high output, compact solar panels and fuel cells, the fact is we're very likely stuck, for the foreseeable future, with conventional systems that have been around for at least a decade. To paraphrase the refrain regarding fusion power, recreational marine fuel cell use has been five years away for the past ten years. The good news is, the systems we know have been, if not perfected, refined to the point where surprises are few and, if properly designed and installed, failures uncommon. And, there's something to be said for not adopting technology that's on the bleeding edge as it tends to be both costly and unreliable.

Batteries

Regardless of which technology you use flooded, gel or AGM, batteries are the very lifeblood of your vessel. As an aside, gel and AGM batteries fall into the category of sealed valve-regulated lead acid or SVRLA, which essentially means they operate under a case pressure of approximately 1.5 psi. Without them all vital systems, propulsion, navigation, communication, navigation lights and pumps cease to operate. Yet, for many of the vessels I inspect they are all too often relegated to afterthought status, buried under other gear, with poor access and little or no ventilation. All conventional batteries require ventilation; for dissipation of hydrogen gas as well as heat that is generated during the charging process. Contrary to popular belief, even "sealed" batteries will vent hydrogen gas if overcharged (and once they do vent they are essentially ruined). Overcharging can occur if charging systems are not properly initialized or in the event of an alternator regulator or charger malfunction. Therefore, provisions must be made to dissipate production of this highly volatile and lighter than air gas. If installed in boxes with lids, the latter must be equipped with holes that are located at the highest point, to prevent gas from being entrapped. The same holds true for battery lockers, if lighter than air gas can be trapped, provisions for ventilation must be made. Failure to ventilate batteries in this manner can lead to battery box or locker explosions. The ingredients for which are painfully simple, trapped gas and a loose terminal that generates a spark, often when a load or charge source is applied.

This, however, isn't where the requirements for ventilation end. As batteries are being charged, they generate heat, which must be allowed to dissipate. If several batteries are installed, tightly packed cheek by jowl, with no air space between them, those in the center of the pack often operate at higher temperatures. As a battery's temperature increases, its rate of chemical reaction also increases; a process that can lead to what's known as thermal runaway.

When this occurs, a melt down or fire becomes a veritable certainty. Therefore, ensure that all batteries, particularly house banks and those located in boxes; include air gaps between each other and between the battery and its enclosure. Gaps need not be particularly large; a quarter to one-half inch is adequate.
If you have an infrared pyrometer, and today no boat should be without one, make it a point to check the temperature of all batteries while charging, again especially those in the house bank.

Battery choices remain primarily unchanged from those available a decade ago, flooded, gel and AGM, with one exception. A variation on the AGM referred to as thin plate pure lead or TPPL, has made its way to the recreational marine market. These batteries utilize ultra-pure lead pressed into extremely thin and tightly packed sheets, offering higher energy density, higher maintained terminal voltage and higher charge acceptance rates. If you opt for this route with your next battery replacement, or new vessel acquisition, be certain your charge sources are programmed for this battery technology as it differs slightly from conventional AGM charge protocols.

Alternators and Regulators

It's among today's most common boat building and systems design flaws, relying on stock, off the shelf engine alternators to charge large, often SVRLA battery banks. Conventional, "stock" alternators supplied by engine manufacturers with their engines are designed for a few very specific roles. They are designed to recharge their own engine's starting battery after each start cycle. Interestingly, the amp-hour usage involved in starting even a large diesel engine is often surprisingly small, typically less than one amp-hour (an amp hour is the equivalent of a load of one amp operating for one hour or 3600 amps for one second; the average engine draws about 400 amps for two to three seconds, still less than one amp-hour). Alternators of this sort are often also designed to supply comparatively high amperage, over 100 amps, during the early running stage, while the engine is still cold, supplying power to resistive heating elements located in the air intake manifold. Doing so significantly reduces smoke production. However, when asked to go beyond this comfort zone, stock alternators are simply incapable of coping.

Today, the average house battery bank may be as large as 500 or 750 amp-hours, which means a vessel's alternator or alternators must be capable of continuously producing significant current for hours on end, and herein lies the problem. While many stock alternators are deemed "high output", producing a 100 amps or more, only those with continuous duty ratings are capable of producing this much power indefinitely, without overheating.

In practice, when called upon to do so, conventional alternators chronically undercharge large house battery banks. Once the batteries are fully charged, from other sources like inverter chargers, then stock alternators chronically overcharge battery banks as a result of their excessively high float voltage. It's a lose-lose scenario, with the result being batteries that die an early, and costly death.

The solution to this seemingly vexing and especially common problem involves the installation of proprietary, continuous duty alternators mated to external, "smart" regulators. The latter are an essential element in the alternators/battery charging process. Nearly all continuous duty alternators are capable of accepting external regulation, and in most cases regulators and alternators can be mixed and matched at the discretion of those designing the charging system.

The beauty of utilizing an external regulator lies in its adjustable nature, it's specifically designed to provide an optimum charge for all flooded or SVRLA batteries, using temperature compensation to further tailor the charge to the needs of the battery bank (warm batteries have a lower charge acceptance rate when compared to cool batteries, adjusting the output of the charge source extends battery life).

For twin engine, twin alternator installations it's vitally important

Once unheard of, large, multi-bank inverters have become considerably more common in the past five years. Their output can be equal to that of a medium-size generator. When linked to appropriately sized alternators, they are capable of powering air conditioning systems, ranges and other high current consumers without the need to start, or add wear and tear to, a generator.

that the output of both alternators be synchronized, i.e. they must behave as one alternator. This end can be achieved by using a single regulator to control both alternators or by using twin interconnected regulators that are relegated to master and slave status. Failing to observe the synchronizing protocol often results in one alternator producing little or no current while the other carries the lion's share of the loads, which results in diminished overall output and shortened alternator life.

A carbon pile load tester may be used to determine the health of large, deep cycle batteries. By placing a high resistive load on the battery, and then monitoring its voltage and current draw, an accurate analysis of the battery's condition can be determined.

Chargers and Inverter/Chargers

Chargers and inverter/chargers are your primary means of re-charging and maintaining battery banks while dockside or at anchor, via the generator in the latter case. Much like alternators and their associated regulators, your house charger must be properly sized and programmed for the battery bank it serves. Today, nearly every charger is capable of being programmed so that it will tailor its output to any commonly available battery type, and in some cases specific battery manufacturer's requirements, however, in the vast majority of cases such programming is not carried out, which means the charge profile is incorrect. The result of this all too common scenario is slow recharge rates and/or diminished battery life. The good news is it's often easily rectified. Fully two thirds of the chargers I encounter are improperly programmed. Thus, it is my strong recommendation that you check the programming of yours (as well as your alternator regulator programming), to confirm it's properly set. This is often quite easy and only takes a few minutes, however, if you are unsure call a pro in and ask him or her to confirm, in writing, the settings they've checked or changes made.

If you rely on your charger to replenish your house bank after spending time at anchor, it's important to ensure that it is appropriately sized. If your house bank is 500 amp-hours for instance, and your charger is a model that produces a mere 50-amps, the recharge time will be inordinately long, particularly if you are relying on the generator to do so. High output chargers are available and some are capable of being "ganged", interconnected so they work as one larger charger, rather than fighting each other in the manner described earlier, when discussing disparate alternators.

Finally, ensure that any charge source used to maintain a house battery bank is equipped with the aforementioned temperature compensation option. I say option because in many cases chargers are not shipped with the temperature sensing probe, it must be ordered separately (considering its cost, and value, this makes little sense). If your charger is not equipped with a temperature compensation probe and it was manufactured within the past decade, chances are good it can be equipped with one now.

Particularly where today's larger SVRLA battery banks are concerned, alternators, batteries and chargers, must be thought of as a unified, interdependent system rather than piecemeal components. When thoughtfully designed as a whole, and properly installed, they can be relied upon to deliver reliable, efficient service.

Ideally, intelligent battery chargers should be used for recharging and maintaining all batteries, and especially those of the AGM and gel variety. Such chargers should include variable profile settings for different battery types and even brands, as well as temperature compensation.