Deep Cycle sizing

General

Sizing of Deep Cycle batteries is critical to the performance of electrical items on any in any application,especially in house banks. Insufficient capacity results in systems failure, poor battery performance and shortened battery life.
Excessive capacity results in unnecessary weight, cost and space usage.

To ascertain the correct battery size a simple arithmetic calculation of power usage of each electrical accessory between charging periods (usually daily) is required. From this a calculation of current each accessory uses (amps) multiplied by the duration of use (hrs) gives the ampere hour consumption of the application. Ampere hours is the unit of measurement of battery capacity.

It is a characteristic of lead acid batteries that regular discharges below 50% of capacity will result in a disproportionate reduction in life. When a battery is discharged, up to 85% of capacity can be restored relatively quickly. The remaining 15% required to bring the battery to full charge has to be "trickled" in at relatively low current rates resulting in a full charge time from, say, 50% depth of discharge (DoD), of around 6 to 8 hours. Therefore the best workable capacity results from a battery bank which is 2.5 to 3 times the daily consumption. It is commonly recommended that capacities should be twice daily usage but this sizing results in discharges well below 50% and a significantly shorter recharge time because a larger battery can absorb greater ampere hours before the regulating voltage control causes a tapering down of the charging current.

Remembering that a battery simply stores power it is obvious that the charging capacity coupled with the number of charging hours is equally as critical to good battery performance. Insufficient charging system output or insufficient charging time will result in system failure. If a battery is operated at low levels of charge the battery efficiency is reduced. Failure to periodically bring the battery to full charge will result in reduced battery performance possibly to the point of failure.

The Battery Sizing Calculation [1]

There is an example worksheet attached to this document showing you how you can calculate the size batteries you require, by listing all of the electrical accessories on your boat or motorhome. Include either the current draw in amps of the power usage expressed in watts. This information can be obtained from the specifications contained in the appliance instruction book or from the supplier. Take care to ensure that the true position is indicated. For example, you may have six lights on your boat but realistically only use three at any one time.

Because the battery capacity is expressed in Ampere/hours we need to convert any wattage figures into amps of load. This is simply done by dividing the watts by the system voltage. For example a 12 volt 100 watt spotlight consumes 8.5 amps. 100 divided by 12 equals 8.5.

When extending the figures into the "A/hrs/day" column, only extend the circuits which apply when the house bank is at rest or when the engine is not running. For example the electric clutch on and engine driven compressor drawing eight amps would not be included as the current draw stops when the engine is turned off. However, these current demands need to be taken into account when calculating the available charging current and should be deducted from the alternator output.

Once all of the accessories have been included and their individual consumption calculated, simply add the right hand column. This will provide you with the power usage. From this the battery capacity is established. The power usage calculated should represent between 33% and 40% of the total battery capacity. Please note, whilst this is generally a "daily" figure, individuals may decide that they only wish to run their charging system once every three days. This is possible provided the calculations reflect the number of hours of usage between charges.

Alternator Sizing and Charging Times

Selection of an alternator with an output equal to the daily ampere hour load would result in a required running time of approximately 1.25 hours per day provided the charging voltage is no less than 14.4 volts and the battery capacity is at least 2.5 times the daily a/hr usage. The use of alternators which have a higher output than the daily a/hr usage will reduce engine running time but only within limits unless a larger battery capacity is fitted.

To calculate the required engine running time you can take the daily a/hr usage and divide by the alternator size and multiply by 1.2.

Example: 100 a/hrs per day/80 amp alternator = 1.25 * 1.2 = 1.5hrs.

Additional points worth considering

As mentioned previously, charging of lead acid batteries to fully charged generally takes between 6 and 8 hours but 80% to 90% of charge can be returned in much shorter times. In practice house batteries in boats rarely become fully charged while in use on the water. If the batteries are not periodically taken to a full charged state (say every two to three months) a portion of the capacity is permanently lost. Correct maintenance practices must be followed.

The higher the battery capacity of a battery the greater the ability of the battery to absorb power. This is another reason why correct battery sizing is critical.

Alternator sizing is also very important and sized according to the desired charging time. For example a boat or motorhome with a daily power consumption of 80 ampere hours, a 220 ampere hour battery and a 80 amp output alternator would require approximately 1.25 hours of charging time. Obviously batteries are not 100% efficient and typically absorb between 85% and 90% of the capacity provided by the alternator. Whilst some manufacturers make claims of superior efficiency in practice these differences have no effect. If measurements were made of this system the batteries would operate between 40% and 85% of state of charge. The final 15% of charge can only be "trickled" in and takes several hours.

Care should be taken when working around batteries, particularly when they are on charge of have recently been charged. Batteries emit explosive gases which if ignited can cause serious injury, particularly to the eyes. Safety glasses should be worn at all times when working on or around batteries.

When doing the design for a new installation, or the addition of accessories in an existing boat, it is advisable to take into account possible additions of electrical load. For example if you are considering putting a microwave oven on your boat or motorhome at some stage in the future consideration to the increased load should be made. This may be in the form of allowing for an additional battery bank to be added (say in parallel to the existing one) and also alternator size wherever possible. The addition of an accessory which significantly increases the load on the batteries and charging may stress the system to such an extent that problems will arise. This could be likened to increasing your engine size by say 30% and using the same diameter propeller shaft. You may be able to do this if the original shaft was heavy enough in the first place.

Charging voltages are critical. Small differences in charging voltages (as low as 0.4 volts) can have significant effects. This easily understood when remembering that the voltage rise, which causes charging current to flow, is very low. A 50% discharged battery has a terminal voltage of around 12.2 volts. A charging voltage of 14.0 volts represents 1.8 volt rise. A charging voltage of 14.6 volts (the recommended for flooded deep cycle batteries) provides a rise of 2.4 volts. This is 33% higher than that which is provided by the lower charging voltage. Charging current is proportionally higher and charging time using the higher charging voltage is significantly reduced.

The 14.6 volt charge rate setting also induces gassing within the cells which mixes the electrolyte. Stratification of the electrolyte occurs when charging and discharging of the battery takes place. Discharge produces water which is lighter and floats to the top. Charging produces acid which is heavier and tends to sink to the bottom. Most common cause of poor battery performance is insufficient charging voltages. Lower recharge voltages often result in shortened battery life.

Deep Cycle Batteries for Marine and RV Applications.

1. Construction

Batteries used to provide power for cycling applications need to be constructed differently than engine starting batteries.

Thicker plates - mechanically stronger

More dense active material

Glassmat separator - holds active material in plate

Grid Alloy - reduces grid growth/corrosion

2. Charging Parameters

Batteries fitted into cycling applications need a different charging regime than engine starting batteries. Starting an engine only removes around 1% of the battery capacity. Charging voltages of around 14.0 volts (2.33 volts per cell) are fine. Flooded house batteries require 2.4 to 2.45 vpc (14.4 to 14.7 volts for a 12 volt system). Gelled batteries require 2.3 vpc (13.8 volts) with a maximum of 2.43 vpc (14.6 volts).

These higher charging voltages:

Restore charge in the minimum time

Mix the electrolyte

Drive off sulphation, lengthening life and improving performance.

3. Product Differences

Not all batteries are created equal. In the HELLA ENDURANT BATTERY range the types manufactured for commercial applications rather than recreational will provide superior life and performance. The "Commercial" grade product is generally in 6 volt in the form of the R232 and L16. These sizes have a thicker plate and a are significantly more robust than the 12 volt blocks like the US85, 105 and 130.

4. Positioning the battery.

Installation in the engine room or close to a heat source will reduce life because of an increase rate of internal corrosion.

Links
[1] http://batterytown.co.nz/#/content/3220