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Episode Overview

Be it jump-starting your Jeep or keeping the cold ones crisp, plug in when off the grid with battery options from flooded lead acid to lithium.
Outdoor experts Ben and Lauren host a supercharged chat with Sam and Zac from Hard Korr about the background of batteries, their chemical construction, best uses, compatible charge cycles, safety, and more.
From the crank battery in your car to deep-cycle charging of devices – get to know the batteries that bear the best results out bush.

Shortcuts

Mentioned in this episode

Absorbed Glass Mat (AGM) batteries
Lithium batteries

Hard Korr Battery Box
Hard Korr Voltage Sensitive Relay Kit
Hard Korr Dual Battery Wiring Kit
Solar Chargers
Smart Solar Regulators
Portable Solar Panels
MPPT Portable Power Packs

Types of Batteries

While the most common batteries are found beneath the bonnet of your car, other types include flooded lead acid, Absorbed Glass Mat (AGM), calcium, gel, and lithium. Where AGM batteries are more popular for use at the campsite, the lithium variety are also used as a power source for electronics.

AGM Battery Construction

The AGM battery is comprised of plates segregated by fibreglass mats. The battery's acid and electrolytes are absorbed by the mats, preventing fluidity within the battery. Pressure is then applied to the plates within each cell of the battery's casing.

Vehicle (Crank) Batteries Vs Deep-Cycle (Auxiliary) Batteries

A vehicle battery is otherwise known as a 'crank' or 'start' battery, producing short, sharp bursts of high current ideal for starting an engine. The plates within a crank battery are thinner and its active material less dense, allowing a higher surface area for the chemical reactions to occur. As a result, the battery releases a higher current. Thanks to your vehicle alternator, a crank or start battery can drop a dramatic volume of charge quickly without needing to deeply discharge.
On the contrary, deep-cycle or 'auxiliary' batteries are designed to charge periodically, allowing you to discharge its capacity without damaging the cells. Unlike crank batteries, their plates are thicker, delivering continuous power at a lower current-draw, for longer. This allows prolonged use, deeper discharge, and overall longer service life – boding well for 4WD-ing and camping, and ideal for powering fridges, lights or fans.

Where AGM batteries are more popular for use at the campsite, the Lithium variety are also used as a power source for electronics. Credit: Hard Korr

Don’t Use a Crank Battery as a Deep-Cycle Battery!

Crank or start batteries are not designed for multiple discharge and recharge cycles, unlike deep-cycle varieties. Discharging a crank battery’s full capacity as done with an auxiliary will shorten its service life significantly.

Do secondary car batteries require a corresponding battery chemistry?

The short answer is no. In most to all cases, the crank and auxiliary battery will be of different chemistry and size. Although the crank battery is connected, it is charged via the vehicle’s alternator while the auxiliary battery is charged through a DC-to-DC charger or a Voltage Sensitive Relay (VSR). Given this, the batteries needn’t be of the same chemical makeup.

Considerations for a Dual Battery Set-Up

In the alternate scenario of charging two auxiliary batteries parallel (excluding the crank battery beneath the bonnet), these *are* required to be of the same chemistry. Whilst the crank and auxiliary batteries have opposing charge cycles, a dual battery system where two auxiliary batteries are charging together require a corresponding chemical makeup.

It’s unknown whether the chemistry of the second battery – dual or not – is required to be the same as the crank. However, if connected from the battery, it is accurate to assume they should each be chemically constructed the same way with the same amp-hour charge.

Can you charge a Lithium battery from the alternator?

It’s not ideal. Alternatively, a lithium battery can be charged via a VSR.
The VSR – an isolator – detects the voltage produced by the alternator, charges the battery, then cuts the circuit link when it detects a drop in voltage from the pre-set minimum (i.e. when the car engine has been turned off). Consequently, the crank battery doesn’t discharge from the auxiliary battery charging after the engine stops running.

Charging an Auxiliary Battery with a New Car (Smart Alternators)

While new cars on the market allow the charging of auxiliary batteries via a DC-to-DC charger, older models haven’t required this. This is because newer car models have smart alternators.

Variable Voltage Smart Alternators

One of the two types of smart alternators is the Variable Voltage Alternator, found more commonly in more recent car models. As its purpose is to save power and fuel emissions, this alternator drops below 12.7V when it detects that charging the battery is unnecessary, even when the engine is on.
In these situations, a VSR will not work, given it has inbuilt fixed cut-in and cut-out points. Instead, it will assume the vehicle is off, cut the link, and cease the charging of the auxiliary battery while the vehicle is still running. For this reason, a DC-to-DC charger is necessary for such vehicle types.

Using a DC-to-DC Charger

Where a VSR will only charge a battery to 85% capacity (depending on the battery’s chemistry), a DC-to-DC charger has a more advanced charge program, tailored to the different types of batteries available. After setting in accordance with the battery type, the DC-to-DC charger will charge the battery to 100% capacity. A DC-to-DC charger thus offers benefits, whether your vehicle requires one or not.

Basic Terminology Explained for Beginners

When discussing batteries, Cold Cranking Amps (CCA) often arises as a common term. Cold Cranking Amps are important to look for in a starter battery as opposed to deep-cycle batteries, as kick-starting an engine requires a large volume of power. Cold Cranking Amp measurements are based on a thirty second time limit at a temperature of zero degrees

Fahrenheit.
For example, if a battery has a CCA rating of 600 amps, this means it can deliver 600 amps of power to the starter battery, for 30 seconds in zero degrees Fahrenheit. This needs to happen without it dropping below 7.2V.
While AGM batteries may be an exception, CCAs are irrelevant to deep-cycle batteries such as lithium batteries, as they are unable to exert the high current required to jump-start engines. To jump-start a petrol vehicle, there is 1 CCA required for every 1 cubic inch of displacement in an engine, while diesel engines require 2 CCA per 1 cubic inch. Whilst lithium batteries are still not recommended, it is possible to deliver sufficient amps from other deep-cycle battery types (AGM more commonly) via a high-rated Anderson board. Nonetheless, using deep-cycle batteries to jump-start vehicles should only be attempted in emergencies, as discharging the battery quickly shortens its life span.
Another term commonly referenced in relation to deep cycle batteries is Amp Hours (AH). An amp hour indicates the number of amps a battery can deliver in one hour. Older or lesser quality 100AH lithium batteries can't always deliver that current over one hour, and for this reason Amp Hours are only a theoretical measure. For example, the battery could instead deliver 50 amps over two hours.
In fact, the ultimate current delivered from that battery will differ depending on how quickly it is discharged. This is indicated by the battery's C Rating measurement, which measures the current in which the battery is both charged and discharged. For example, a battery with a 100 Amp Hour and C20 rating indicates that the battery will discharge continually over a 20-hour period.

Comparing Lithium Batteries

In the case of reputable manufacturers, a battery that reads 100 Amp Hours should correspond to a C20 rating. On the contrary, cheaper manufacturers use a rating 20% higher than a C20, in the interest of selling more batteries with less lithium.
Where AGM batteries are more linear, a lithium battery will start at a voltage of 14.2V, drop to 13.2V, hover between this and 12.4V, then finally drop to 10V. Given this, the battery will require an overall 'nominated' figure i.e. an approximation or midpoint. In this case, the nominal voltage would be 12.8V.
Whilst there is no legal requirement to list a C20 rating, there are introductions to new laws that require passing a specific read in order to be accepted into the country. This is in the interest of safety.

Lithium Battery Safety

A poorly constructed lithium battery is dangerous and prone to exploding. It's important to ensure these batteries are manufactured to a high standard before purchasing.
There continues to be oversight of these products to ensure only safely constructed batteries are accepted, with new protocol surrounding this as of recent months.

Using the Right Charge Cycle for Your Battery

In discussing discharging, we're referring to the battery's charge cycle. Depending on the chemistry of the battery in question, a charge cycle indicates the voltage/s delivered at various levels, for different periods of time, in order to reach full charge. This differs to the process of an alternator, which delivers charge straight into the battery.
Different batteries require different charge cycles. For example, while a flooded lead acid battery with 100 Amp Hour is ideally discharged to 50% capacity to maximise service life, a lithium battery is safe to be discharged to 80%. That said, a lithium battery can realistically discharge to 99% at a pinch, and – depending on their chemistry – other batteries can be discharged to 70%-80% of their capacity. Nonetheless, habitually discharging to below its ideal capacity will drop a battery's service life.
After heavy discharging of a flooded lead acid battery, an equalization program is required to be introduced every 28 days. The process ensures all cells are of an equal voltage, undoing the build-up of negative chemicals. Without this, the battery will fail to charge to its full capacity, which in turn decreases its service life.
Where a fully charged lithium battery ranges between 14.2V and 14.4V, an AGM battery at full charge sits at 13.8V. A lithium battery holds its charge for 3-4 months, while an AGM will be at 13.8V for around a month. It is not ideal to store an AGM battery without charge for too long without replenishing.
It is suggested to charge your battery using more advanced chargers, such as DC-to-DC, as much as possible. Solar and DC-to-DC chargers have a pre-programmed cycle to ensure maximum usage of the battery life.
The explanation behind why there's an ideal depth of discharge for batteries is complicated, and beyond the scope of this episode. Essentially, if a charger isn't delivering the voltage required, the battery's charge will simply fail to reach 100%. For example, wherever the amp reading is on 13.6V, the charger will stop.

Charger Types Explained (PWM, DC-to-DC, MPPT)

Types of chargers include Pulse Width Modulation (PWM), DC-to-DC, and Max Power Point Tracking (MPPT). Both PWM and MPPT chargers are types of solar regulators, suited to charging batteries with a solar panel.
The PWM charger gradually charges by moderating the width of the electrical pulses, like a sinewave. The width will either increase or decrease to moderate the charge. In the right circumstances, a MPPT regulator can charge a battery quickly. For instance, if a solar panel's maximum open circuit voltage is high enough, the MPPT takes advantage of that, delivering both a higher current and faster charging.
Cons of MPPT chargers are that they're heavier, less portable, and more advanced in electricity circuitry. The latter means they are less reliable over time, while portability is key when off-road adventuring.
While most people with solar systems on their house have a MPPT controller, the variation of MPPT and PWM controllers in an off-grid system of that size is negligible. In fact, the value of an MPPT charger comes with the larger kilowatt capacity system on a house. This is because the maximum voltage of solar panels on a roof is much higher than that of portable solar

panels.

Why do you need a regulator with a solar panel set-up?

Solar panels give out an open voltage of 22V and close voltage of 19.2V. As delivering 19V into a 12V battery isn't possible, a regulator converts the 19V back to a 12V so it can feed the 12V battery.
Portable power packs are available as all-in-one units with inbuilt MPPT controller, therefore requiring connection to a raw panel. As the power pack has solar input specs, the solar panel output needs to correspond to these. In the case of inbuilt MPPT controllers within battery packs, it is suggested to disconnect the regulator and plug the panel directly into the power pack. Whilst a 24V wouldn't work, it would be rare for a 12V solar panel not to suit that regulator.

Compatibility Between Batteries and Solar Panels

If the rating of a regulator isn't sufficient to handle the current coming from a solar panel, the process won't work. For example, a 40 Amp Hour AGM power pack with inbuilt MPPT and solar input specs of 18-20V with 5 amps fits a 200-watt solar panel. However, the solar panels deliver 11 amps and are unable to regulate down to 5 amps. Essentially, if a regulator only handles a maximum of 5 amps, the panels must correspond to this (i.e. 80-90 watts), where a current that is too high presents the risk of frying the regulator. Whilst most regulators include around 15% of inbuilt 'fat' for protection, it's still recommended not to exceed the ideal current.
A low amp rating doesn't allow too many options for adequate solar panels. Most panels should state the number of amps they're rated to use.

Important Tip if Charging Lithium batteries with an AGM Program

While some batteries such as AGM require a 'float' program – a continuous voltage to keep them floating at a certain charge – such a process will damage a lithium battery due to its difference in design. When releasing a load to power the system's devices, the charger is usually capable of recognizing this.

The Future of AGM and Lithium Batteries

While AGM batteries are currently the more popular choice and accessible option, the advantages of Lithium batteries may see them ultimately prevail as we move forward in the 12-Volt space.
With new technology and the gradual decrease in price of lithium-ion phosphate, it's not out of the question for AGM batteries to eventually phase out in favour of lithium types. Given the fast-charging, long-lasting characteristics of Lithium batteries, and with AGM systems still common, it's possible there will become more of a demand for lithium battery-compatible

appliances and voltage regulators to ensure consistent use and power out of AGM systems.

Limitations of AGM and Lithium Batteries

It's understood that owners of AGM systems can be cut from their load at only a 30% discharge. Certain accessories (an example being a fridge) require certain voltages, which is where AGM batteries can fail. Their chemistry discharges in a linear fashion, i.e. from a full charge of 13.8V to a full discharge of 10.5V, which means the load will inevitably cut out at some point. While voltage regulators are an optional accessory at present, it's hoped that they become more of the future part and parcel.
The main issues with lithium batteries are their price point and safety concerns. Price wise, it's unlikely lithium batteries will reach the same price as AGM batteries anytime soon. Their tolerance of heat is also low, where it is strongly advised to not keep them beneath a bonnet as both a safety and performance consideration. Considering this limitation, lithium batteries indicate an optimal temperature range across three states of use: storage, charging, and discharging.

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Catch you out there!