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Battery Failure Modes

Introduction

This training course deals with the reasons that vehicle batteries fail in service.

It will provide you with information on the reasons for battery failure when in service.

The course consists of the following modules:

Battery failure overview
Battery quality & performance
Service wear and temperature related failure
Sulphation and stratification
Deep cycling & charging
Short circuit, dead cell & internal breaks

Each module has its own training video, downloadable resources and some will be followed by a short multiple-choice test.

Once you have completed all modules there will be a final test to check your understanding and knowledge.

Once passed you will earn a certificate for the completion of this course.

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Module 1 - Battery Failure Overview

Understanding the life cycle and factors that affect the performance and contribute to failure is key to accurate battery problem diagnosis.

Once the condition of a suspect battery has been established it is possible to use this information to identify the reasons for failure.

This can help to prevent further failures for the same reasons by educating end users with good battery care, usage and maintenance guidance.

To do this we must first understand the life cycle of a battery before looking at the reasons for failure.

Module 2 - Battery Quality & Performance

The weight of a battery is a good quality indicator.

Some non-OE branded manufacturers reduce the amount of materials used in construction to keep production costs low.

As the costliest material used is lead, the largest production savings are made by using smaller, thinner and less plates.

Therefore, these lower quality products will weigh less than the OE equivalent.

This affects battery reliability, specification, service performance and life cycle.

Battery performance and lifespan is achieved using a careful balance of plate numbers and electrolyte acid strength.

Some non-OE brands with reduced lead content may use higher concentrations of acid than OE brands to ensures the battery can deliver the specified performance

But this higher acid concentration is more corrosive and accelerates the rate of wear and tear, reducing service life.

It also limits the length of time the specified performance can be maintained.

Therefore, when compared to the OE equivalent, it will deliver the same performance initially, but this will decrease far more quickly.

The life cycle of a battery can be split into three phases formatting, peak and decline.

Each phase can be adversely affected by battery usage and vehicle operating conditions.

Battery Failure Modes

The formatting phase of every battery takes place during the first few operating cycles.

During this phase the plates act like a sponge, absorbing electrolyte, this process also removes any impurities on the plate surface.

This increases the available plate surface area and cold cranking performance.

After formatting, the battery enters the peak phase of power delivery.

It remains in this phase until deteriorating conditions such as normal service wear and tear and corrosion reduce performance.

At this point it enters the decline phase and its performance steadily decreases until it is not able to produce the current required to crank the engine.

On some non-OE batteries, the peak phase of optimum power delivery is much shorter and the decline phase leading to battery failure is much faster.

Module 3 - Service Wear & Temperature Related Failure

As we have already covered in the mandatory courses it is essential that the correct battery technology and specification is applicated to vehicle type and driving habits.

Even when applicated correctly a battery is still a consumable item and will deteriorate through the effects of normal wear and tear.

When in service, each time a battery is cycled it loses a small amount of performance.

Over time this natural aging process affects the battery's state of health and its ability to provide enough cold cranking amps for engine starting.

Factors such as operating conditions and temperature can affect the speed at which a battery deteriorates.

Therefore, its precise length of service life is impossible to predict accurately.

Further information can be found in the battery testing and warranty handling course.

Cold weather battery failure is caused by low battery temperatures and increased vehicle cold cranking requirements.

Low temperatures slow down the chemical reaction between the battery's plates and the electrolyte.

At 0°C a fully charged battery loses approxi-mately 30 percent of its cranking performance.

So even a new battery will only deliver around two thirds of the specified performance at this temperature.

If the battery has been subjected to wear and tear this 30% loss of efficiency may take it below the level of cranking performance needed to start the engine.

As the temperature falls further cranking performance losses increase.

Additionally, reduced temperatures increase the engines cranking requirements as the oil is more viscous and the engine components have a higher resistance to rotation.

This increased engine starting requirement added to the battery performance losses are the reasons for cold weather battery failure.

During warmer weather, average under bonnet or ambient temperatures over 60°C accelerate the break-up of negative plate material and increase electrolyte evaporation.

A 10°C rise in battery temperature doubles the self-discharge rate from approximately 0.1 to 0.2 volts per month.

Both factors significantly reduce battery service life.

Module 4 - Sulphation & Stratification

Battery failure can also be caused by sulphation.

Normal battery discharge results in the conver-sion of acid into water and plate material into lead sulphate.

Known as sulphation this is visible as a white grey coating on the positive and a non-metallic lustre on the negative plates.

If recharged within a short space of time the chemical reaction is reversed removing the sul-phation from the plates converting it back into sulphuric acid.

If the battery is left in a discharged state for a long period of time the sulphation crystals become larger reducing the chargeable plate area.

This coating impedes the recharge process leading to permanent plate damage which can cause short circuits and battery failure.

Plate sulphation is more likely to occur if the battery is:

Installed on an infrequently used vehicle.

Subjected to poor stock control and re-charge procedures prior to fitting.

Undercharged when in service due to loose drive belts, charging system faults or high resistance in battery cables and connections.

Uncontrolled extra electrical loads fitted to the vehicle

The symptoms of sulphation are excessively long charging times and a reduced fully charged voltage.

Another common reason for failure is acid stratification.

Normally the sulphuric acid within the electrolyte solution is equally distributed throughout each of the cells.

Therefore, the entire surface area of each plate is in contact with it.

In a battery with stratified electrolyte, the sulphuric acid is concentrated at the bottom of the cells, resulting in low acid strength in the upper cell area.

This limits the plate activation area, promotes corrosion and reduces the performance of the upper cell region.

The increased acid strength in the lower area artificially raises the voltage so the battery appears fully charged but provides low cranking performance.

The plates in the lower cell area become heavily sulphated resulting in premature battery failure.

Acid stratification can be caused by constantly keeping a battery below 80% state of charge.

Short distance driving while using a lot of elec-trical consumers is a common reason for this.

Acid stratification is also more likely in the win-ter as cold temperatures mean it takes longer to charge the battery.

Module 5 - Deep Cycling & Charging

We will now look at how deep-cycling can cause battery failure.

As a battery is cycled normally, a small amount of the plate material is permanently lost as it reacts with the acid in the electrolyte to produce current.

Deeply discharging a starter battery to 35% or more will cause permanent and irreversible dam-age.

If fully recharged rapidly after the deep discharge large amounts of plate material are lost.

If not fully recharged, excessive grid corrosion will occur.

Both conditions will result in premature failure.

This type of failure is common on taxis, delivery and passenger service vehicles.

Overcharging can occur if the vehicle charging system or alternator is faulty, or if incorrect off-vehicle charging procedures and equipment are used.

In this scenario, the battery will overheat causing electrolyte evaporation, break-up of the positive plates and premature failure.

Tell-tale signs of overcharging include a strong hydrogen sulphide or rotten egg odour, low electrolyte levels, and a black coating on cell filler plugs.

Undercharging is the opposite of overcharging and occurs if the battery does not receive enough charge to charge it fully.

If undercharging is left undiagnosed it slowly causes plate sulphation to occur.

The causes of undercharging are usually the same as those for plate sulphation.

Module 6 - Short Circuit, Dead Cell & Internal Breaks

Short circuit, dead cell and internal break conditions are typically seen within the first 12 months of a battery's service life.

It is possible to identify a short circuit or dead cell with most conductance testers.

A voltage of approximately 10.50 volts on a fully charged battery is usually also an indication of a dead cell.

An internal break results in the battery circuit becoming incomplete and no voltage will register when tested.