GS Yuasa E-Learning Support Documentation

New Product Knowledge

Overview:

This support documentation has been designed to work in conjunction with the GS Yuasa e-learning course “New Product Knowledge” and covers of the following subjects:

- **Modern vehicle emission control**
- **Introduction to new battery technologies**
- **AGM battery**
- **EFB battery**
- **AGM battery care**

Modern vehicle emission control

Regulations & legislation

Because of current increasing global warming issues, the environmental pressures on vehicle manufacturers to reduce their vehicle exhaust Carbon Dioxide (CO_2) emissions and improve fuel economy has now been reinforced with EU Legislation. This new EU legislation on emissions targets passed in 2009 commits vehicle manufacturers to cut the average CO_2 emissions from new vehicles to 130g/km by 2015 and 95g/km by 2020.

Various methods are being used to influence the vehicle manufacturers to reduce CO_2 emissions from their vehicles which include:

- Increased costs of vehicle duty
- Increased fuel taxation
- Increased frequency of inner city road toll charges

Other costs to be introduced on high emission vehicles include a government “Showroom tax” on new vehicles which is proposed to be increased over forthcoming years based on fleet average emissions of vehicles made by a manufacturer.

Legislation discussions have stated figures of up to 250€/gram of CO_2/km may be charged based on the manufacturer’s average fleet emissions which exceed the legislative level for the time between reduction targets This charge will be applied to every vehicle sold by that manufacturer.

Based on figures published by the Department of Energy and Climate Change DECC (2012), in 2009 motor vehicles contributed 69.7 million tons of CO_2 to the UK atmosphere which is 13.8% of the total published CO_2 emissions in the UK. The UK average new car CO_2 emissions in 2004 was 171.4 grams of CO_2/km compared to the 2011 reduction target of 138.1grams of CO_2/km which equates to a 19% reduction.

Eco initiatives & solutions

To meet the growing environmental challenges posed by the introduction of emissions legislation, vehicle manufacturers have developed various eco-solutions to help drivers save fuel and reduce vehicle CO_2 emissions. Some initiatives are related to changes in the battery technology and requirements and some are not, for example:

- Tyre Pressure Monitoring System (TPMS) which informs the driver via a dashboard warning lamp that tyre pressure(s) are low resulting in reduced fuel economy
- Low rolling resistance tyres to increase vehicle fuel economy by minimising the loss of the energy caused by the repeated cycles of deformation and recovery of the tyre which is dissipated from the tyre in the form of heat
- Gear Shift Indicator that prompts the driver the optimum time to change gear to maximise fuel economy

New radical technologies being introduced include electronic camshafts or electronic valve timing systems which allow the engine tune to be optimised to driving style, improving fuel efficiency and reducing emissions. There has also been an increase in the volume of full hybrid and electric vehicles introduced into manufacturers ranges to meet increased market demand for improved fuel economy and emissions reduction.

Micro-hybrid solutions

Micro-hybrid eco solutions include start - stop, charge management and regenerative braking which require changes in battery technology to support their implementation.

Start - Stop

Start - stop is a fully automatic system that, switches off the engine when the vehicle is stationary. The engine is then restarted automatically by releasing the brake and depressing the accelerator pedal or clutch pedal dependent on transmission type. This system dramatically increases the number of engine starts the battery must deliver.

A standard ignition vehicle may start a few times a day whereas on a start - stop vehicle this figure could easily reach 75 or more. The battery also supports all electrical loads on the vehicle whilst the engine is not running, and it is not being charged.

Start - stop vehicles must be able to determine if the engine can restart when the engine has been switched off. Therefore, new electronic methods of monitoring the battery status are required.

Charge management

It is likely that vehicle owners would not be aware of the installation of this technology as its operation is seamless, unlike Start - Stop which is clearly detectable as the engine stops if all system operating conditions are fulfilled when the vehicle comes to rest

When the alternator is charging it can consume up to 10% of engine power. Charge management systems monitor battery status and the vehicles electrical consumption. The system controls the alternator and can suspend charging depending on battery status and vehicle operating conditions which improves fuel economy but also increases battery loads. Use of this system requires the battery to support all electrical loads even though the battery is not fully charged. Therefore, a battery that is optimized for partial state of charge operation and has a dramatically increased cyclic life is needed.

Regenerative braking

Regenerative braking systems harvest the kinetic energy normally lost when decelerating or braking. This is then converted into electricity by the alternator and stored in the battery.

The alternator is activated only when the accelerator is released, or the brake applied. When the accelerator is depressed, the alternator is switched off ensuring full engine power is directed to the drive wheels.

The system monitors battery charge level and if this falls below a threshold level it will continue to charge the battery even during acceleration to prevent complete discharge.

A conventional technology battery is very inefficient when utilized in in a regenerative braking system. This type of battery is only able to reuse approximately 5 to 15% of the recovered energy due to its relatively high internal resistance. New battery technology developments such as EFB and AGM with reduced internal resistances provide more efficient use of the recovered energy.

Introduction to new battery technologies

The ever-growing requirement for more efficient, cleaner and technologically advanced vehicles means that the prevalence of vehicles featuring the previously mentioned systems has increased to approximately 70-80% of all vehicles produced in Europe since 2015.

To meet the requirements of these systems two new battery types have been developed.

AGM technology is installed on high performance vehicles featuring advanced start - stop, charge management and regenerative braking systems and EFB technology is installed on start - stop vehicles with lower specifications.

If a vehicle is fitted with an AGM when manufactured then the replacement must also be an AGM, the same applies for EFB batteries. Failure to comply with this will result in loss of emission reduction system functionality and premature battery failure

AGM battery

Glass mat separators

AGM means absorbed glass mat and may also be known as Valve Regulated Lead Acid or VRLA type battery. These batteries feature thin glass mat separators between their positive and negative plates. The glass mat absorbs the liquid electrolyte trapping it very close to the surface of the plates. This means there is no free electrolyte and no possibility of leakage.

Self-discharge and internal resistance are reduced allowing the discharge and recharge rate to be significantly faster than conventional flooded types.

Due to the thinner separators and lack of an electrolyte reservoir above the plates a higher number of larger plates can be installed in each cell without increasing container size. More plates are packed into each cell increasing pressures which gives exceptional levels of vibration resistance and durability.

AGM construction technologies

The AGM battery features an individual cell valve design that maintains a partial pressure of approximately 2 psi in each cell. This triggers the recombination of Hydrogen & Oxygen into condensed water vapour during battery charging.

The lid features a labyrinth that directs this condensed water vapour back into the battery and prevents any leakage if the battery is tilted. Safety features such as 2 flame arrestors and pressure relief valves protect against damage caused by over-charging and eliminate the risk of any external ignition source entering the battery.

AGM performance and specification

AGM batteries typically deliver a 30 - 40% increase in cold cranking power (CCA) over conventional flooded lead acid battery types resulting in increased engine cranking speeds, shorter engine starting times and reduced CO_2 emissions during the engine start cycle. They also have an increased cyclic durability endurance at deep discharge levels of approximately 50% Depth of Discharge (DOD) which is typically 3 - 6 times that of a standard aftermarket conventional flooded lead acid battery.

The cyclic operation of AGM batteries in a partial state of charge of approximately 50% for original fitment AGM battery is approximately 3 – 5 times that of aftermarket battery. From 2013 model year vehicles this increases to approximately 8 - 12 times that of conventional flooded lead acid battery.

The ability of an AGM battery to accept charge immediately after starting the engine and from energy produced by a regenerative braking system, known as Dynamic Charge Acceptance (DCA) is currently up to 3 times that of a conventional flooded lead acid battery.

EFB battery

Introduction

The EFB is based on a conventional flooded Lead Acid battery design but with improved specification and performance. Like AGM it features increased cyclic durability and an improved ability to accept charge current by various changes to battery design, construction and materials.

EFB technology offers a cost-effective solution for low specification entry level vehicles, where the battery is not operating across such a low range of State of Charge (SOC) as an AGM battery. This is due to the vehicle manufacturer having to reduce vehicle CO_2 emissions by a lower amount to meet EU reduction targets as base line vehicles already have a lower CO_2 emission level than the high performance and specification vehicles where an AGM battery is required.

EFB construction technologies

EFB batteries feature an increased number of thinner plates with anti-corrosion additives and lower electrolyte acid content. This reduces internal resistance and improves charge acceptance.

The negative plate active material includes carbon and lithium additives to further improve charge acceptance and the positive plate features high density active material with special additives to increase surface area which improves battery durability, extending service life.

Electrolyte mixing device

Normally the sulphuric acid in a flooded battery is equally distributed throughout each of the cells. However, EFB batteries can be affected by acid stratification. This is when the acid in the electrolyte solution settles at the bottom of the battery leading to permanent damage over time. To prevent this, some EFB batteries feature an electrolyte mixing device to maintain total electrolyte circulation. This utilises accelerating, braking and cornering forces to create a pressure difference between the lower and upper parts of the electrolyte. The pressure difference forces the electrolyte to flow through the mixing device from the bottom to the top of the battery.

EFB performance and specification

EFB batteries typically deliver a 15 - 20% increase in cold cranking power (CCA) over conventional flooded lead acid battery types resulting in increased engine cranking speeds, shorter engine starting times and reduced CO_2 emissions during the engine start cycle. They also have increased cyclic durability endurance at deep discharge levels of approximately 50% Depth of Discharge (DOD) which is typically 2 - 4 times that of a standard aftermarket conventional flooded lead acid battery

The cyclic operation of EFB batteries in a partial state of charge of approximately 50% is approximately 2 – 3 times that of conventional flooded lead acid battery.

The ability of an EFB battery to accept charge immediately after starting the engine and from energy produced by a Regenerative Braking system, known as Dynamic Charge Acceptance (DCA) is currently twice that of a conventional flooded lead acid battery

AGM battery care

Charging

When installed on the vehicle, AGM battery charging voltages are the same as for any standard battery with no need for any special adjustments to the charging system. This is due to the extremely low internal resistance of the AGM battery resulting in almost no heating of the battery even under conditions requiring high charge and discharge currents.

Due to the extremely low internal resistance of AGM batteries, the acid starved design and reduced charging and discharge time it is essential when charging off the vehicle that the correct type of equipment is used.

Constant current or boost chargers **must not** be used as this will result in:

- Heating of the battery
- Boiling of the electrolyte
- Increased internal battery pressure
- Loss of recombinant gases to the atmosphere through the PRV (Pressure Relief Valve)
- Drying out of the battery

All these factors will greatly reduce the lifespan and performance of the battery and cannot be rectified due to the sealed VRLA design. Therefore, GS Yuasa recommend the use of smart chargers that are compatible with AGM type batteries.

NOTE: A conventional flooded lead acid battery should not be installed to OEM equipped AGM or EFB vehicles.