



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**EFFECTIVENESS OF BATTERY CAPACITY ON ENGINE
PERFORMANCE**

This report submitted in accordance with requirement of the Universiti Teknikal
Malaysia Melaka (UTeM) for the Bachelor Degree of Mechanical Engineering
Technology
(Automotive Technology) (Hons.)

by

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DECLARATION

I hereby, declared this report entitled “Effectiveness of battery capacity on engine performance” is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor Degree of Mechanical Engineering Technology (Automotive Technology) with Honours. The member of the supervisory is as follow:

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(Mr.ZainaL Taufik Bin ZainalAriffin)

ABSTRACT

This study was conducted to investigate the performance of the engine and the types of different batteries. Batteries play an important role for the control of a car. One important element in the system of a vehicle. Care wrong battery can cause negative effects to on a vehicle .. Three types of batteries that were used in this study, namely, N60, N70, and DIN100. The study used a water brake dynamometer for engine operation record of horsepower, torque and exhaust emissions.

ABSTRAK

Kajian ini dijalankan untuk mengkaji prestasi enjin dan jenis-jenis bateri yang berbeza. Bateri memainkan peranan penting untuk mengawal sesebuah kereta. Salah satu elemen penting dalam sistem sesebuah kenderaan ialah bateri. Penjagaan bateri yang salah boleh menyebabkan kesan negative kepada sesebuah kenderaan. Tiga jenis bateri yang telah digunakan dalam kajian ini, iaitu N60, N70, dan DIN100. Kajian ini menggunakan enjin dinamometer brek air untuk rekod operasi kuasa kuda, tork dan ekzos pelepasan.

DEDICATIONS

I acknowledge my sincere indebtedness and gratitude to my parents and my family for their love, support and sacrifice throughout my whole life. Their sacrifice had inspired me from the day I born until what I have become today. From the day I have born, they have teach me about how to learn and write. Without them, I cannot achieve the success, I cannot find an appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to achieve what I have today. Lastly, I would like to thanks all person which contributes to my bachelor degree project directly or indirectly. I would like to acknowledge their comments and suggestions, which has crucial for the successful completion of this project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

FTK	-	Fakulti Teknologi Kejuruteraan
gal	-	Gallon
H ₂ O	-	Water
L	-	Litre
pcd	-	Per Capita Per Day
UTeM	-	Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

1.0 Introduction

Chapter 1 is the framework of this project includes brief introduction about the battery capacity, problem statement, objective and scope of this project.

1.1 Background of the Study

Batteries of several technologies are employed in different automotive applications, helping vehicle manufacturers meet EU targets for reduced CO₂ emissions from transport. Advanced lead-based batteries now provide start-stop functionality and other micro-hybrid features in a significant proportion of the new vehicles created in Europe, directly lowering their fuel consumption by 5-10%.

The various grades of hybrid powertrain also require different battery combinations to provide a level of vehicle propulsion, while high-voltage lithium-ion and sodium-nickel chloride batteries have been employed to deliver zero emission driving in Europe's first generation of electric vehicles. This report provides a joint industry analysis of how different types of batteries are used in these automotive applications, with the intention to increase the level of information publicly available on the topic.

A battery is a device for energy in chemical form, which can be released as electricity. The lead acid automotive battery is made up of a series of interconnected cells, each of which has a nominal voltage of 2 volts. There

are 6 cells in a battery, which are connected in series, to give a nominal voltage of 12 volts.

Each cell consists of a number of positive lead peroxide plates and sponge lead negative plates held together by a lead strap. The plates are separated by means of an envelope separator, which enclose the positive plate to offer maximum protection against short circuits.

The cell groups are fitted into 6 compartments in a plastic battery container. A cover which has access for electrolyte through six vent caps is then heat sealed onto the container. Diluted sulphuric acid is used as the electrolyte.

1.2 Problem Statement

Battery is the power source of a vehicle. The specifications of the battery is rarely known by people and they do not know if the battery is compatible with the vehicle. Car users must choose the correct type of battery to their vehicles. Is this will affect the engine performance of the car? In this project, the effect of the battery capacity on the engine performance is analysed.

1.3 Project Objective

Based on the background and problem statement stated above, the objectives of this project are stated below:

1. To study the torque horsepower by an engine using different battery capacity.
2. To study the exhaust EMS of engine using different battery capacity.

1.4 Scope of Project

In order to achieve the objective of this project, several scopes have been identified:

1. Studying the torque and horsepower of Proton Perdana V6 using different battery capacity.
2. Studying the engine performance by using Chassis Dynamometer test with different battery capacity.
3. Studying the exhaust emissions using exhaust gas analyser (EMS).
The material that must be used in the making of this project.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

All types in of automotive and industrial batteries that are used in vehicles on public roads, including lead-based batteries, nickel-metal hydride batteries, lithium-ion batteries and sodium nickel chloride batteries.

2.1 Lead-based batteries

Lead-based batteries are currently the only available mass-market technology for SLI applications in conventional vehicles, including those with start-stop and basic micro-hybrid systems, due to their excellent cold cranking performance, reliability and low cost. Starter batteries of 12V are standardised globally. The handling and behaviour of these batteries is well understood in all EU countries. Advanced lead-based batteries (absorbent glass mat or enhanced flooded batteries) provide start-stop functionality to improve fuel efficiency in all micro- hybrid vehicles currently on the market. In start-stop systems, the internal combustion engine is automatically shut down under braking and rest, reducing fuel consumption by up to 5-10%.³ In addition, some start-stop systems provide for regenerative braking, in which the vehicle's kinetic energy is converted to electricity and stored within the lead based battery. Start-stop systems are already commercialised in several mass-market car models, with Pike Research estimating 37 million units for the global micro-hybrid car market by 2020. In comparison with other battery technologies, lead-based traction batteries are not competitive for use in full hybrid electric vehicles or electric vehicles because of their lower specific energy and higher

weight. However, for all electrified powertrains (from micro-hybrid to full electric vehicles), the 12V board-net and electronic component supply are currently provided by auxiliary 12V lead-based batteries (in addition to the larger traction battery). The 12V lead-based battery is also used to maintain the safety management of the larger traction battery. This is expected to continue for the foreseeable future. All lead-based batteries use the same basic chemistry. In vehicles, three lead-based sub technologies are currently available:

1. Flooded SLI batteries
2. Enhanced flooded batteries (EFB)
3. Absorbent glass mat (AGM) batteries .

2.1.1 Flooded SLI batteries

Because of their lower cost, flooded lead based batteries are used in the vast majority of conventional ICE vehicles to provide starter, lighting and ignition (SLI) functions. Flooded lead-based batteries are characterised by a vented design and an excess of free-flowing electrolyte between and above the electrode stack (Nachhaltige Rohstoffnahe Produktion, Fraunhofer Institut Chemical Technology (2007)).

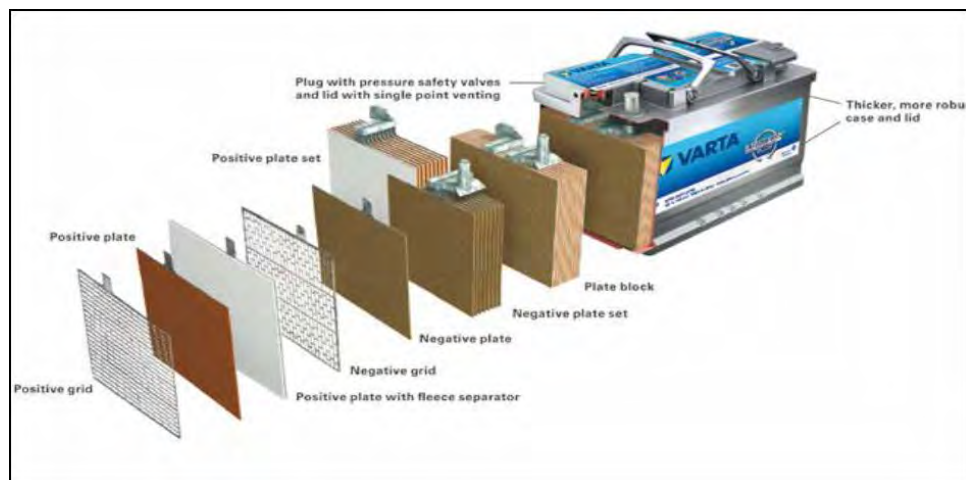


Figure 1 Lead Acid

2.2 Hybrid battery

2.2.1 Nickel-metal hydride batteries

NiMH batteries are primarily used in mild hybrid and full-hybrid vehicles, where they have been the technology of choice over lithium-ion batteries because of their durability and lower cost. At end of life, and in compliance with the Batteries and ELV Directives, all NiMH batteries from automotive applications are collected and recycled. The metals are used predominantly in the steel industry. Conventional nozzles of the air atomizing type in which an auxiliary fluid under pressure, such as air, steam, or other suitable gas, is used to facilitate breaking up a liquid into discrete particles have presented various difficulties. The first and second air passages and the liquid passage terminate in a common atomization zone adjacent the housing outlet where liquid flowing through the liquid passage is atomized into a spray pattern. (Richard et al., 2011).

2.2.2 Nickel-cadmium batteries

NiCd batteries are used in specific industrial applications in which particular performance characteristics are required, including an excellent ability to take mechanical and electrical abuse, an ability to operate at extreme temperatures, and a lower loss of capacity when ageing. Industrial applications include air transportation, train, tram and metro rolling stock, and stand-by uses in extreme weather conditions. NiCd batteries are no longer used in vehicles, and are only available as spare parts for vehicles put on the market before 2008.

2.2.3 Nickel-Zinc and Nickel-Iron Batteries

This report does not analyse nickel-zinc (NiZn) and nickel-iron (NiFe) batteries in detail, as currently these are not widely used in any automotive application, and this is expected to be the case for the foreseeable future. Both use nickel hydroxide based cathodes and work with a concentrated alkaline electrolyte, while the anode consists of either metallic zinc or iron. NiZn batteries have been the subject of intensive research over several decades, with manufacturers still targeting the automotive segment. However, two main technical challenges still need to be solved under volume production and operating conditions the negative Zn electrode's lack of stability under cycling conditions and the risk of dendrite growth leading to early internal short circuiting. At present, this prevents NiZn batteries from being used in applications where high reliability over a long period of life is requested, including the applications covered in this report (Derived from survey for EUROBAT members).

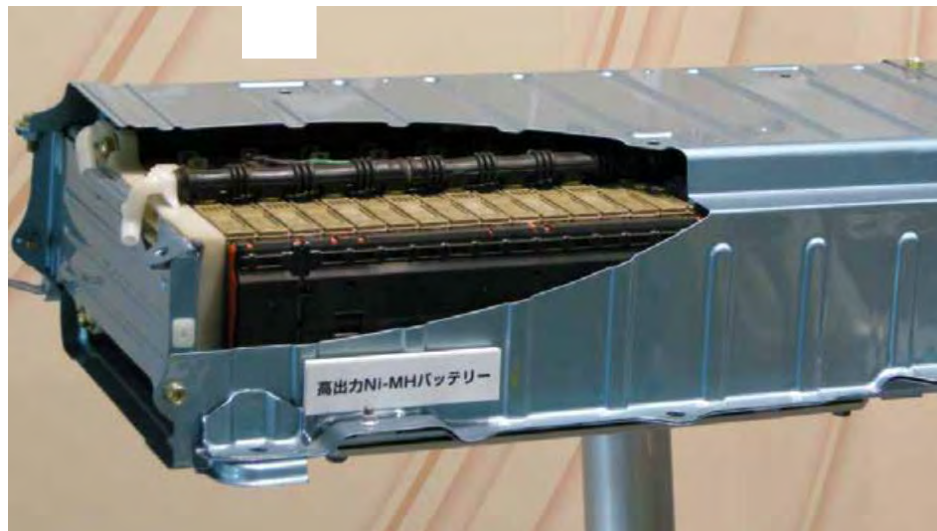


Figure 2 Hybrid

2.3 Lithium-based batteries for automotive application

Lithium-ion batteries are used in hybrid and electric vehicles due to their high energy density and because their relatively greater expense is less of a barrier in these higher-end vehicles. Lithium-ion batteries are also being investigated for use in dual battery applications alongside a lead-based battery. 12V lithium-ion batteries are not expected to become a viable mass market substitute for lead-based starter batteries in the next decade, due to limitations in their cold cranking ability and a higher cost. Early approaches are being undertaken by certain car manufacturers (with research continuing), but have so far been limited to niche applications in which weight savings are the primary driving factor and climatic conditions are not a concern.

2.3.1 Chemistries

There are several active materials used in lithium-ion rechargeable batteries. Systems using metallic lithium as a negative active material are called lithium-metal batteries, while systems based on carbon or lithium titanate as the negative active material are called lithium-ion. The positive active material is a lithiated metal oxide or a mixture of those components. The electrolyte is composed of fluorine-based lithium salts (such as LiPF_6) dissolved in organic carbonate liquid mixtures. Non-aqueous solutions have to be used, as lithium reacts to water. A moisture-proof casing is essential to avoid moisture ingress and evaporation of the organic solvent. While the battery is being charged, the lithium atoms from the positive electrode migrate as ions through the electrolyte toward the negative electrode, where they are deposited between carbon layers. This process is reversed during discharge. Lithium-based batteries are also available as lithium polymer batteries, which can, for example, use a lithium-metal alloy electrode in conjunction with a solid or gel-type electrolyte. Different lithiated metal oxides are used by battery manufacturers in the

battery's cathode or anode, each with unique performance characteristics (Olivier Briat, Jean-Michael Vinassa 2013).

2.4 Components of Lithium-Ion Batteries

There are the components:

1. Various metal oxide-based materials for cathode
2. Carbon based materials for anode
3. Lithium salts
4. Copper for negative substrate and collectors
5. Aluminium or steel for positive substrate and cell case
6. Others (separator, electrolyte, binders)



Figure 3 Lithium Ion

2.4.1 Sodium-based batteries for automotive applications

There are no manufacturers of sodium-sulphur batteries for automotive applications. Sodiumnickelchloride batteries are found especially in electric vehicles and hybrid electric vehicles, including fleets of buses in Bologna, Rome, Lyon, Barcelona and Madrid.

2.4.2 Chemistry

Sodium-based batteries have a high energy density, long cycle life, and can operate in harsh environments (i.e. temperatures from -40°C to +60°C). Unlike many batteries, sodium-based batteries are based on a solid ceramic electrolyte with liquid sodium metal acting as the negative electrode. They operate at an internal temperature of between 250°C to 350°C to keep components in a molten state, which requires thermal insulation against the environment to avoid thermal losses. External heating is required in periods without electrical use to keep the battery ready to operate.

2.4.3 Sodium-Nickel Chloride Technology

The cathode in these batteries is based on nickel (Ni) and common salt (NaCl), while the anode consists of molten sodium (Na). The electrolyte is made up of tetrachloroaluminate of sodium (such as NaAlCl_4), which is a liquid at the operating temperature of the cells. And by a ceramic separator that is conductive only for sodium ions. While the battery is being charged, nickel (Ni) and common salt (NaCl) will form the sodium ions and nickel chloride (NiCl_2). The sodium ions will move through the ceramic and fill up the anodic compartment. The reaction is reversed in discharge and there are no chemical side reactions. When the battery is operated, the heat produced by charging and discharging cycles compensates for the heat loss, and typically no external source is required (Sarah J. Gerssen-Gondelach 2011).