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Procedia Computer Science 76 (2015) 250 – 256

Procedia Computer Science

2015 IEEE International Symposium on Robotics and Intelligent Sensors (IRIS 2015)

Electric Vehicle Battery Modelling and Performance Comparison in Relation to Range Anxiety

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Abstract

In electric vehicle, rechargeable battery served as energy source for all its system operation which include electric motor for propulsion system and also other auxiliary components. Therefore, it becomes an important issue to be tackled in EV technology in order to enhance the battery energy capacity for long range operation. In general public view, people tend to be very concern in purchasing the electric car. One of the concerns lies on the question of how far they can travel with only battery for their car propulsion means. Therefore, this study tries to investigate the relation between battery types and the range anxiety faces by electric car makers. The investigations reveals that, Li-ion as the battery with high energy density cover more area or distance travel.

Peer-review under responsibility of organizing committee of the 2015 IEEE International Symposium on Robotics and Intelligent Sensors (IRIS 2015)

Keywords: Electric Vehicle (EV); range anxiety; battery SOC; battery OCV.

1. Introduction

The emergence of electric vehicle (EV) technology in this era is heavily related to the continuous rising consciousness of global warming, climate changing and crude oil crisis [1]. In electric vehicle, rechargeable battery

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Peer-review under responsibility of organizing committee of the 2015 IEEE International Symposium on Robotics and Intelligent Sensors (IRIS 2015)
doi:10.1016/j.procs.2015.12.350

served as energy source for all its system operation which include electric motor for propulsion system and also other auxiliary component in EV system. Among all the subsystem in EV, the propulsion subsystem itself consumed up to 75% of battery energy to run the car [2]. Therefore, it become an important issue to be tackled in EV technology in order to enhance the battery energy capacity for long range operation.

In general public view, people tend to be very concern in purchasing the electric car. One of the concerns lies on the question of how far they can travel with only battery for their car propulsion means. The lack of exposure on EV technology frequently affect their decision to purchase an electric car [3]. According to the expert, the performance of EV battery in terms of driving range plays a vital role in determining the success of the electric mobility system [4]. This issue raises a concern among car makers as they face "range anxiety" where they worry that the consumer will hesitate to buy an electric car which run only a few miles [5].

Many researches has been done on extending the driving range of EV especially in the area of energy sources. Current development in battery technology listed the Li-ion and NiMH batteries as the major technologies used in EV [5]. The Li-ion recognized as the most potential candidate thanks to its light weight and small size feature. Li-ion battery however is high in cost and have detrimental effect specifically in the battery thermal limitation [5]. Several researches on modeling Li-ion battery are done to improve its performance by manipulating the thermal management system [6]. However, very limited research conducted in regards of the range anxiety faced by EV technology.

Therefore, this study aims to explore and compare the existing battery technology in EV in terms of their driving range. How far the car can go is a key component to be explained in changing the perception of the consumer where the anxiety range becomes a barrier to purchase an EV. Driving range is closely related to the energy capacity of the battery. Battery with high energy capacity will result in longer driving distance. Thus, this study will be focusing on several types of battery used in EV with their performance measurement in terms of travel range and vehicle speed to be compared.

Nomenclature

EV	electric vehicle
HEV	hybrid electric vehicle
SOC	state of charge
OCV	open circuit voltage
Li-ion	lithium ion
NiMH	nickel metal hydrite
NiCd	Nickel cadmium
R_0	resistance of the fully charged battery
i	discharge rate
A	constant discharge current in amps
h	time of discharging in hours
C_{10}	10 hour capacity of the battery in amp-hours

2. Types of battery used in EV

There are several different types of battery used for EV application such as Lead-acid, Nickel-Metal-Hydrite (NiMH), Nickel-Cadmium (NiCd) and Lithium-ion (Li-ion).

2.1. Lead Acid

This type of battery is used in conventional car also for the starting, ignition, lighting and other electrical function. This type of battery were used during the earlier time of EV technology. It is relatively inexpensive however the built of this battery is too heavy and suffer an insufficient range for EV application.

During the charging and discharging process of the electromechanical reaction follows as in equation (1).