Energy Return Factor Analysis of Lithium Polymer Battery During Charge/discharge Cycles

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Abstract— Electricity is the most convenient form of energy. Conversion to other form of energy from electricity is very easy. Unfortunately during the energy conversion process, there will be an energy loss. Most electricity in the Indonesia is generated at power plants that consumed coal and natural gas. These are fossil fuels that emit carbon dioxide that will contribute significantly to global warming. With the national policy to produce electric vehicle, it is necessary to analyse the energy return factor of the battery as a source for electric energy for the electric vehicle. Preliminary study using a commercial lithium polymer battery have showed that the energy return factor is 80.5% and dropping to 80.4% after 100 cycle of 1C charge and 2C discharge regime. Increasing the energy return factor by understanding the effect of charge/discharge regime will be a benefit for the nation reduction use of coal and natural gas consumption. The EIS study also revealed the mechanism reaction in the charge process and its shows that the trend of electrolyte resistance is decreasing within the raise of SOC.

Keywords— Energy return factor, lithium polymer battery, energy conversion, electric vehicle

I. INTRODUCTION

Electricity is the most convenient form of energy that can easily convert into other form of energy such as radiant, heat or mechanical. The first source of continuous electric current was generated using a device that utilize the chemical reaction by Allessandro Volta in 1800 [1,2]. This device was the first primary battery. In 1859 Gaston Plante successfully constructs the first rechargeable battery (secondary battery). Before the invention of the first direct current dynamo machine by Zenobe Gramme in 1869, the secondary battery was charged by Daniell cell or Bunsen Cells [3].

In July, 2012 the National Electric Vehicle programs (Mobil Listrik Nasional/Molina) was initiated by the Indonesian Government. The main purpose of this program was to develop a environmentally and sustain transportation system. One of the main subjects in Molina program was to develop Energy Supply System (ESS) for the electric vehicle (EV). Rechargeable lithium polymer battery was one of the ESS that is going to be used in the EV.

With the use of lithium polymer battery for EV, it is imperative to study the return of energy factor (REF) during charge/discharge process. This is important due to the fact that the battery will be charged using the electric current that come from the State Electric Company (PLN) electrical grid.

In 2012 the State Electric Company (PLN) has installed capacity electricity of 32.901 MW and the total 2012 production up to 200.318 GWh. [4]. World Bank Indicator Report 2010 shows that only 7.8% of this energy is generated using from hydroelectric sources. Others electric power came from 41.4% from coal, 29% from oil, 16.3% from natural gas and 5.5% from other sources including geothermal [5]. These numbers showed that only a fraction of the nation electricity came from the clean and sustain sources. Most of the energy came from the non-renewable and not entirely environment friendly sources.

ERF or energy efficiency can be defined in many ways and different directions. In simple term it is a measure of the amount of energy input needed to provide an amount of energy output.

ERF is can be used as an indicator of how efficient a device or a conversion system uses non-renewable energy compare to an alternative method of producing the same service. Rydh use ERF as an indicator in a photovoltaic and/or conversion system in comparison with the energy being produced from fossil sources [6]. Fig 1 show the energy flow in comparing alternative energy sources to a common energy sources.

During battery a charge/discharge regime, several factors can lower the ERF value. Most of energy lost is due to the conversion of the energy form, some of the factors that affect the ERF value are [7]:

- Power Conversion Efficiency of the chargers being used this is the ERF factor of the energy out of chargers vs energy onto charger