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An Indonesian Standard of Lithium-ion Battery Cell Ferro Phosphate for Electric Vehicle Alications

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Abstract

In general, the process of developing new standards had problems in early the development process. In particular to identify what steps are necessary to develop new standards. Methodology of writing this article was conducted using the methodology of Framework for Analysis, Comparison and Testing of the Standard (FACTS). The results of this paper are the new standard for the Indonesian National Standard of Lithium-ion Battery Cell Ferro Phosphate for Electric Vehicle Alications. The standard of development data is can be use by automotive industrial and also for the government to decide new policy on electric vehicle especially in Indonesia.

Keywords: *standard, cell battery lithium-ion secondary cells, electric vehice and stakeholders*

1. Introduction

The demands of green technology and environmentall friendly vehicles pose a phenomenon that changes the automotive industry from fossil-fuelled vehicles to electric vehicle (hybrid). This phenomenon is evident with more of 100 kinds of electric vehicles have been develop since 1891 until 2008 [1]. The data of electric vehicles around the world since 1990s until 2008 is shown in Figure 1.

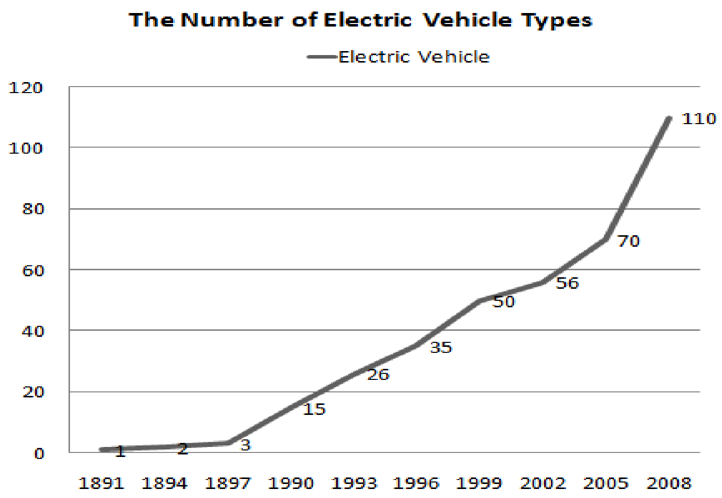

Figure 1. Number of Electric Vehicles [1]

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Based on the phenomenon and rapid changes in automotive industry from fossil-fueled vehicles into vehicles with electrical energy, the government launched a national Electric Vehicle (EV) program. The program is intended to allow the State of Indonesian can prepare and participate to take advantage of the phenomenon of change in the automotive industry [2].

To be able doing the research of electric vehicle, required an electric vehicle standards as a reference the research. Standard product can provide assurance to consumer that the product is according to performance, safety or the production process in form of certification or labeling standards of product produced [3]. Standards can be differentiate products in the market, which is a good product or not. However, due to the unavailability of the Indonesian National Standard or technical specifications of the electric vehicles in Indonesia, have an impact on the lack and the quality of the reference in the national electric vehicle research [4].

The number of components that make up an electric vehicle is inve many aspect, making standard of electric vehicles can not be created for the product in all vehicle parts but per vehicle components. This is in accordance with the decision of the government that Indonesia will develop five standard components of electric vehicles since 2015, one of it which is cell Lithium-ion battery Ferro Phosphate Secondarry for Electric Vehicle Alication [5]. Results from this research is expected to develop the standards in accordance with national capabilities and globally accepted [6].

2. Research Method

In this research, is using Framework for Analysis, Comparison and Testing Standard (FACTS) method. FACTS is methodology developed by National Institute of Standard and Technology (NIST) U.S. which provides a framework for analyzing, comparing and testing standards [7]. FACTS methodology consist of four main steps are shown on Figure 2.

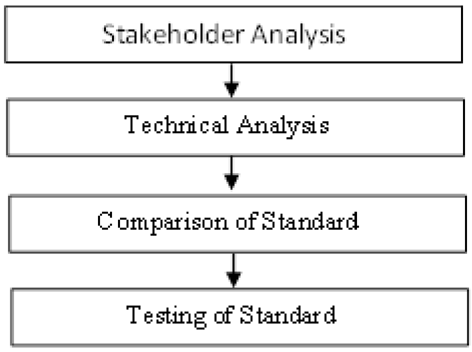

Figure 2. Process stage in this research

The first step taken is to identify who the stakeholders and collect data and their requirements. This step aims to find out what are the reqiurement of stakeholders cell Lithium-ion battery in Indonesia for electric vehicle alications. The following list of stakeholders based an different perspective of governent requirement, R&D battery, laboratory of battery, manufacturers of battery, manufacturers of electric vehicle and users of electric vehicle [8]. Data of stakeholder's requirement are obtained by literature studies. Second step is taken in technical analysis of stakeholder needs. Output of this research is technical data requirement specification of stakeholder cells Lithium-ion battery ferro phosphate for use in electric vehicle alications.

The third step is taken to collect international standards such as International Electrotechnical Commision (IEC) related to cell Lithium-ion secondary battery for electric vehicle alications. Then identified gap and overlap those standards according to the result of technical analysis. The fourth stage is done by combination of the results in analysis of the technical specifications of battery, stakeholders with the results of standard reference gaps and overlaps. The combined results of these steps may be used for any verification testing standards that meet technical specifications stakeholder's electric vehicle batteries. So the results can be used to create the design of the standard formula. The design of standard formula to use as a questionnaire for material to be distributed to the stakeholders then for verification of national capabilities.

3. Results and Discussion

This research consist of four stages as shown in Figure 2. The following description is stakeholder analysis, technical analysis, comparison of standard and testing of standard.

3.1. Stakeholder Analysis

In this phase, identify who the stakeholders and collect data based on their requirements. Data of stakeholders requirement are obtained by literature studies. Here's a quick summary of stakeholder requiremets in Table 1.

Table 1. Stakeholder requirements [9]

Stakeholder	Requirement
Goverment	• Capable of traveling 300 km on a single charge • Fast charging and low emission
R & D Baterry	• Capacity 42,5 mAH/g, energy density 127,5 wh/kg and tage 3 t • Save energy, Heat resistant, Fast charging • Charge time is 2 hours and capable of traveling 100 km on a single charge • Large capacity, energy saving and durable
Laboratory of Battery	• tage stable, ability to pass the over charge test, ability to pass the over discharge test, and able to pass the safety test lithium cells both in performance and abuse test
Manufacturers of Battery	• Do not exploded when a short circuit haen, have 3000 cycle and able to survive in temperatures 70^0C • Long life cycle, do not overheat and fast charging • Capable of traveling 300 km on a single charge
Manufacturers of Electric Vehicle	• Six-cell batteries ca be used in EV if it has the capacity 200 W, charge time is 5 hours and capable of traveling 150 km on a single charge • Large capacity, have 2000 cycle and 6-8 hours charge time • Aged years and capable of traveling 120 km on a single charge • Energy 21 KWh and Capable of traveling 100 km on a single charge • Able to drive the electric motor 40 V, 20 Nm torque and rotation 500 rpm
Users of Electric Vehicle	• Environmentally friendly • The distance travelled long for a single charge and price of EV is less cost

3.2. Technical Analysis

Based on the results of technical analysis, it can be seen that the stakeholders cell Lithium-ion secondary batteries for electric vehicle alications in Indonesia require different types of measurements or tests to ensure that the product has a good quality is: measurment energy density, external short circuit test, heating thermal abuse test, measurment cycle life, energy efficiency measurment, measurment power, storage test, vibration test, test over charge, over discharge test, crush test, impact test, temperature cycling test, altitude test and forced internal short circuit test [11].

In this phase, change the language that expressed by stakeholders into the technical language in Table 2.

Table 2. Technical Analysis [10]

Requirement	Technical Analysis
• Capable of traveling 300 km on a single charge • Fast charging and low emission • Capacity 42,5 mAH/g, energy density 127,5 wh/kg and tage 3 t • Capable of traveling 100 km on a single charge • Large capacity • tage stable • Capable of traveling 300 km on a single charge • Six-cell batteries ca be used in EV if it has the capacity 200 W and capable of traveling 150 km on a single charge • Large capacity • Capable of traveling 120 km on a single charge • Energy 21 Kwh and Capable of traveling 100 km on a single charge • The distance travelled long for a single charge and price of EV is cheap	• Measurment Energy Density
• Save energy • Energy saving	• Measurment Energy Efficiency
• Able to pass the safety test lithium cells both in storage and during test	• Storage Test
• Able to drive the electric motor 40 V, 20 Nm torque and rotation 500 rpm	• Measurment Power
• Durable • Have 3000 cycle • Long life cycle • Have 2000 cycle	• Measurment Cycle Life Characteristic
• Environmentally friendly • Fast charging • Charge time is 2 hours • Able to pass the safety test lithium cells both in performance and abuse test • Do not exploded when a short circuit haen • fast charging	• External Short Circuit Test
• Ability to pass the over charge test	• Over Charge Test
• Ability to pass the over discharge test	• Over Discharge Test
• Able to pass the safety test lithium cells both in performance and abuse test	• Vibration test
• Able to pass the safety test lithium cells both in performance and abuse test	• Shock Test
• Able to pass the safety test lithium cells both in performance and abuse test	• Crush Test
• Able to pass the safety test lithium cells both in performance and abuse test	• Impact Test
• Heat resistant • Able to survive in temperatures 70^{0}C • Do not overheat	• Temperatur Cycling Test
• Heat resistant • Able to survive in temperatures 70^{0}C • Do not overheat	• Heating Abuse Test
• Able to pass the safety test lithium cells both in performance and abuse test	• Altitude Test
• Price of EV is less cost	• The price of EV can become cheap when the battery cell Lithium-ion secondary batteries as an energy source driving the electric vehicle can be produced in their own country (Indonesia)

3.3. Comparison of Standard

In this stage, identification of gaps and overlaps between standards which discusses cell battery Lithium-ion secondary for electric vehicles alications such as: IEC 62660-1: 2010, IEC 62660-2:2010 and IEC 62281:2012. These are three standards chosen based on results focused group discussions among stakeholders.

IEC 62660-1:2010 is standard for secondary Lithium-ion cells for the propulsion of electric road vehicles part 1 that discusses about performance test [12, 13]. IEC 62660-2:2010 is standard for secondary Lithium-ion cells for the propulsion of electric road vehicle part 2 that discuss sbout realibility and abuse test [14, 15]. IEC 62881:2012 is standard for safety of primary and secondary lithium cells and batteries during transport [16, 17]. Comparison of standar is done by adjusted to the result of technical analysis.

Table 3. Comparison of Standard [18]

Measurment/Test	IEC 62660-1:2010	IEC 62660-2:2010	IEC 62881:2012
Energy density	Sub section 7.5	-	-
Energy efficiency	Sub section 7.8	-	-
Storage	Sub section 7.6	-	-
Power	Sub section 7.4	-	-
Cycle life	Sub section 7.7	-	-
External short circuit	-	Sub section 6.3.1	Sub section 6.4.5
Over charge	-	Sub section 6.3.2	Sub section 6.5.1
Over discharge	-	Sub section 6.3.3	Sub section 6.5.2
Vibration	-	Sub section 6.1.1	Sub section 6.4.3
Shock	-	-	Sub section 6.4.4
Crush	-	Sub section 6.3.3	Sub section 6.4.6
Impact	-	-	Sub section 6.4.6
Temperature cyling	-	Sub section 6.2.2	Sub section 6.4.2
Heating abuse	-	Sub section 6.2.1	
Altitude	-	-	Sub section 6.4.1

3.4. Testing of Standard

It this stage, the result of comparison standard can be used to create the design of the standard formula. The design of standard formula then can be used as a questionnaire material to be distributed to stakeholders for verification of national capabilities.

Table 4. Testing of Standard [19]

Measurment or Test	A	B	C	D	E	F
Energy density	*	Yes	*	Yes	*	*
Energy efficiency	*	Yes	*	Yes	*	*
Storage	*	Yes	*	Yes	*	*
Power	*	Yes	*	Yes	*	*
Cycle life	*	Yes	*	Yes	*	*
External short circuit	*	Yes	*	Yes	*	*
Over charge	*	Yes	*	Yes	*	*
Over discharge	*	Yes	*	Yes	*	*
Vibration	*	Yes	*	Yes	*	*
Shock	*	Yes	*	Yes	*	*
Crush	*	Yes	*	Yes	*	*
Impact	*	Yes	*	Yes	*	*
Temperature cyling	*	Yes	*	Yes	*	*
Heating abuse	*	Yes	*	Yes	*	*
Altitude	*	Yes	*	Yes	*	*

Note:
A: Government
B : R&D Batterry
C : Laboratory of Battery
D : Manufacturers of Battery
E : Manufacturers of Electric Vehicle
F : Users Electric Vehicle
• : Being discussed

4. Conclusion

This paper analyze the methodology to develop standard of Indonesian national Standard of Cell Lithium-ion Battery Secondary for Electric Vehicle Alications. The methodology used consist of 4 stages: stakeholder analysis, technical analysis, comparison of standard and testing of standard. Based on the results of processing data, it can be concluded that stakeholders cell Lithium-ion battery in Indonesia requires 15 types of measurement / testing, among others: energy density, external short circuit, heating thermal abuse, cycle life, energy efficiency, power, storage charactheristic test, vibration, over charge, over discharge, crush, impact, temperature cycling, altitude and forced internal short circuit.

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