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Analysis of Technology and Policy Application for Recycling Lithium-ion Batteries To Support National Defense

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Abstract. Indonesia is a country with the richest biodiversity in the world, but Indonesia faces challenges in the field of environmental development. Along with the issuance of Presidential Decree number 55 in 2019 on the acceleration of the electric vehicle environmental challenges and threats to be faced Indonesia is waste Toxic and Hazardous Materials of the lithium-ion battery. This waste can threaten the defense and security of the State in the future. The purpose of this study was to analyze the battery recycling technology right so that it can be applied. The method used in this research is a comparative qualitative methods - descriptive method to analyze and compare the most effective recycling. From two previous studies and interviews with speakers at the Center for Material and Technical Products (B4T) showed that a good recycling technology to be applied is hydrometalurgi for separating compounds of metals and minerals contained in waste batteries. Recycling is beneficial to prevent the waste of natural resources, prevent the importation of raw materials, and prevent an environmental contamination. This technology can be applied and developed by the battery industry, the defense industry, as well as agencies and institutions.

Keywords: recycling, the lithium-ion batteries, the environment, waste batteries, hydrometalurgi

1. Introduction

In today's technology in addition to energy portable electronics, lithium is also regarded as the best technology for sustainable transportation. This assumption is because the lithium battery has a high energy and has a power per unit of battery, thus making it has the characteristics of lighter and smaller size than other rechargeable batteries. Along with the Presidential Decree number 55 in 2019 on the Acceleration Program Motor Vehicle Electrical Based Batteries (Battery Electric Vehicle) for Road Transport, the demand for lithium-ion (Li-ion) in the near future for transportation applications and the industry will be even greater [1] , Besides being used for civilian electronic equipment and electric-based vehicles, lithium batteries are also used in the military. Currently the private Defense Industry engaged in batteries, namely. Garda Persada has

been producing lithium-ion batteries as the energy source of military communications equipment and communication devices that use radio organizations. Each year, the military uses a battery for the purposes of communication devices in large quantities. Lithium-ion battery is also the technology will be developed for renewable energy sources by torpedoes, unmanned air vehicle (UAV), and for other applications such as transceiver station (Lancerdefense, 2018) [2]. For domestic content level (DCL) on battery production has also been stipulated in Presidential Regulation, ie 35% to 80% depending on the usability and year of production. Garda Persada has been producing lithium-ion batteries as the energy source of military communications equipment and communication devices that use radio organizations. Each year, the military uses a battery for the purposes of communication devices in large quantities. Lithium-ion battery is also the technology will be developed for renewable energy sources by torpedoes, unmanned air vehicle (UAV), and for other applications such as transceiver station (Lancerdefense, 2018) [2]. For domestic content level (DCL) on battery production has also been stipulated in Presidential Regulation, ie 35% to 80% depending on the usability and year of production. Garda Persada has been producing lithium-ion batteries as the energy source of military communications equipment and communication devices that use radio organizations. Each year, the military uses a battery for the purposes of communication devices in large quantities. Lithium-ion battery is also the technology will be developed for renewable energy sources by torpedoes, unmanned air vehicle (UAV), and for other applications such as transceiver station (Lancerdefense, 2018) [2]. For domestic content level (DCL) on battery production has also been stipulated in Presidential Regulation, ie 35% to 80% depending on the usability and year of production. Lithium-ion battery is also the technology will be developed for renewable energy sources by torpedoes, unmanned air vehicle (UAV), and for other applications such as transceiver station (Lancerdefense, 2018) [2]. For domestic content level (DCL) on battery production has also been stipulated in Presidential Regulation, ie 35% to 80% depending on the usability and year of production. Lithium-ion battery is also the technology will be developed for renewable energy sources by torpedoes, unmanned air vehicle (UAV), and for other applications such as transceiver station (Lancerdefense, 2018) [2]. For domestic content level (DCL) on battery production has also been stipulated in Presidential Regulation, ie 35% to 80% depending on the usability and year of production.

Source: PT Nipress Tbk., 2016 [3]

Picture 1. Lithium-ion batteries

Various examples of portable lithium-ion batteries have been shown in Figure 1. As a constituent component of lithium-ion batteries are including the following:

Table 1, The composition of lithium batteries

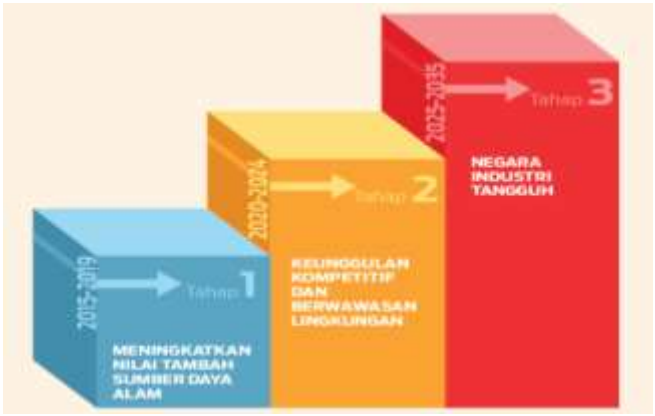
Component	*Amount (wt%)*
Cathode, anode, and the electrode	40 ± 1.5%
plastic box	22 ± 1
steel casing	11 ± 1.5
copper foil	9 ± 0.5
Aluminum coatings	6.5 ± 0.5
Electrolyte	5 ± 1.5
Solvent	5.5 ± 1
Boards and electrical circuits	2.5 ± 0.5

*Source:*Paulino et al. (2008) [4]

As shown in Table 1 that the metal composition of Li-ion battery that is the main Al, Cu, Co, Fe, and Li. The metals found in the cathode and anode of the battery. Usually the anode consists of copper foil coated by a layer of fine carbon cathode while metals Al, Co and Li.

As with other types of batteries, lithium-ion batteries also have a time limit on usage. So a presidential decree number 55 in 2019 on the Acceleration Program-Based Electric Vehicle Batteries (Battery Electric Vehicle) for Road Transport has also set about battery recycling. Lithium battery recycling is important to be implemented because it can recover precious metals such as cobalt (Co), lithium (Li), and other metals contained therein. In addition to preventing waste of natural resources, recycling of lithium batteries also have significant advantages when viewed from the standpoint of environment and health, because these batteries contain reactive materials, organic and inorganic compounds that can be a threat to the environment and also [5].

According to Law No. 3 of 2002 on National Defense, National Defense is any effort intended to defend the sovereignty, the territorial integrity of the Unitary Republic of Indonesia and the safety of the nation from threats, interference, obstacles, and challenges (AGHT) against the integrity of the nation and country , Indonesia has a universal national defense system called "universe". The overall defense system is a defense system that involves all citizens, regions, as well as national resources more, and be prepared early by the government and implemented in total, integrated, focused and sustainable to defend national sovereignty, territorial integrity, and safety of all countries. of all the threats [6]. Threats can be either a physical attack (military) or non-physical (non-military). One of the threats faced by Indonesia is environment pollution. American cooperation with Indonesian institutions USAID (2016) stated that Indonesia is a country with the richest biodiversity in the world, but Indonesia faces challenges in the field of environmental development [7]. When lithium batteries are not recycled then this will add to the problems of the State in the environmental field.



Source: National Industrial Development Master Plan 2015-2035

Picture 2, National Industrial Development Stages

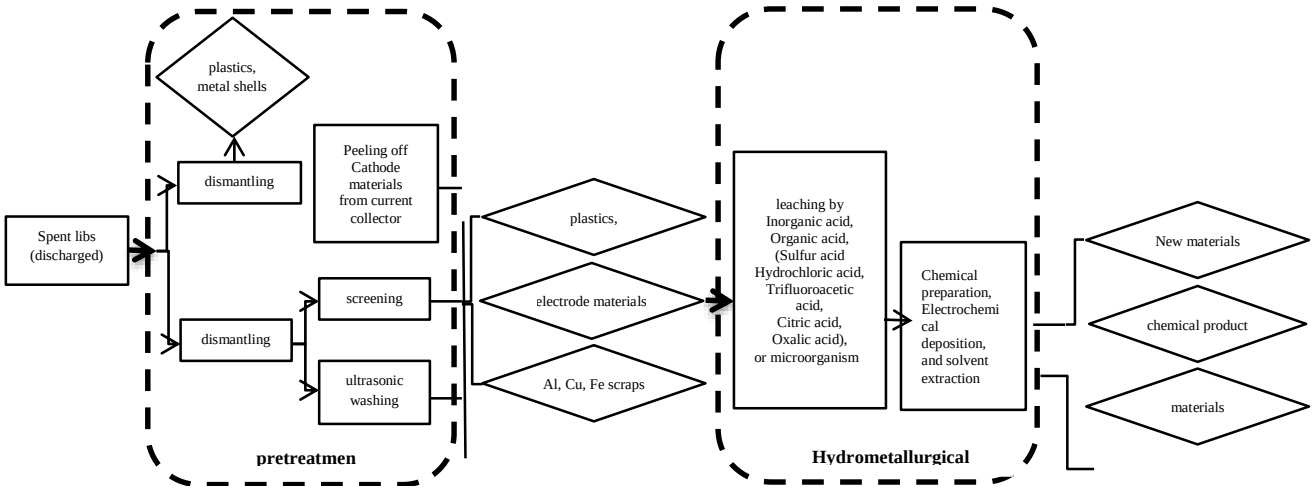
Based on the master plan for development of national industry, national industrial development stage consists of three phases as illustrated in Figure 2. Where the 2nd stage for the years 2020 to 2024 is the development of national industry towards achieving competitive advantage and environmental [8]. Then recycle lithium-ion battery not only has the appeal of green economy and preserving the environment for human beings, but also in line with the national industry development master plan in the 2nd stage.

This study aimed to analyze the battery recycling technology effective to be applied in order to prevent environmental pollution and waste of natural resources. One alternative effective technology is expected to help industry in civil and defense industrial batteries, agencies and institutions to be able to apply and develop these technologies.

2. Previous Research

2.1. Recycling of Lithium-Ion Batteries: Recent Advances and Perspectives. (Bin Huanga, b, Zhefei Pana, Xiangyu Sua, Liang Ana)

Currently, the commercial lithium-ion battery composed of a transition metal oxide or phosphate, aluminum, copper, graphite, lithium salt electrolyte with hazardous organic, polymer separator, and plastic or metal. Disposal of lithium-ion battery causing serious consequences, such as environmental pollution and waste of resources. To overcome this problem, a battery recycling technology innovation. The following methods were used:



Picture 3, Flow chart of the lithium ion battery recycling process

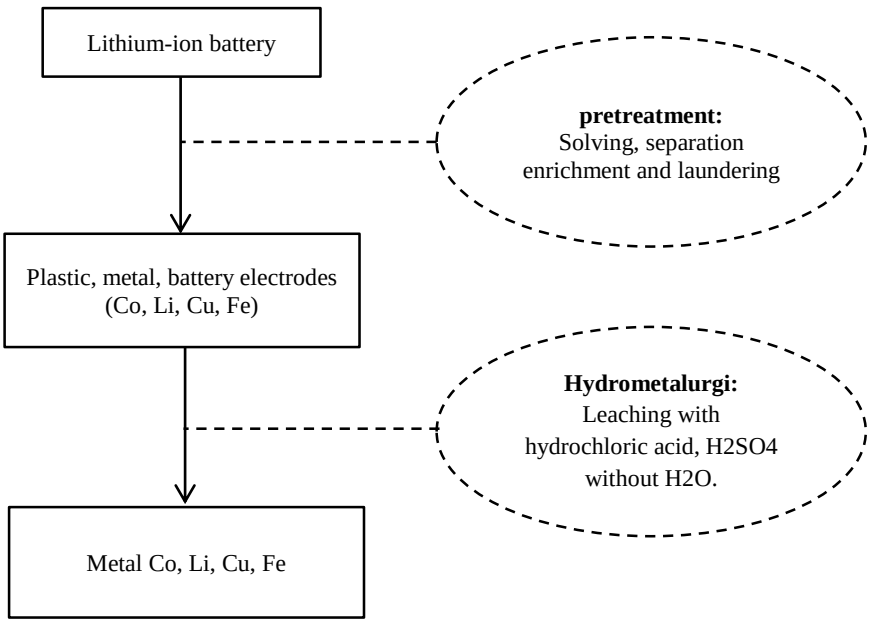
From this research, obtained the pure metals from waste batteries can be used for raw materials [9]. Here are some examples of the metal samples were obtained:

Table 2, Metals And Chemicals Acquired from Battery Recycling Used Lithium-Ion.

Lithium-ion Battery Waste	Obtained products	Purity	recycling process
LiCoO2	Co	~100%	Electrodeposition after leaching
LiCoxNi1-XO2	Ni	~100%	Electrodeposition after leaching and solvent extraction
A mixture of lithium-ion battery waste	Co	99.2%	Electrodeposition after electrochemical leaching
	Cu	99.5%	
	MnO2	96%	
LiCoO2	Co	99.5%	Electrodeposition after leaching and supercritical fluid extraction

2.2. Lithium Battery Recycling Management And Policy (A. R. Rahman and Afroz)

In this research, recycling of lithium-ion batteries hium former focused on the extraction of the active metal cobalt (Co) and lithium (Li). Because the price of cobalt is higher than the price of other metals.



Picture 4. Recycling Process of Lithium-ion Batteries

From the recycling process above results are as follows;

Table 3. Powder Li-ion battery

Element	*Composition (% by weight)*
Together	27.6
Li	3:19
Al	0.92
Ni	0.2
Cu	1.5
Fe	1:35

Table 4. Metals obtained

No.	***Metals obtained (anode / cathode)***	***Weight (g)***
1	Lithium	8,578
2	Cobalt	24.51
3	Aluminum	0.45
4	Copper	2.96

3. Method

This study uses comparative-descriptive qualitative analysis using primary and secondary data. Methods of comparative-descriptive qualitative analysis is the research done by comparing the similarities and differences with one another variable and researched based framework that has been determined [10]. The primary data used in this study was obtained through interviews with the research process recycling of batteries in the great hall of materials and engineering goods (B4T) and secondary data obtained from the study of literature.

4. Result and Discussion

4.1. Result

4.1.1. Analysis of a large hall battery recycling materials and engineering goods (B4T)

From interviews with speakers at the Center for Material and Technical Products (B4T), it is known that the lithium battery imports during 2017 to 2018 experienced a significant increase. The following data import increase of lithium-ion batteries:

Year	**Import Lithium-ion**	**number of Batteries**	**Import Price Total Battery**
2017	For Laptop	3570204	US $ 120 737 585
2017	For Other Electronics	116 954 696	
2018	For Laptop	6528919	US $ 207 092 100
2018	For Other Electronics	200 229 034	
The total increase in imports of batteries			**US $ 86,354,515**

Based on its estimated useful life of digital batteries have a shelf life of 1-3 years. Of electronic equipment will munculmasalah battery waste disposal. Moreover, Indonesia accelerated electric-based vehicles. Where the electric vehicle battery life is 5-8 years.

Waste batteries are hazardous waste and toxic materials that have been regulated under Government Regulation No. 101 of 2014 on Toxic and Hazardous Materials. If the toxic and hazardous substances are not used properly it will cause adverse impact on the environment and the State. Thus the Center for Material and Technical Products (B4T) has started research on recycling of lithium-ion batteries. B4T have done in laboratory scale with dismantling method to retrieve the active material. The focus of this recycling is to take waste material in lithium batteries and materials that can be reused.

4.2. Discussion

Based on research conducted by researchers at one of the research institutes, development, and engineering who were investigating the recycling of lithium-ion battery that is Center for Material and Technical Products (B4T) and conduct an interview with one of the experts in the field of batteries obtained the data that is now Indonesia is in the process of finding the right technology for the recycling of lithium-ion batteries. Technologies that are considered effective and efficient to be applied on an industrial utilization of waste batteries. Battery recycling is regulated in a presidential decree number 55 in 2019 on the Acceleration Program-Based Battery Electric Vehicle (BEV) for Road Transport Battery recycling is carried out as environmental protection and treatment carried out by the agency, Related industries which have waste management permit. To follow up on it, now B4T currently developing research on battery recycling focuses on the synthesis of lithium content of lithium-ion battery waste.

There is a difference from the previous penlitian hydrometalurgi done. In the first study using several kinds of acid and the second study only using hydrochloric acid (HCl) and sulfuric acid (H_2SO_4) without dilution. The first study focused on the separation of one substance or compound, while in the second study. Both studies also have in common, they both transform waste into raw materials using techniques hydrometalurgi. Both of these studies did not use the remanufacturing techniques (reuse) or repurposing (stasionaer storage applications and the like).

The lithium battery recycling in addition to saving the environment from pollution recycling also has economic benefits, such as saving natural resources and energy, and reduce imports [11]. As has been stated in the policy-based acceleration of the electric vehicle, that the production of domestic battery should contain domestic component level (DCL), which has been determined at 35% to 80% in the period 2020-2024 year. For the raw material of nickel (Ni) and cobalt (Co) is available in Morowali. Kemeterian industry (2019) stated that PT. QMB New Energy Materials has a construction capacity of 50,000 tons of nickel and 4,000 tonnes of cobalt for battery production [12]. As for the lithium source is definitely not available in Indonesia. By using the recycling method, it can prevent the waste of Nickel (Ni), cobalt (Co), and also can obtain lithium in used batteries so it can be reused to prevent imports. This recycling is also one solution fulfilling the raw materials in the supply chain of lithium-ion battery production.

5. Conclusion

Based on the results of this study concluded that the recycling method that can be applied is hydrometalurgi. The method can be obtained through metal compounds that can be used as raw material for the manufacture of lithium-ion battery back. When the recycling policy can be implemented well, it can prevent the waste of natural resources, prevent imports, and prevent environmental pollution. Besides recycling is one solution to the raw material of lithium-ion battery products. Hydrometalurgi method can be applied by civil battery industry, the defense industry in the field of battery, and the agencies and institutions.

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