Effect of Lithium Battery on Environment

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Abstract:- As we know that lithium is one of the widely used powering sources in today's era. The recharging capacity of the lithium ion battery is quit faster than other electric battery. Apart from the positive side there is a negative impact of the Lithium battery, its extraction requires large amount of water and the released waste from lithium manufacturing effects the environment in multiple ways, the toxic chemical emitted during the lithium extraction pollutes the water, air, and soil. Because lithium cathode degrades over time, these batteries cannot be used in fresh batteries. In this paper we have review the LCA (Life cycle assessment) method to study the effect of Lithium battery on environment.

Keywords:- *LCA, lithium, environment, Toxic.*

I. INTRODUCTION

Lithium is the world's 27th most plentiful element [1]. Spodumenes, the main lithium mineral in the ore, are water insoluble and dilute acids [2].

The lithium battery has played a significant part in powering the advanced world, yet there is concern about its environmental impact. These batteries are utilised in a variety of applications, including mobile phones and electric vehicles. The feature that distinguishes lithium batteries from other electric batteries is that they are more cost effective. When comparing prices for power and range, lithium batteries are the better option. Lithium-ion-batteries can achieve an energy density of 125 to 600 Wh/L, which is significantly higher than any other battery. Whereas a lead-acid battery could take up to 10 hours to recharge, a lithium battery can be recharged in as little as three hours.

However, in addition to the benefits of lithium batteries, they have some negative environmental consequences, as the extraction of lithium requires a large amount of water, up to 500,000 gallons per metric tonner of lithium. The toxic chemical emitted during the lithium extraction pollutes the water, air, and soil. Because lithium cathode degrades over time, these batteries cannot be used in fresh batteries. Lithium battery landfill fires can smolder for years, releasing hazardous chemicals into the atmosphere that affect our breathing and contribute to global warming.

The biggest flaw with these batteries is that they quickly run out of power and must be discarded.

II. REVIEW LITERATURE

From 2013 to 2017, electronic waste was one of the biggest rising waste streams [3]. The rise in waste material necessitates a huge dumb area to dispose of it, which increases the amount of chemicals emitted into the environment [4]. Lithium battery recycling is no longer practiced in Australia, and lithium battery usage has dropped to about 98 percent [5]. An Australian non-profit group (Australian battery recycling project) is now working on battery recycling and environmental management. The goal of this research is to examine the many ways for recycling batteries that are already in use, as well as the cost, material consumed, and environmental application of each method.

III. BACKGROUND

Lithium-ion battery component varies depending upon size, use, and cathode material. A typical lithium ion portable battery is made up of 27.5 percent lithium cobalt oxide, 20.2 percent steel, 16 percent graphite, 14 percent polymer, 9 percent copper, 5.5 percent aluminium, 4.3 percent nickel, and 3.5 percent electrolyte [7][8]. The recycling of portable batteries can be split down into three categories: mechanical, pyro-metallurgical, and hydro-metallurgical processes. Combining these process allows recover the various materials. In the mechanical process, there are two steps. To begin, disassemble the battery and free the components. These techniques may include crushing and shredding [9]. These methods are also used to separate crushed components based on their physical qualities [10]. Magnetic separation, air ballistic separation, and sieving are examples of mechanical processes.

In hydrometallurgical operations, metals are recovered by employing acids or bases to remove metals into a solution [10]. The hydro-metallurgical process comprises mechanical pre-treatment.

Pyrometallurgical methods use high temperatures to recover the materials. These processes may involve pyrolysis, melting, purification, and refining. Pyro-metallurgical methods are not used to recover lithium or organic compounds like paper and plastic [9].

IV. METHODOLOGY

The environmental effect component is analyzed using the wheel of life assessment. The purpose of this product (portable lithium-ion batteries) was to compare the various recycling techniques for these batteries. The opportunity of the analysis only includes the end of life phase of the product life cycle. Human toxicity potential (HTP), terrestrial eco-toxicity potential (TETP), and global warming potential over a 100-year time period were among the effect categories chosen (GWP 100). GBP 100 (kg CO2-

eq) was chosen due to the relevance of measuring the effects of current activities on global warming, whereas HTP and TETP (kg DCB-eq) were chosen due to the end-of-life focus of the research. In current years, the majority of lithium-ion batteries have been transferred to landfills, where the components can be drained into the environment.

The evaluation was performed out using the GaBi LCA program, and all characterization was performed out using the CML 2001-April 2013 database. The data were also normalized in order to compare them to a reference value: the impact of one person over the course of a year. For this normalization, the ‘world year 2000' factors were employed. The results are expressed in terms of the annual effect potential per individual.

V. RESULTS

A. *Recovered materials*

Through a combination of survey findings and secondary sources, data on the process employed and the materials recovered for eight different recycling companies around the world was acquired. Companies that employ both hydrometallurgical and pyro-metallurgical techniques to recover materials from lithium-ion -batteries are referred to as the processes.

Copper and cobalt are recovered by all of the companies in the analysis, as demonstrated in the results. Steel, nickel, and aluminum were also present in the sample, but only in minor quantities. The majority of businesses claimed to be able to recover plastic, while some did not claim to be able to do so using pyro-metallurgical procedures in the first step, which burn organic materials. For energy recovery, all of the remaining firms were converted, land filled, or burnt. Plastics that were dumped on the ground were not considered recovered.

The exclusively pyro-metallurgical method recovered the least number of materials, according to the total survey results. Hydrometallurgical techniques, on the other hand, are more battery-specific and capable of recovering a wide range of materials [11].

Mechanical techniques were used to recover the greatest quantity of materials. According to the survey findings, mechanically separated materials are frequently delivered to specialized recycling facilities for refinement.

B. *Costs*

We questioned the recycling companies if they charge collectors a fee for recycling or if they pay collectors for spent batteries. For the batteries containing cobalt that are commonly purchased by recyclers, there is a strong link between recycling and material value. The majority of batteries purchase spent batteries for processing.

C. *Efficiency*

The recycling efficiency by weight related with the techniques utilized was also requested in the questionnaires addressed to recyclers. Due to privacy concerns, the majority of corporations disallowed this. The maximum feasible recycling efficiency for each company was estimated by considering composition and materials recovered. These efficiency were positive, assuming that all recovered plastic was recycled and that each item was recovered completely. However, if manganese was recovered, it was not cover in the computation because the cathodes were assumed to contain cobalt (shown in table).

Company	Process	Location	Max. calculated efficiency	Provided efficiency
P1	Pyrometallurgical	Europe	55.6%	64.9%
P2	Pyrometallurgical	Europe	31.1%	>65%
M1	Mechanical	Europe	69.6%	-
H1	Hydrometallurgical	Asia	65.3%	-
H2	Hydrometallurgical	North America	57.5%	-
H3	Hydrometallurgical	Asia	55.6%	-
C1	Combination	Europe	50.1%	-
C2	Combination	Europe	69.6%	52.2%

Table 1

For each of the three organizations who responded, the discrepancy between calculated and provided efficiency is large. Company P1 was mentioned as recovering energy from plastic incineration and using recovered carbon as a reducing agent. For firm P2, the maximum computed efficiency is actually lower than the EU batteries directive's requirement (50 percent recovery [11]). According to the survey, they did not retrieve the steel or nickel.

If the efficiency of firm C2 is less than the maximum predicted value, The disparity in efficiency is clearly related to their assumptions that 30% of plastic is recovered in their estimates. Purely mechanical processes, on average, have the highest efficiency (70%) followed by hydrometallurgical and combination processes (60%) and pyro-metallurgical processes (43%) respectively.

D. *Environmental impacts*

The environmental effects of recycling lithium-ion batteries were categorized based on the procedures used and the distance travelled between collections and recycling. A comparison between recycling and landfill was also made. The results of the survey did not provide enough detail to calculate the environmental damages directly. As a result, a Life cycle assessment (LCA) for both the hydrometallurgical and metallurgical processes was carried out utilizing secondary inventory data from 2004 [6]. The inventory data was entered into the GaBi LCA software, and the effects on the three impact categories were calculated. (Table)

Process	GWP 100 (kg CO2-eq)	HTP (kg DCB-eq)	TETP (kg DCB-eq)
Processing	0	0.0558	0
Electricity generation	36.4	3.07	0.0891
Plastics incineration	645	0.402	0.00499
Total	681	3.53	0.0941
Total (PE)	1.63e-11	1.37e-12	8.61e-14

Table 2: Life cycle impact assessment, by pyro-metallurgical process

Process	GWP100 (kgC02-eq)	HTP (kg DCB-eq)	TETP (kg DCB-eq)
Processing	0	0.000783	0.0169
Electricity generation	16	1.36	0.0169
Landfill residue	487	0.449	0.294
Landfill gypsum	817	0.754	0.493
Total	1320	2.57	0.803
Total (PE)	3.16e-11	9.95e-13	7.35e-13

Table 3: Life cycle assessment, by hydrometallurgical process

According to the results of the pyro-metallurgical process, electricity generation has the greatest impact on HTP and TETP, while plastics incineration has the greatest impact on GWP 100. In GaBi, a European distribution of energy sources was assumed for the analysis. However, the effects of power generation differ by country, and these effects may be lessened if a substantial proportion of energy was generated from renewable sources. In the case of plastics incineration, the survey results revealed that plastics do not need to be consumed during the heat treatment step. Before the heat treatment stage, Company P1 used mechanical techniques to separate the polymers.

According to the hydrometallurgical process results, power generation has the greatest impact on HTP, but gypsum and residue landfill has the greatest impact on GWP 100 and TETP.

Currently, waste lithium-ion batteries are not handled in the Australian region. As a result, there are environmental consequences to its export. An examination of the environmental effects was undertaken using Life cycle assessment (LCA) methods to compare shipments to different continents. The distance travelled by road was believed to be the same for all four general locations; hence it was not included in the calculations. Batteries acquired in Australia were likewise assumed to be sent from Sydney. For the analysis, the transport option 'EU-27-Container ship including fuel' was selected in GaBi LCA program. (table)

Location	Distance (by sea)	GWP 100		HTP		TETP	
Units	km	Kg CO2-eq	PE	Kg DCB-eq	PE	Kg DCB-eq	PE
Europe (Rotterdam)	21428	306	7.3e-12	14.1	5.5e-12	0.0446	4.1e-14
North America (Houston)	17112	245	5.9e-12	11.2	4.4e-12	0.0356	3.3e-14
Asia (Singapore)	7914	113	2.7e-12	5.2	2.0e-12	0.0165	1.5e-14
Australia (Sydney)	0	0	0	0	0	0	0

The findings demonstrate that picking recycling places closer to Australia can lessen the environmental impact of recycling batteries. Transporting batteries to Europe also results in a 45 percent rise in GWP 100 impacts for pyro-metallurgical operations and a 550 percent increase in HTP impacts for hydrometallurgical processes. GaBi LCA software was used to calculate the environmental impact of land filling batteries. Due to software restrictions, only the effects of the batteries' nickel, copper, and aluminum content were evaluated. The findings were analyzed using the assumption that 5% of heavy metals were leached to soil [6]. It should be noted that the GWP 100 data were not available via GaBi program.

In terms of GWP 100, landfill had a lower impact than the other methods, but landfill had a higher impact than recycling in both HTP and TETP. When batteries are buried in the ground, the environmental impact is three to four orders of magnitude greater.

VI. CONCLUSIONS

The goal was to look into the many technologies that have recently been employed for recycling lithium-ion batteries, as well as their environmental implications.

Copper, cobalt, and nickel are all often recovered components, according to the findings. On average, pyrometallurgical procedures recovered less material than hydrometallurgical processes, with insufficient data to estimate how many materials were recovered in purely mechanical processes. Six of the eight companies polled claimed to have retrieved the plastic. Only two of the six companies demonstrate that plastic was recycled further. The remainder of the enterprises either sends recovered plastic to landfill, consume plastic incineration with energy recovery, or do not indicate the end process.

The life cycle assessment (LCA) component of the study examined the environmental consequences of hydrometallurgical and pyro-metallurgical processes using secondary life cycle inventory data.

Plastic incineration had the greatest impact on global warming potential, energy production for human toxicity potential, and terrestrial eco-toxicity potential for pyro-metallurgical processes. In terms of hydrometallurgical processes, landfill had the greatest influence on global warming and terrestrial eco-toxicity, while power generation had the greatest impact on human toxicity. Within the global warming potential impact category, the hydrometallurgical process has a bigger impact than pyro-metallurgical and landfill, although landfill has the biggest toxicity impact.

The impact of transporting waste batteries for processing was also discovered to be significant. Transporting batteries from Australia to Europe, for example, was found to increase the potential for human toxicity by 55 percent for hydrometallurgical operations and 45 percent for pyro-metallurgical procedures.

Overall, the findings imply that techniques that use moderate temperatures and can recover plastic should be employed to reduce the environmental impact of recycling portable lithium-ion batteries. Furthermore, the consequences can be reduced by limiting the distance travelled between collections and recycling.

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