Novel Technologies & Methods for Lithium Batteries Expansion of Life Cycle

Vlachou A.K.[1], Kondili M.E.[1,*], Kaldellis J.K.[2]

[1]Optimisation of Production Systems Laboratory, Mechanical Engineering Department, University of West Attica
[2]Soft Energy Applications and Environmental Protection Laboratory, Mechanical Engineering Department, University of West Attica

*corresponding author: e-mail: ekondili@uniwa.gr

Abstract
The technology of Lithium batteries is nowadays greatly developing, as they are an efficient mean of energy storage. Their main use is in electric and electronic devices. Moreover after 2010, these batteries are also used in the development of electric vehicles, an industrial sector which has a high growth rate. Since these technologies are advancing and the quantitative use of Lithium batteries in Europe is expected to increase, a flow of Lithium batteries waste will be generated that will need novel methods to be treated. Therefore, much research should be done focusing on the waste batteries, their collection and possibilities of reuse. Recent approaches in battery recycling are focusing on material separation and partially processed raw material re-use. But concerns about the great amounts of waste, the possible lack of the primary materials included in the batteries and also the possible soil and water contamination, is leading the scientists to find new methods of restoring, reusing and expanding the life cycle of Lithium batteries.
The objective of the present work is to review the current status and future prospects of lithium batteries use and treatment as waste. The increasing importance of Lithium as well as its present applications, the storage and reuse methods as well as its constraints as an energy storage material will be highlighted in the work.
Keywords: Lithium batteries, second life, energy storage materials

1. Introduction

As the demand for electric vehicles alongside with other electric and electronic devices around the world increase, the demand for lithium batteries rises too. Approximately 160,000 tons of consumer batteries, 800,000 tons of automotive batteries and 190,000 tons of industrial batteries enter the European Union every year. (European Commission, 2018). Therefore the need of new methods and technologies that will lead to expand the life cycle of Lithium-ion batteries is essential.

2. Background

2.1. Generally about Lithium ion batteries

Lithium-ion batteries (LIBs) are compact, light, reliable and are an efficient energy density power source; therefore they are an important component of many portable or not electric and electronic devices. Rechargeable LIBs have also many applications in defense, space and aeronautics, in the automotive industry, in energy storage and smart grids.

2.2. Uses and Applications

The two major uses in which Lithium-ion batteries apply, are in the automotive industry, which includes all the electric vehicles such as electric and hybrid cars, electric motorcycles and bicycles and in the most portable electronic devices, such as smartphones, digital cameras, laptops, tablets and electronic cigarettes. Moreover, LIBs are also used as energy storage systems connected to solar systems or as emergency energy storage back ups.

3. The Need to Recycle

3.1. The importance of materials & scarcity

Scientists and experts agree that the extended use of Lithium and other raw metals being used in Lithium-ion batteries, will lead to a future shortage of reserves. This could be prevented by additional and extra development of high-efficient recycling processes, along with Lithium recycling, resulting to pure and sufficiently high quality raw materials. (Hanisch et al., 2015)

3.2. Lithium and other materials

The most extensively used cathode materials in the common “18650” model rechargeable Lithium-ion batteries are Lithium, Cobalt, Nickel, Manganese, Aluminum and Iron.

4. Already Existing Experience

4.1. Reuse of the materials - the current situation

Engineers in Umicore have developed a recycling process to retrieve Cobalt, Nickel and other metals but, as they claim after this procedure the Lithium is left as a byproduct rather than a saleable material. (Hand, 2017). According to a Reuters article, the pyro-metallurgical process generally only yields Cobalt, and Nickel, while Lithium is more difficult and expensive to extract.

Therefore, Lithium usually ends up in waste slag, which can be used as a building material, or is thrown away. However, Umicore uses a combination of pyro-metallurgy and hydrometallurgy processes to retrieve Lithium and rare earths from the waste slag, as well as extracting Cobalt, Nickel, and Copper. (Harvey, 2017)

5. Prospects

5.1. What is the "second use" process

Concerns about the great amounts of waste, the possible lack of the primary materials included in the batteries and also the possible soil and water contamination, is leading the scientists to find new methods of restoring and reusing batteries ("Second use"). In 2014 engineers developed a process as an alternative recycling method for LiFePO4 batteries. This process includes steps to refunctionalize the cathode of already reused cells (Ganter et al., 2014). In 2017 nanoengineers at the University of California San Diego built up a regenerative reusing process that reestablishes utilized cathodes from spent Lithium-ion batteries and makes them to work similarly in the same class as the brand new cells. One of the steps of this process includes the harvest of the degraded cathode particles from an already used battery, then boil them and offer them a thermal treating (Shi et al., 2018).

5.2. What will happen within the next years

Nowadays studies and researches along with recycling companies and automotive industries are showing greater interest in advancing the recycling and re-using methods and technologies, in order to retrieve better percentage of Lithium from spent Lithium-ion cells. Therefore we assume that in the consequent years there is going to be greater improvement leading to achieve more efficient results in this sector. (Chagnes and Swiatowska, 2015)

5.3. Feasibility in Greece

Such a recycling plant to be developed in Greece would be beneficial in many sectors. First and foremost, the marketing and advertising of the factory will help raise public awareness on this major environmental issue, which in the near future is going to escalate as electric vehicles, electric and electronic devises sales will also increase. Moreover such a recycling plant would also have economic benefits for Greece, as it could expand and be able to receive waste batteries and accumulators from the other Balkan countries and other east Mediterranean countries.

5.4. Second life through batteries reuse

International automotive companies are nowadays launching projects, in which they give already used batteries a second life, by using them for energy storage. Reused LIBs have also applications as backup power in renewable energy power systems, in street lighting, in grid management and in charging electric vehicles.

6. Conclusions

While technology makes steps towards to the future and the demand for portable electronic devices, energy storage and hybrid/electric cars will eventually increase within the next years, the demand for Lithium-ion batteries will also increase. Hence, novel technologies in recycling or expanding the life of the already used or "dead" batteries are mandatory to be developed.

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