

## SECTION XVII. TRANSPORT AND TRANSPORT TECHNOLOGIES

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### ANALYSIS OF THE DAMAGE TO THE ENVIRONMENT OF THE LITHIUM-ION BATTERY AS A COMMON TYPE OF BATTERY FOR MODERN ELECTRIC VEHICLES

#### SCIENTIFIC RESEARCH GROUP:

ORCID ID: 0000-0002-1485-0685

**Oleksandr Solarov**  
Ph.D., Associate Professor,  
Associate Professor of the Department of Transport Technologies  
*Sumy National Agrarian University*

**Oleh Klieshch**  
Graduate of the Faculty of Construction and Transport  
*Sumy National Agrarian University*

**Maksym Zarva**  
Graduate of the Faculty of Engineering and Technology  
*Sumy National Agrarian University*

**Yehor Palyvoda**  
Graduate of the Educational and Scientific Institute of Business,  
Economics and Management  
*Sumy State University*

UKRAINE

As far back as the 1970s of the 20th century, there were attempts to invent rechargeable lithium electric batteries, but they were unsuccessful due to the violent reactions of lithium with water, which made it impossible to provide the required level of safety for the relatively safe operation of this type of battery. The first lithium-ion battery was first introduced to the market in 1991.

Lithium is a very active chemical element, due to which a violent reaction with water can cause a fire. Research has found that during the charge and discharge cycle of batteries with metal lithium electrodes, a short circuit can occur inside the battery and the temperature inside the battery can reach the melting temperature of lithium. A strong chemical reaction between the lithium and the electrolyte causes an explosion. Due to the excessive activity of lithium and the danger of its use, the creation of protection systems built into the battery began, thanks to which commercial lithium-ion batteries have the most advanced protection compared to other types of batteries. For this reason, it is lithium-ion batteries that have become widely implemented and used in the modern world.

A modern person often uses a lithium-ion type of battery (hereinafter referred to as the battery) on a daily basis, because the lithium-ion battery is a source of power supply in portable electronics (tablets, smartphones, laptops, digital watches,

cameras), is used in backup power systems, solar batteries, wind installations [1]. Also, lithium-ion batteries are used by aerial drones [3], in electronic cigarettes, in wireless tools such as a hammer drill, etc., as well as in electric vehicles. Since we are engaged in the study of lithium-ion batteries in the context of transport, we will dwell on the last point we mentioned in detail.

In the modern world, there are many types of electric transport: from electric scooters, bicycles, scooters, to full-fledged cars. The most common type of battery in modern electric vehicles is the lithium-ion battery due to a number of its advantages (table 1). It is installed both in hybrid vehicles, trolleybuses, and in full-fledged electric vehicles [1-2]. Since a large number of batteries are installed in an electric car, it will be convenient for us to monitor the harmfulness of the production of lithium-ion batteries, because we have a large scale. Also, since an electric car is a direct competitor of a car with an internal combustion engine (hereinafter referred to as an internal combustion engine), and this was the topic of one of our previous studies [1], a comparison of the harmfulness of the production of lithium-ion batteries for electric cars will be convenient against the background of the harmfulness of using cars with an internal combustion engine. due to which the automotive industry began the transition to electric vehicles.

Table 1

#### **Advantages of lithium-ion battery**

1	Self-discharge of the battery (slow discharge of the battery when it is not used) occurs about 3-4 times slower than in similar types of batteries.
2	Lithium-ion batteries take up 50-80% less space, which ensures attractive compactness for manufacturers.
3	Lithium-ion batteries have 60-80% less weight compared to lead-acid batteries.
4	If a lithium-ion battery type is used in the uninterruptible power supply system (hereinafter referred to as the UPS), then a smaller number of batteries must be replaced during the entire service life.
5	Lithium-ion batteries are more durable due to their chemical composition and technology.
6	No need for maintenance.

*[author's development]*

So far, our research group has provided a brief historical information about lithium-ion batteries and examples of the widespread use of this type of battery in industry, due to the attractiveness of the advantages listed in Table 1. However, the lithium-ion type of battery has a number of disadvantages, the most serious of which is harmful to the environment. Moreover, the harm to the ecology of the lithium-ion battery is present throughout the life cycle of the lithium-ion battery. That is why our research group wants to show the harmfulness and danger of using this type of battery using the example of the life cycle of a lithium-ion battery.

As mentioned in the previous paragraph, damage to ecology occurs from the very beginning of the life cycle. This life cycle in the case of a lithium-ion battery begins with the extraction of the necessary elements for the production of batteries.

Lithium is mined in the Atacama Desert (Chile) and 2 million liters of water are needed to extract one ton of lithium. Such a mining process deals a severe blow to the local ecology. Also, the production of batteries requires cobalt, which is mined in the terribly dangerous mines of the Democratic Republic of the Congo, with the use of mass slave labor, and the Congo owns the vast majority of the world's cobalt reserves. However, these metals are a non-renewable resource, just like oil and natural kerosene, which are used by cars with internal combustion engines, so it is

wrong to say that electric cars are environmentally friendly, because only for the production of the components necessary for them, humanity violates the environment and uses, as in the case of cars with DVZ, limited resources.

The next stage of the life cycle is the production of batteries. The operation of a factory for the production of batteries requires, first of all, significant energy resources. In general, more than 60% of all electricity is produced at thermal power plants (TPP), about 20% - at hydroelectric power plants (HEP), about 17% - at nuclear power plants (NPP), and about 1% - at geothermal, tidal, solar, wind power plants [1]. Therefore, the production of lithium-ion batteries at enterprises is already dangerous for the environment, because most of the energy they consume is produced by burning coal and oil (we also take into account the process of extracting these resources for power plants).

Another harmful factor in the production of batteries is the emission of harmful substances, such as acids and solvents, which pollute not only the air, but also the soil and water, making the land unsuitable for agriculture. However, another major disadvantage of lithium-ion battery production is the harmful effects on the health of the workers working in the production. Contact with solvents, acids, lithium alloys leads to irritation of the skin, eyes and respiratory tract due to inhalation of harmful particles. Note that we have given only a very short list of harmful effects for workers, but even this is enough to conclude that people who work in these harmful enterprises and have constant contact with these chemicals cause significant damage to their health and sometimes they can become disabled.

The use of ready-made lithium-ion batteries is again closely intertwined with electricity. As mentioned in the previous paragraphs, most of the world's electricity is produced by burning coal and oil, so the fact that an electric car does not emit emissions during its movement does not make it environmentally friendly.

The end of the life cycle of a lithium-ion battery is the disposal of the spent battery. There are several methods of disposal: hydrometallurgy, pyrometallurgy, mechanical processing and hermetic disposal. Humanity continues to improve in this direction, however, at the current stage, the process of battery disposal is still dangerous for the environment, at least because battery disposal companies use electrical energy produced in an «impure way».

**Conclusion.** Analyzing all of the above, we can come to the conclusion that currently the lithium-ion battery is environmentally dangerous, because its life cycle is at all stages: from the stage of resource extraction to the stage of disposal; is accompanied by the release of harmful substances into the atmosphere, limited extraction of resources, causing great harm to the health of workers and people living near these enterprises, is also accompanied by soil and water pollution, as a result of which the animal and plant world of the planet suffers.

We can consider an electric car as an idea of "clean transport", which is powered by renewable energy sources and has minimal impact on the environment during production, because the production process and the process of further exploitation are accompanied by damage to the planet's ecosystem, in many ways precisely because of the production and use of batteries powered by "dirty energy".

Therefore, at the moment, the lithium-ion battery, although it is advanced compared to other types of batteries, it poses a great danger to everything on our planet, and until humanity comes up with a breakthrough battery or invents a truly environmentally friendly way clean production of the battery at all its stages (otherwise then it cannot be considered environmentally friendly); the lithium-ion battery in the future will be the cause of a new global environmental catastrophe,

which we partially talked about in our previous study, where we questioned the need for a complete transition of humanity to an electric car in modern conditions.

However, new types of alternative fuels exist and are being developed in the world, which will be the subject of our future research.

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