Hong Kong Student Science Project Competition 2023
Template of Extended Abstract (Investigation Design Proposal)
(Word Limit: 1,600 words, Pages: 3 pages only)

Team Number: SDBC145

Project Title: Aluminium-air battery car

Project Type: Investigation Design Proposal

***To our best knowledge, there are** *similar works in the field*; (if there are,) related research links are as below:**

Mori, R. (2020). Recent developments for aluminium–air batteries. Electrochemical Energy Reviews, 3, 344-369.

The enhancement our project proposed / the difference with related research are:

For the design of aluminium-air battery, it is based on research by Mori. The research is about the development of aluminium-air batteries introducing several components and methods to make each part of the cell. One of its combinations is used to make the new aluminium-air battery used in electric vehicle (EV).

Please delete if not applicable. The competition values the originality of works. Students must do enough literature research to ensure that their works are unique and list relevant reference materials before starting research or invention.

I. Background

Electric vehicles (EVs) are becoming more and more common. Lithium-iron phosphate batteries are used in vehicles. However, the technology of the batteries has not yet been well developed. For example, lithium-iron phosphate batteries need to be charged for a couple of hours.

Moreover, the electric motors of a Tesla are hard to turn on in cold temperatures. Although aluminium-air batteries cannot be charged, they can be recycled after use and most importantly, thay can be operated in cold temperatures. Also, aluminium wastes can be used to make the anode of the aluminium-air batteries. It is hoped that aluminium-air batteries can replace lithium-iron phosphate batteries in electric vehicles.

II. Objective(s)

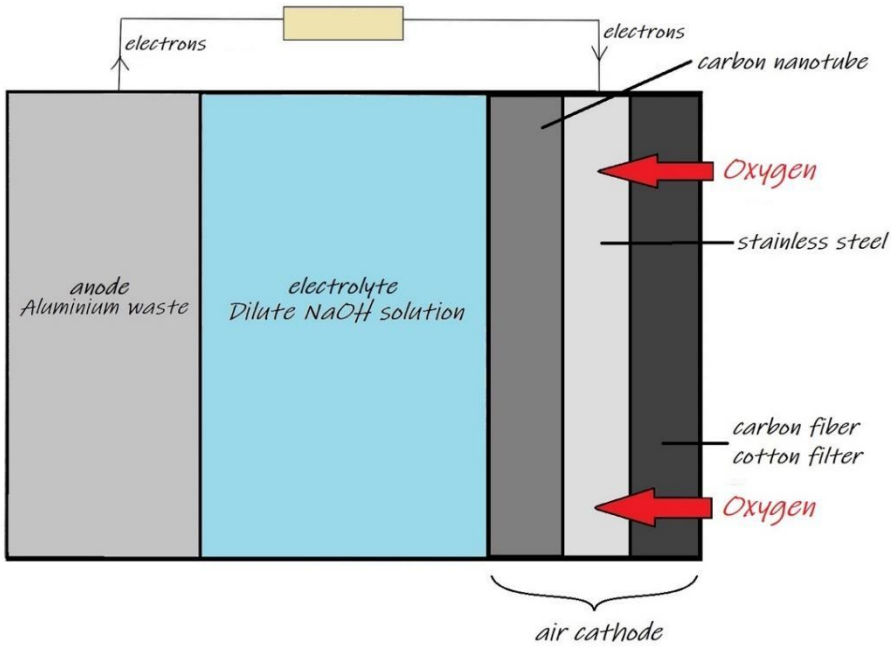
1. To test if EV using aluminium-air batteries can perform better then traditional batteries in cold temperatures.
2. To compare the distances travelled by EV using traditional batteries and aluminium-air batteries at room temperature.
3. To compare the endurance of EV using traditional batteries and aluminium-air batteries in room temperature.

III. Hypothesis

It is expected that when the voltage of the lithium iron phosphate battery and aluminium-air cell is the same, the distance travelled by the EV using the aluminium-air cell is longer under the same time interval.

It is supposed that EVs using aluminium-air cells can operate in cold temperatures such as zero degree Celsius.

IV. Methodology



The overall reaction of the equation in the battery is $4Al+3O_2+6H_2O \rightarrow 4Al(OH)_3$

The NaOH electrolyte can react with the water insoluble $Al(OH)_3$ on the aluminium surface and form a water soluble complex.

The outermost layer of the cathode is a gas diffusion layer which is waterproof. The layer consists a carbon fiber cotton filter. It allows metal–air batteries to absorb oxygen from the surrounding air. Besides, it can enclose batteries to prevent the leakage of aqueous solution electrolytes NaOH.

The innermost layer of the cathode is the catalyst layer. It functions to catalyze the formation of OH^- ion of the battery.

Experiments would be conducted to test the performance of EVs using different types of batteries, under different temperatures and the endurance of the EVs using different types of batteries.

V. Expected Results and Impact of research

Test for performance of the EVs in cold temperature (0°C): It is expected the EV with aluminium-air battery made from aluminium waste can perform well in cold temperature because normal aluminium-air batteries can also perform well in cold temperature, but the lithium-iron phosphate battery cannot.

Test for performance of EVs in room temperature (25°C): It is expected it can perform normally in room temperature because normal aluminium-air batteries can also perform normally as similar as lithium-iron phosphate batteries.

Test for performance of the endurance of the EVs: It is expected the EV with aluminium-air battery made from aluminium waste can travel a further distance than the EV with lithium-iron phosphate battery.

Impact: Firstly, using aluminium waste as a battery material can reduce aluminium wastes. Secondly, replacing lithium-iron phosphate batteries with aluminium-air batteries to start the car can solve the problem of lithium-iron phosphate battery cars and meet the needs of contemporary people. At the same time, aluminium batteries can also be recycled after they are exhausted, which will not pose environmental hazards to future generations.

VI. If your team will compete the Sustainable Development Award, please indicate the specific sustainable development goal the project is related to, and provide justification for compIeting for this award. *(Word limit: 300 words)*

It is related to affordable and clean energy.

1. Aluminium-air batteries are cheaper than lithium-iron-phosphate batteries. They cannot be charged but can be recycled. It is affordable for many people.

2. The reliability of aluminium-air batteries are comparable to lithium-iron-phosphate batteries. It is also expected the power of the electric vehicles with aluminium-air batteries are little lower than lithium-iron-phosphate. Last but not least, it is expected that the endurance of the electric vehicles with aluminium-air batteries are high in cold temperatures.

3.After using the aluminium-air battery, it is easy and convenient to change the battery in the electric vehicles. It is sustainable.

4.Making aluminium-air batteries by using aluminium waste can reduce the amount of use of aluminium. It is environmentally friendly as the batteries can be recycled after use.

It is hoped that the electric vehicles with aluminium-air batteries made by aluminium waste can solve the problems and prevent accidents of lithium-iron-phosphate batteries. While being a blessing to modern people, there will be no troubles for future generations. That is the target of sustainable development.

VII. Conclusion

It is hoped that by replacing lithium-iron phosphate battery with aluminium-air battery by using the aluminium waste in EVs, EVs can operate under cold temperatures and travel a long distance. This provides another safer and cheaper choice for the battery for electric vehicles.