TEAM HERMETICA

presents

Li – ion battery

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Introduction :

A lithium-ion battery or Li-ion battery may be a sort of rechargeable battery. Lithium-ion batteries are commonly used for portable electronics and electric vehicles and are growing in popularity for military and aerospace applications.

In the batteries, lithium ions move from the negative electrode through an electrolyte to the positive electrode during discharge, and back when charging. Li-ion batteries use an intercalated lithium compound because the material at the positive electrode and typically graphite at the negative electrode. The batteries have a high energy density, no memory effect and low self-discharge.

They can however be a security hazard since they contain flammable electrolytes, and if damaged or incorrectly charged can cause explosions and fires.

Such batteries are widely used for electric tools, medical equipment, and other roles. NMC and its derivatives are widely utilized in electric vehicles.

Fig. Lithium Ion battery model

Past Studies:

The very first cell, developed by Alessandro Volta quite 200 years ago was also based upon the concept of electrochemical potential.

There's a general electrochemical potential series consistent with which Lithium has the best electrochemical potential which suggests it has the very best tendency to lose electrons.

Volta took zinc and silver and created a flow of electricity .

In 1991, Sony made the primary commercial model of Lithium Ion Battery which was also based upon the concept of electrochemical potential.

Description:

Lithium-ion batteries, with high energy density (up to 705 Wh/L) and power density (up to 10,000 W/L), exhibit high capacity and great working performance. But temperature, as a critical factor, significantly impacts on the performance of lithium-ion batteries and also limits the appliance of lithium-ion batteries. Moreover, different temperature conditions end in different adverse effects. The suitable temperature region for LIBs normally is −20 °C ~ 60 °C. Both coldness and heat that are outside of this region will cause degradation of performance and irreversible damages, like lithium plating and thermal runaway.

So during this project, thermal management of the battery is connected during a serial way using nano-fluid. We are using nano fluid(mixture of water & aluminium) for reducing battery temperature with the assistance of Ansys software. And the nano-fluid flows from inlet to outlet direction.

For this simulation we are using the NTGK model, which is an empirical correlation developed between current potential and electrochemical potential.

$$\partial \rho CpT/\partial t - \nabla \cdot (k \nabla T) = (\sigma+|\nabla\varphi+|2+\sigma-|\nabla\varphi-|2+\varphi ECh$$

$$\nabla \cdot (\sigma+\nabla \varphi+)=-(jECh)$$

$$\nabla \cdot (\sigma- \nabla \varphi-) = jECh$$

$$jECh=Qnominal/Qref\ Vol \cdot Y [U - (\varphi+ - \varphi-)]$$

The design must be ready to effectively cool the batteries without the utilization of an environment to hold away heat but even be a light-weight and reliable design. This design must include a failsafe within the event of thermal runaway, a drag common to lithium-ion batteries. This failsafe will completely shut off the system if the batteries reach a particular temperature. A cooling system that comes with nano-fluids will achieve a light-weight and efficient way of cooling batteries.

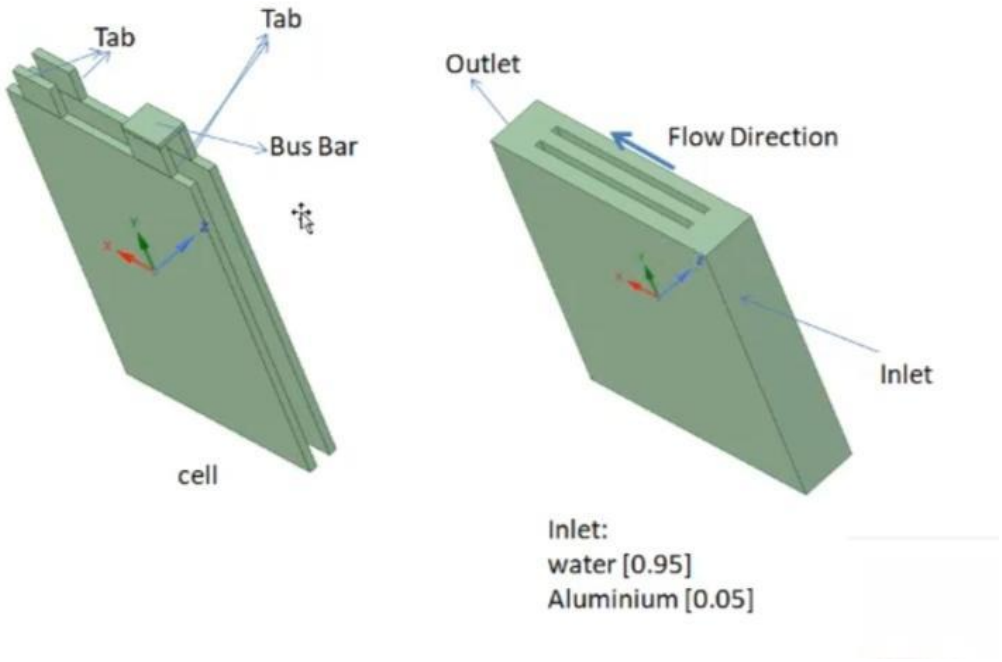


Fig.Descriptive diagram of Lithium-Ion battery

In our project, we have studied the thermal management system of Lithium-Ion module and battery pack when submerging the cells into a secondary thin cylinder filled with water-Al2O3 Nanofluid. For this direct contact of lined to the cell, no circulation of cooling liquid is needed and air is flowing as the working fluid to remove the generated heat.

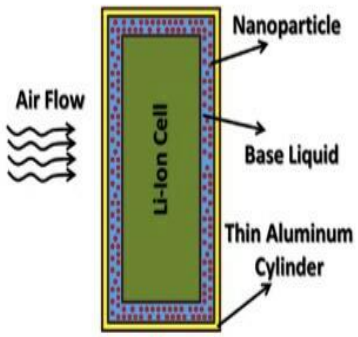


Fig. Physical model of the cooling method

Maximum temperature for various nanoparticles volume fractions.

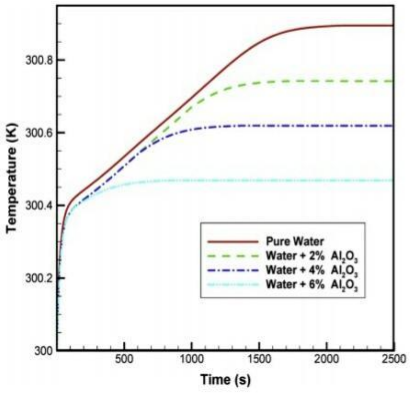
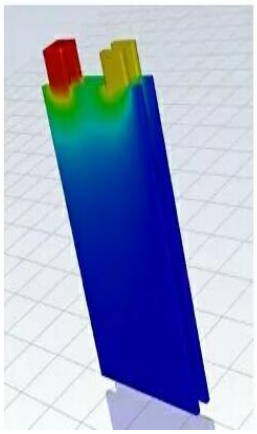
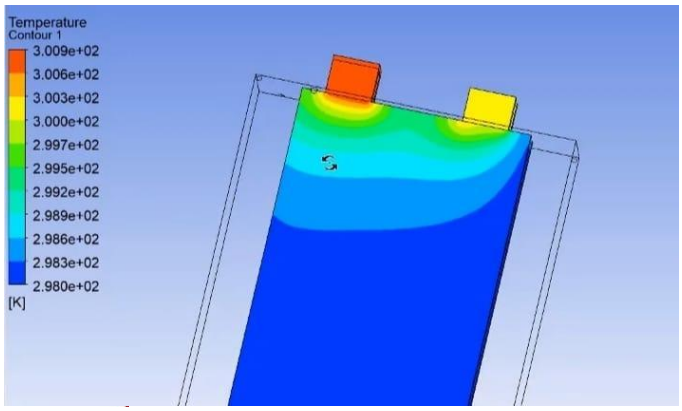
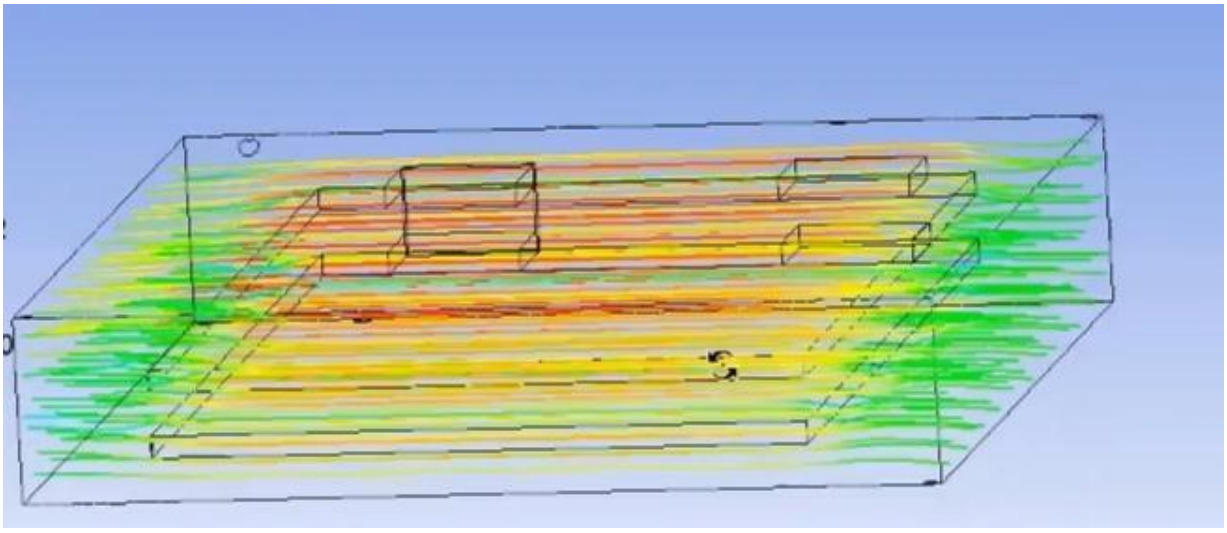


Fig. Variation of temperature with time

These nanofluids have a high coolant tendency, lowering the temperature of the battery, because the battery begins to work , charge flows, and therefore the temperature of the battery steadily rises. We created nano fluid to work in an outer-jacket battery, which extracts heat, lowers battery temperature, and extends the battery's operating range.







Using a secondary thin rectangle filled with water-Al2O3 nanofluid, the thermal management system of a Lithium-Ion module was investigated. The heat produced will condense in the liquid.

The intermediate liquid can absorb a lot of heat due to the close interaction of the liquid. The heat will then be passed to the air circulating around the module by the thin aluminium that surrounds it.

Impact/large scale application:

1.Emergency Power Backup Or UPS (Uninterruptible Power Supply)

Emergency power backup systems benefit critical equipment: computers, communication technology and medical technology.

2. Dependable Electric And RV Power

Lithium batteries offer reliable, stable, long-lasting power – the simplest solution for staying comfortable and safely exploring remote locations. With a lifetime of over ten years, lithium batteries provide power for long journeys and lose little power between uses. Lightweight lithium batteries power your RV or electric vehicle with increased efficiency thanks to reduced weight and size as compared to lead-acid batteries.

3. Reliable and light-weight Marine Performance

Mixing water and electricity provides the potential for varied problems. Lithium batteries allow you to specialise in the fun of being on the water, not on the fear of whether your marine motor starts at the top of an extended day.Upgrading your boat to a long-lasting rechargeable lithium battery gives you years of reliable motor starts at a fraction of the load of a standard lead-acid accumulator .

Whether you would like to power a little trolling motor, or power all of the conveniences of home on a yacht, lithium batteries are capable and dependable.

4. Solar energy Storage

The use of solar energy within the US increased 30% from 2013 to 2014. Even within the desert, there are days when the sun doesn’t shine or times when your solar equipment needs repair. Avoid getting left within the dark with lithium batteries for solar energy storage.

Rechargeable lithium batteries are the simplest match for solar panels thanks to how they charge, and the way fast. Solar panels produce low resistance charging, which is what lithium batteries require.

5. Surveillance Or Alarm Systems In Remote Locations

Don’t let the absence of hard-wired electricity limit your security. does one get to monitor remote perimeters, a fleet of vehicles, job sites, or a short lived location where a permanent alarm.

Rechargeable lithium batteries are ideal for remote monitoring systems thanks to their long life, small size and not losing power via self-discharge during the time that your system is inactive. Lithium batteries have a self-discharge rate that's 10 times less than lead-acid batteries, making them ideal for situations where they're not under continuous use.

6. Personal Freedom With Mobility Equipment

Modern technology has made lifestyle easier for people with mobility restrictions. From electric wheelchairs to stairlifts, numerous individuals depend upon reliable mobility technology to measure an independent life.

7. Portable Power Packs That Eliminate Downtime

Rechargeable lithium batteries are well-known for powering our phones and therefore the latest lightweight laptop computers. Lithium batteries are lighter and smaller than lead-acid batteries. They also tolerate movement and temperature changes, also as they maintain their power delivery during use.

Advantages:

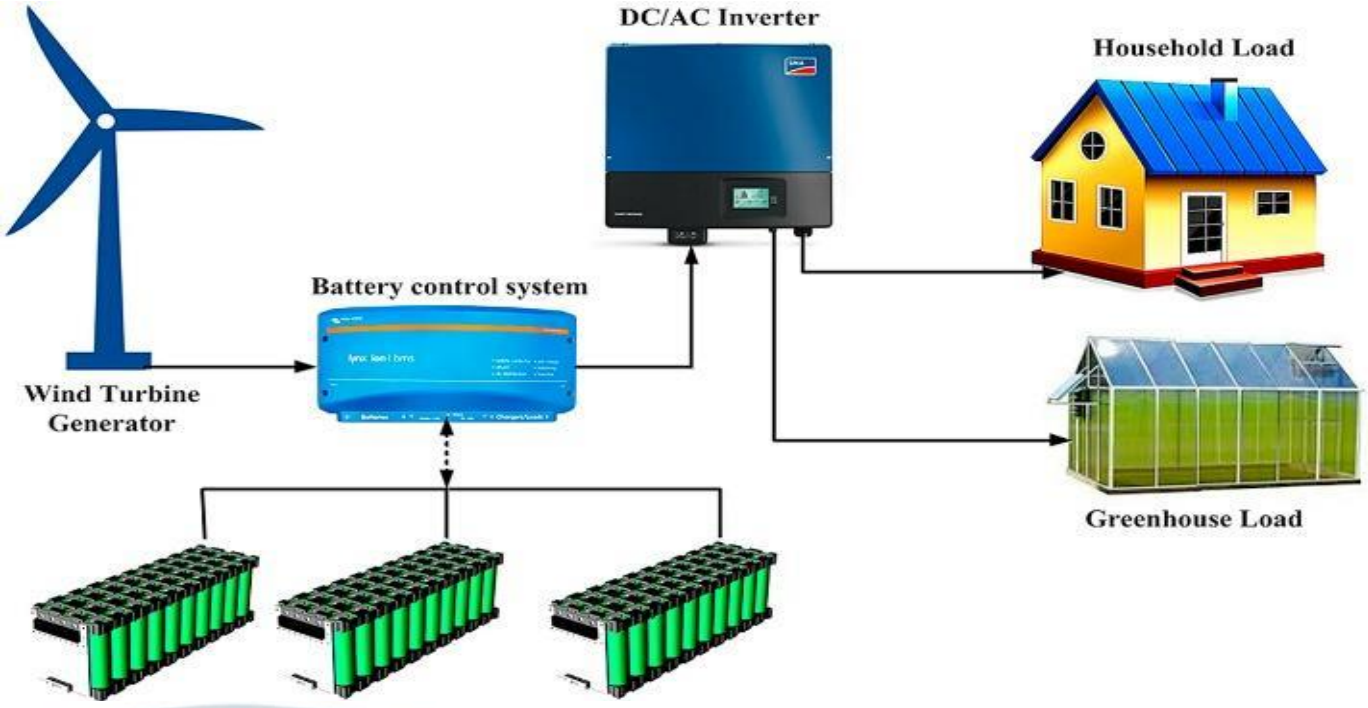
- Weight – Lithium chemistries are nearly always lighter than VRLA or NiMH alternatives.
- High Cycle Life – whilst low as 80% depth of discharge, Lithium batteries often exhibit a cycle life above 1,000 cycles.
- Low Self Discharge Rate – particularly true of primary chemistries.
- Does not need prolonged priming when new. One regular charge is all that's needed. that of nickel-based batteries.
- Low Maintenance - no periodic discharge is needed; there's no memory.
- Eco-friendly features.

Disadvantages:

- Cost – Lithium alternatives are (almost) always costlier than a VRLA or NiMH alternative.
- Safety – again there are exceptions to the present but generally Lithium batteries are often very dangerous if used incorrectly.
- Requires protection circuit to take care of voltage and current within safe limits.

Future Aspects:

Lithium batteries are driving a renaissance in electric-vehicle development, and what's attractive isn't just the charge capacity of current prototypes, which is twice that of the nickel metal hydride batteries in hybrid vehicles. New generation of advanced Li-ion batteries is predicted to be deployed before the primary generation of solid-state batteries. They'll be ideal to be used in applications like Energy Storage Systems for renewables and transportation (marine, railways, aviation and off-road mobility) where high energy, high power and safety is mandatory.



The global automotive lithium-ion battery market was $17.4 billion in 2019 and is predicted to succeed at $95.3 billion by 2030, growing at an estimated CAGR of 17.1 % during the forecast period. Growing demand for electric vehicles, compact size, less charging time and low maintenance cost are a number of the factors that are driving the worldwide automotive lithium-ion battery market. Additionally, the regional government's push towards the adaptability of electrical vehicles (green vehicles), to reduce the carbon footprint, is further, propelling the expansion of the automotive lithium-ion market. However, factors like high cost, thanks to the limited number of automotive lithium-ion battery manufacturing players and therefore the limited number of charging stations are restricting the expansion of the market.

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