MTP Performance Report

- Topic - Design aspects of lithium-ion batteries for electric vehicles.
- Supervisor - Dr Pattabhi Ramaiah

Firstly, data analysis on the temperatures of various Indian cities was done. The data was collected from the WORLD METEOROLOGICAL ORGANIZATION. Climatological information was based on monthly averages for the 48-year period 1953-2000. Data analysis was done with the help of the programming language, Python.

Afterwards, a thorough literature survey is being done. Some of the highlights have been presented below.

Li-ion is considered to be one of the most sophisticated pieces of technology in energy storage right now. It is also the most commercialized technology for its cost to performance ratio.

What we call Li-ion is a family of chemistries. They differ by Cathode material (mostly) or by Anode material. There are major variations that should be included in the Li-ion family or not is debatable, and then there are minor or very custom variations made for very specific purposes. The most common chemistries which are well known and commercialized by multiple companies are:

1. NMC (Nickel Manganese Cobalt)
2. LFP (Lithium Ferro Phosphate or Lithium Iron Phosphate)
3. NCA (Nickel Cobalt Aluminium Oxide)
4. LMO (Lithium Manganese Oxide)
5. LCO (Lithium Cobalt Oxide)

Li-ion cell is made of:
Cathode: NMC, LFP, LMO, NCA, or LCO
Anode: Carbon (In Graphite form) or LTO
Separator: Ceramic or similar material

Electrolyte: Lithium salt (e.g. LiPF6), in organic solvent (e.g. Ethylene Carbonate)
Current Collectors: Aluminium and Copper.

A summary of all the common chemistries has been presented below in a tabular and pictorial form.

Battery	Energy Density (Wh/kg)	Cyclability (Cycles)	Advantages	Disadvantages
LCO	150–190	500–1000	Technological maturity, Low-self discharge, High discharge voltage	High cost, low inherent safety
LMO	100–140	1000–1500	High inherent safety, Cobalt-free	Low energy density
LFP	90–140	up to 2000	High inherent safety	Low energy density
NCA	200–250	1000–1500	Low cobalt content	Capacity fade at elevated temperature
NMC	140–200	1000–2000	Low cobalt content	Safety issues in Ni-rich batteries

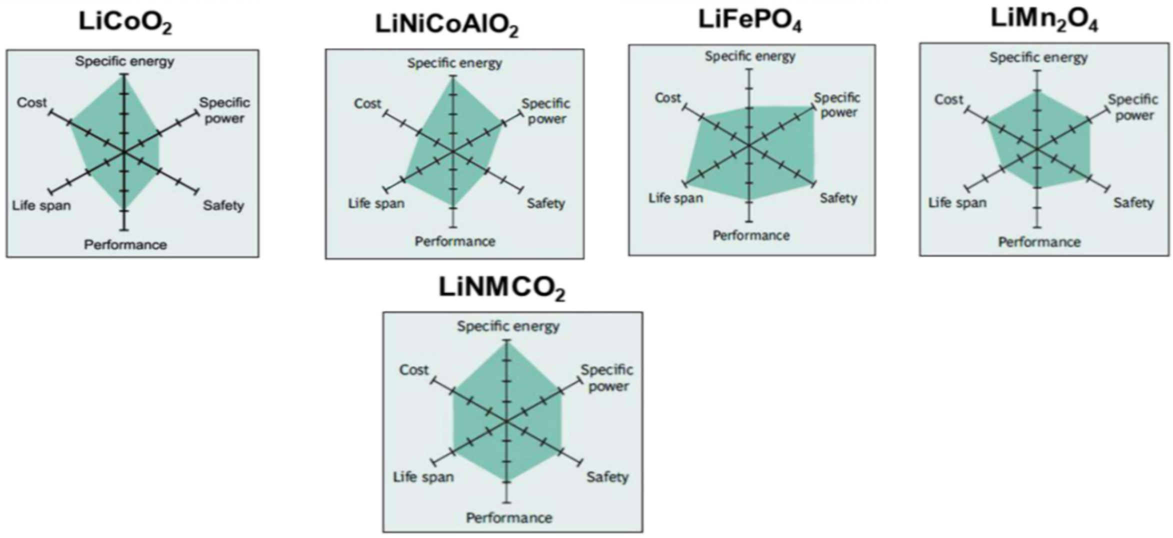

Figure: Comparisons of different types of Li-ion batteries used in EVs.

Clearly, Lithium Nickel Manganese Cobalt Oxide (NMC), Lithium Iron Phosphate (LiFePO4) and Lithium Manganese Oxide (LMO) stand out as being superior among these candidates.

Now I am working towards estimating the influence of cathode materials on the power output characteristics of Lithium-ion batteries. The factors influencing the crack formation and growth in Lithium ions, as well as the cathode material. The simulation of crack growth and hence the performance characteristics will be estimated through molecular dynamics simulations using Large-scale Atomic/Molecular Massively Parallel Simulator (LAMMPS).

References:
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[4] J. M. Paulsen , C. L. Thomas and J. R. Dahn , Layered Li-Mn-Oxide with the O2 Structure: A Cathode Material for Li-Ion Cells which does not Convert to Spinel, J. Electrochem. Soc., 1999, 146 , 3560 —3565

Prateek Gandhi
20SD06011
MTech
Mechanical Systems Design