VOLTEMPO®

Changing the way the world travels

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Introducing Voltempo

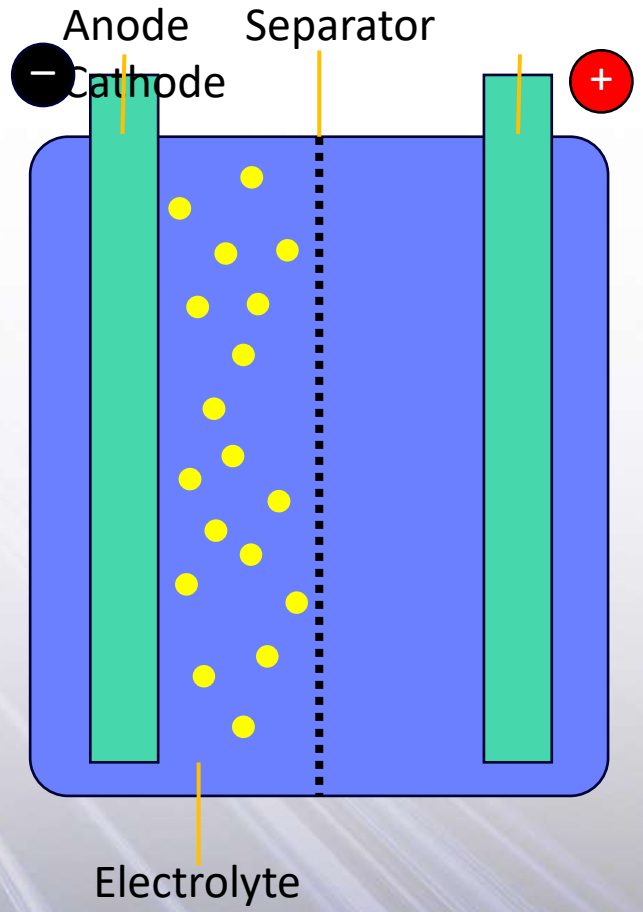
- Voltempo designs and manufactures charging hubs designed specifically for HGVs
- 1MW charging ready for the next generation of vehicles
- We are also running eFREIGHT 2030, one of the consortiums that won ZEHID funding from the Department for Transport (£49.2 million)
- Rolling out a public electric HGV charging network across the UK during 2024 and 2025

About me

- Working with lithium-ion batteries since 1994
- Developed one of the very first lithium-ion battery management systems – used in mobile phones, laptops and industrial hand-held computers
- Working in the EV industry since 2003
- Worked with Nissan, Renault, Mitsubishi, Volvo, Mahindra, TATA and others on battery systems
- Driving my own electric car since 2006
- Worked on the development of two electric commercial vehicles in the early 2010s

All batteries work on the same principle

- A positive end and a negative end (called electrodes)
- Positive is called a cathode
- Negative is called an anode
- There is a separator between the positive and the negative terminals
- There is an electrolyte (either a liquid or a gel) containing ions
- An ion is an atom that has an unequal number of protons and electrons. This makes the atom unstable, and that instability enables it to store and transfer an electrical charge
- When a battery delivers power, electrons flow from one ion to the next, travelling from the anode to the cathode
- When a battery is recharged, electrons flow back from the cathode to the anode



Different battery chemistries change the battery characteristics

- All batteries are a compromise between Power and Energy Storage
  - High power batteries can charge and discharge very quickly, but have low energy density
  - Low power batteries charge and discharge slowly, but have high energy density
- In addition, battery life is important
  - Cycle life (the number of times a battery can be charged and discharged)
  - Chemical life (the number of years before a battery chemically breaks down and becomes unusable)
- Battery Systems Engineers are always looking for the right compromise to deliver the right performance

High Power or High Energy Storage?

Higher Power

- Delivers immediate power
- Charged really quickly
- Can be charged and discharged a greater number of times (charge cycles) – 10-20,000 cycles
- 20 year plus lifespan
- Requires minimal heating and cooling
- More stable battery chemistries

The Compromise

- Can deliver reasonable amounts of power
- Can be charged in around one hour
- Typically around 1,500-2,500 charge cycles
- 7-15 year life
- Requires heating and cooling for intensive applications
- Reasonably stable battery chemistries

Better Energy Storage

- Slower charging and discharging
- Can store significantly more energy in a smaller package
- Has fewer charge cycles before reaching end of life – 200-500 cycles
- 5-7 year life
- Heats up very quickly if charged or discharged too quickly
- Less stable battery chemistries

Today's Battery Chemistries

- LFP – Lithium Iron Phosphate
  - Iron Phosphate provides the stability
  - Lower internal resistance than NMC, requiring less cooling, and less prone to overheating
- Better power delivery than NMC
- Lower energy density – reduced range
- Longer lifespan – 2,000-3,000 cycles

- NMC – Nickel Manganese Cobolt Oxide
  - Nickel provides the energy density
  - Manganese stabilises the battery to prevent them overheating
  - Cobolt enhances the effectiveness of the electrolyte, increasing performance
- Higher energy density – greater range
- Shorter lifespan – 1,000-1,500 cycles
  - Provides a typical car with a 200,000 – 250,000 mile lifespan

Future Battery Chemistries

- Solid State batteries
  - Replaces liquid or gel electrolyser with a solid material
  - This reduces size, delivering high power with good energy storage
  - However – 500 cycles
- Unsuitable for electric HGVs where you will be charging every day

- Sodium batteries
  - Replaces lithium with sodium – a much more readily available material
  - Much lower energy density
  - Low power delivery
  - A very long way off
- Don’t expect to see this in HGVs until the 2030s

- Lithium Niobium
  - A very high-power battery with exceptionally long life
  - 10,000+ cycles
  - Can be charged from flat-to-full in six minutes
  - A British invention
  - Going into production in Wales in 2025
  - Going to be used in the Berkeley Bulldog e-trailer

Does Battery Electric work for Heavy Goods Vehicles?

- Today:
  - Rigid bodied vehicles used for regional distribution with back-to-depot operations
  - Lots of use cases out there already – refuse collection, consolidation deliveries into towns and cities, regional distribution
  - Technically they work, but there is a question mark over cost
  - However, fleet operators are winning new business and able to charge a premium for zero carbon deliveries
- 2024:
  - Articulated HGVs will start arriving in volume
  - 180-200 mile real world range – 80% recharge in around one hour
  - Ideal for regional distribution, and long-distance distribution when the charging infrastructure is in place

eFREIGHT 2030

- eFREIGHT 2030 is a collaboration between fleet operators, vehicle manufacturers, infrastructure providers and data analytics
- Chaired by Sir Vince Cable
- Won £49.2M of DfT funding
- We will be running trials of articulated HGVs with fleet operators between now and 2030
- Creating business models for decarbonising the HGV sector
- Public nationwide charging network for HGVs in place by 2025 – each site will have a minimum of six charge bays and provide 1MW charging
- Vacancies available for more fleets to join our programme and gain access to vehicles, charging systems and research

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