Indore EV Tragedy - Why Do Electric Vehicle Batteries Catch Fire?

Mains: *GS III – Science and Technology*

Why in News?

The recent electric vehicle (EV) fire incident in Indore has raised serious concerns about the safety of EV batteries in India.

Are EV batteries safe?

- **Lithium ion Batteries** – Most electric vehicles today rely on lithium-ion batteries, the same technology used in smartphones and laptops.
- These batteries offer:
  - High energy density.
  - Longer lifespan.
  - Better efficiency compared to traditional lead-acid batteries.
- Under normal conditions, EV batteries are safe due to the presence of a *Battery Management System (BMS),* which regulates temperature, voltage, and charging cycles.
- However, failures in this system or external factors can lead to dangerous situations.
- **Thermal Runaway –** A major cause of EV battery fires is a phenomenon known as *thermal runaway*.
- EV battery packs consist of thousands of tightly packed cells.
- During charging and discharging, these cells generate heat.
- If one cell overheats, it can trigger a chain reaction, causing adjacent cells to overheat.
- This cascading effect can overwhelm the cooling system and lead to:
  - Rapid temperature rise
  - Release of flammable and toxic gases (such as hydrogen fluoride)
  - Ignition and intense fire
- Thermal runaway is particularly dangerous because it spreads quickly and is difficult to control.

What are the factors triggering thermal runaway?

- **Physical Damage –** Battery packs are enclosed in reinforced steel or aluminium casings.
- However, Strong impacts (e.g., accidents or undercarriage hits), Deformation or puncturing of cells,can cause internal short circuits, leading to overheating.
- **Overcharging and Faulty Charging Systems**

- Charging beyond designed limits can destabilize battery chemistry.
- While manufacturers include safeguards, **third-party or damaged chargers** may bypass these protections.
- Poor wiring or overloading in older buildings can also increase fire risk.
- **Manufacturing Defects –** Rare defects such as microscopic metal protrusions inside cells can:
    - Bring positive and negative electrodes into contact.
    - Cause sudden high current flow.
    - Generate excessive heat.
- **Environmental Conditions –** External factors play a significant role, especially in India:
    - High ambient temperatures strain cooling systems.
    - Parking in direct sunlight increases battery temperature.
    - Charging immediately after long drives adds thermal stress.
- Flooding is another risk factor:
    - Contaminated water can infiltrate battery packs.
    - This may cause short circuits even days after submersion.
- **Battery Ageing and Poor Maintenance –** Over time, battery components degrade.
- Ignoring warning signs (like swelling or overheating) increases risk.
- Lack of periodic inspections can allow faults to go unnoticed.

Are EVs more dangerous than conventional vehicles?

- **EV fires** – They often attract attention, but they are not uniquely dangerous.
- Petrol and diesel vehicles also catch fire frequently due to flammable fuel and high engine temperatures.
- However, EV battery fires differ in key ways:
    - Burn at higher temperatures
    - Spread faster
    - Are harder to extinguish
- Unlike conventional fires, EV battery fires can sustain themselves by releasing oxygen internally, requiring:
    - Large quantities of water
    - Specialized fire suppression techniques
- **Lessons from the Indore Incident –** The severity of the Indore tragedy was exacerbated by multiple factors:
    - Presence of LPG cylinders in the building
    - A fuel-powered sports bike parked nearby
    - Failure of electronic door locks during a power outage
- This highlights that EV-related risks are often compounded by poor safety practices and infrastructure gaps, rather than battery failure alone.

What are the technological and industrial responses?

- **Advanced Cooling Systems –** Modern EVs use liquid cooling channels
- New research focuses on phase-change cooling, where coolant evaporates to absorb more heat

- **Improved Battery Design –** Development of solid-state batteries (using solid electrolytes instead of liquid)
- Reduced risk of leakage and thermal runaway
- **Fire Containment Mechanisms –** Internal firewalls to prevent propagation between cells
- Improved insulation and compartmentalization
- **Testing and Certification –** In India, the Bureau of Indian Standards (BIS) has strengthened safety norms.
- Updated guidelines introduced in 2023
- The AIS-156 standard (by Automotive Research Association of India) mandates:
    - Thermal propagation testing
    - Minimum 5-minute escape window for users in case of fire
- **Role of Users in Ensuring Safety –** User behavior plays a critical role in minimizing risks:
    - Use only manufacturer-approved chargers.
    - Avoid unattended overnight charging.
    - Ensure home electrical systems can handle high loads.
    - Allow battery to cool before charging after long drives.
    - Get batteries inspected after accidents or impacts.
    - Keep charging areas well-ventilated and free from flammable materials.

What lies ahead?

- Electric vehicles are a crucial component of India's transition to sustainable mobility.
- While EV battery fires are rare, their consequences can be severe due to the nature of lithium-ion chemistry and thermal runaway.
- The Indore incident underscores the need for a holistic approach involving robust technology, stringent regulations, and responsible user behavior.
- Rather than undermining confidence in EVs, such incidents should serve as an opportunity to strengthen safety frameworks, improve public awareness, and accelerate innovation.
- With appropriate safeguards, EVs can remain a safe and sustainable alternative to conventional vehicles.
- As the country accelerates its transition towards clean mobility, understanding the causes of such incidents becomes crucial.
- While EVs are generally considered safe and environmentally friendly, rare but severe battery fires highlight technological and regulatory challenges that need to be addressed.

Reference

[The Hindu| The Indore EV Incident]



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