Good example of what are the safety issues with lithium batteries in hybrid cars ...

Law, Security

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Introduction

In recent years, the lithium-ion battery safety issues have been the subject of interest in the field of battery technology. This is because the development of projects in the industry of automobile focuses mostly on the vehicles that utilize an alternative power such as hybrid vehicles; and lithium battery technology is employed in hybrid cars. Hybrid and battery electric automobiles are currently accessible. Corporations are doing the final measurements for every vehicle types (Hollmotz and Hackmann, 1). Moreover, the technology of lithium battery has been searching fresh markets associated with the development of cordless communication equipment such as portable computers, cellular phones and power gears (RECHARGE, 1).

Along with these new technologies, several safety issues and hazards have taken place (Hollmotz and Hackmann, 1). Regardless of the soaring safety measurements used in generating these batteries, numerous unpleasant incidents have been described that leads to the inquiry about the safety of this technology (RECHARGE, 1).

Numerous electrical energy conversion and storage devices have been studied in vehicle application. Studies show that lithium-ion (Li-ion) batteries have better quality than nickel metal hydride (Ni-MH) batteries in terms of specific power and energy on cell level for every performance standpoint applications (Srinivasan, 1).

For hybrid type of vehicles, the utilization of lithium ion batteries has been the general approach among various performance viewpoints. The existing risks made safety systems call for development.

This paper will give a general idea of the safety issues of the lithium-ion battery technology such as electrical and chemical hazards. The concept of lithium-ion battery and hybrid vehicles will be first discussed prior to the discussion of risk issues. This paper is limited to hybrid vehicles in which lithium ion batteries are utilized.

Lithium Ion Battery and Hybrid Vehicles

In 2008, around one billion small lithium ion cells were sold making it a relatively mature battery technology for electronics applications (Gaines and Nelson, 2). Hybrid vehicles production's main issue is the battery selection. There has been an agreement for the battery to be of lithium-ion type. However, the lithium-ion chemistries (material for electrolyte, anode and cathode) to employ are still a big problem. Choosing proper lithium-ion chemistry depends on several factors which include useable power density, useable energy density, calendar life, cycle, cost and safety (Burke and Miller, 2).

Every lithium ion batteries relatively work in similar way. Throughout charging the battery, the positive electrode of lithium based battery take out some of its lithium ions, and eventually move them to the electrolyte to get to the negative side electrode and linger there. Energy is stored by the battery in this procedure. During discharging, the lithium ions return transversely from the electrolyte to the positive electrode. Energy is produced during this process (Srinivasan, 6).

Non-stop development for the improvement of lithium battery system has conquered countless limitations and has brought the technology closer to fulfilling the greater part of the requirements made by the USABC (Srinivasan, 6).

The five fundamental structural components of a lithium ion battery are anode, cathode, separator, heavy-duty case and electrolyte solution. For electric vehicles, lithium ion batteries is made up of the housing with the vehicle interfaces, the cells, the battery management and cooling system (Hollmotz and Hackmann, 3). Li-ion batteries have a safety composition in case of possible flammability and chemical leakage (Canis 6).

Lithium-ion batteries present numerous advantages making them appropriate for the utilization in vehicular applications. Some of the advantageous traits of lithium batteries are higher power and energy capacity and lesser cost in comparison with Ni-MH cells (Srinivasan, 13). The higher power density means a higher power train efficiency that will result to a lower fuel consumption of hybrid vehicles (Hollmotz and Hackmann, 3). Another important advantage of the Li battery is that its chemistry is versatile that can change the system’s characteristics. It gives additional degrees of freedom for study. Nevertheless, no ideal chemistry for Lithium battery is found yet. The chemistry for Lithium can improve or make some characteristics absent (Srinivasan, 13).

Oswa (5) presents the advantages of Lithium batteries. These advantages are: Lithium ion batteries are lighter than other rechargeable batteries; have a very high energy density allowing a bigger energy storage due to being a very reactive element; charge lost can be as low as five percent for each month in comparison to NIMH batteries with twenty percent charge loss each month; do not require a complete discharge; can handle hundreds of discharge and discharge cycle.

On the other hand, some of the lithium disadvantages are: lithium ion batteries have short life (2 to 3 years) regardless of their usage; cost high compared to the other batteries; degrade sooner if exposed to heat because of its extreme sensitivity to high temperatures; and are destroyed if totally discharged (Oswa 5).

Safety Issues

Hollmotz and Hackmann (6) enumerated some possible safety issues and risks that can be experiences with the use of lithium ion bateries, and these are: explosion, electric and fire danger; hazardous goods; threat from chemical reactions; mechanical hazard due to battery components' higher weight and; thermal hazard due to high temperatures.

The possible hazards are treacherous consequences brought by chemical and electrical risks depend on the surrounding stress circumstances. The hazards are classified as electric hazard, chemical hazard, high voltage hazard and hazard as a result of battery function loss (RECHARGE, 10).

The chemical hazard may be brought by the components within the battery. The incident of unintentional exposure of substances inside the battery must be considered. Exposure can be caused by breakage of casing and internal pressure. Spillage can be due to flammable and corrosive properties of electrolytes. Gas emission can be due to flammable characteristic of volatile organic components in the battery (RECHARGE, 10).

The electrical hazard of batteries is related to the energy content of the cell. The joule effect, which is the generation of heat due to flow of current inside a battery, can be hazardous during charging and discharging. The heat produced by high flow of current can result to a local hot spot when the cooling efficiency of the global battery is surpassed. In order to prevent such risks, charging state must be controlled. Exothermic reactions are present during overcharging and over discharging that can cause chemical instability (RECHARGE, 10).

Furthermore, cumulative effect can exist due to chemical and electrical hazards. It could happen during short circuits wherein the joule effect causes the temperature to rise until the solvent inside the battery escape through a vent. Possible consequences are fire, ejection of parts and emission of harmful gas (RECHARGE, 11).

Lithium batteries with high voltages in big industries give further hazards. Loss of battery insulation can directly harm a person upon exposure to high voltage and current. Lithium ion batteries of high voltage of 60 V must comply with the electrical protection standards which include insulation faults control, terminals protection etc. (RECHARGE, 11).

Battery service function when lost can pose danger to the battery user. Hazards related to this incident depend upon the application (RECHARGE, 11).

Safety problems from lithium batteries can be caused by the following: ignitable and flammable electrolyte; overcharge susceptible cathode; delicate and thin separator; thermally unbalanced cathode; overcharge susceptible anode; high water sensitivity and high metallic sensitivity. To improve safety, some good ideas are: protected active material, improved separator, thermally constant cathode and inflammable electrolyte (Anderman, 9).

Risk can also be caused by physical external impacts and high voltage system failure. Human error or misuse of a technician, mechanic or assembler can also cause dangers (Florence, 2). Furthermore, explosion and deflagration are probable during local gas saturation that will be followed by ignition caused by sparks (Hollmotz and Hackmann, 6).

Battery safety is extremely important to the industry of lithium battery. Safety problems are more dominant in bigger size battery in comparison with smaller sizes batteries. Lithium deposition and solvent oxidation can lead to unfavorable accidents during overcharging of lithium batteries (Oswa, 5).

According to statistics, around 30, 000 HEV’s are in use in Germany. With this number, accident of HEV’s are expected. However, crash severities are predicted to be in low number. Accidents caused by penetration or intrusions of the batteries are predicted to not take place because automobiles are designed to prevent these reactions (Hollmotz and Hackmann, 7)

Safety technologies are classified in different levels and these are cell level, chemical substance level, vehicle level and battery component level. These mentioned levels depend on each other and they constitute the safety level of the battery. However, a good grading in one level does not guarantee the safety of the whole unit.

It is also imperative to focus on accelerations rather than disturbances in assessing the accidents' statistical data. It is suggested that a landscape for various cell technologies must be created since the modules of batteries are frequently located inside the part of the automobile where intrusion is very unlikely.

Many test requirements exist. The requirements are not analogous with the projected load features of vehicle crash or accidents. Thus, more practical component examinations must be defined (Hollmotz and Hackmann, 8).

Conclusion

The lithium ion batteries utilization in hybrid vehicles is extremely; however, a number of risks regarding its production and usage exist. These safety issues are classified as electric hazard, chemical hazard, high voltage hazard and hazard as a result of battery function loss.

We need to note that understanding this technology further including the reactions of the substances in the cell and in the system during unfavorable incidences is needed for safety concerns. Knowledge of the risks will give rise to a practical safe scheme.

Safety is still a big issue concerning Li batteries. It was emphasized by the previous incidents going around the electronics industry. To settle and answer this challenge, both material and engineering approaches are being done. Safety will stay as the focus in the subject of hybrid vehicles, and a great deal of efforts and considerations are necessary to guarantee that accidents will not take place to weaken this conception (Srinivasan, 13).

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