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NiMH Battery Spills and Exposures

(RON SHAW — hybrid vehicles incidents)

(Editors Note: This is the final segment of the four part series on hybrid vehicles addressing responder concerns and safety recommendations at the scene of an incident involving a hybrid vehicle. Included is a general overview and guide on how to cope with hybrid vehicle (auxiliary low voltage, and high voltage) battery spills and exposures.)

With permission from Toyota Motor Sales of USA, Inc., this article is based on the Toyota hybrid ERG spill and first aid model templates. Toyota has been the forerunner providing relevant information to emergency responders enabling them to safely mitigate hybrid vehicle incidents. Their product information, training and recommendations have been utilized by other manufacturers for their own use, as well as responders worldwide.

This article is intended to serve as an informational reference, and should not replace any existing hybrid vehicle response standard or SOPs/SOGs that your agency may have for vehicle rescue. The Toyota recommendations have been written in a generic format that will be useful for agencies developing their own hybrid vehicle rescue SOPs/SOGs.

High Voltage Nickel Metal Hydride (NiMH) Battery Packs

NiMH is the most popular type battery currently being utilized by the automotive industry for hybrid vehicle battery packs. As discussed previously, hybrid battery packs are comprised of low voltage modules bundled or connected in series to make a large high voltage output battery or battery pack.

When isolated, each module of a high voltage battery pack has a low output. However, when configured in series the total sum of HV modules in the battery pack are added together producing a high voltage (DC) output.

Boosting the battery voltage output using multiple low voltage modules is not a new concept. It is similar to a 9 Volt battery commonly used in a smoke detector or toy. The 9V battery is made up of (six) pen style batteries or cells each having an output of 1.5 Volts. When the batteries/cells are connected in series, their total (voltage) sum would increase the voltage to approximately 9 Volts.

Several manufacturers of hybrids utilize Panasonic prismatic type HV modules, each having six (or more) sealed cells. The individual module cells have integrated partitions making them very rigid.

High voltage battery packs typically used in a hybrid vehicle are encased in a battery cabinet (metal or plastic), which is secured on top of the floor pan to the vehicle frame.

Should there be a catastrophic collision where an opposing vehicle’s extreme mass (such as a heavy truck or bus) breached the battery pack, it is possible that a leak-age may occur. This would be considered an extreme and rare occurrence.

HV NiMH Battery Properties

The NiMH batteries all have a commonality; the electrolyte. Unlike a common automotive battery utilizing an acid electrolyte (2-3 pH), NiMH battery electrolyte is a strong base or alkaline (13.5 pH).

The NiMH battery electrolyte also differs in viscosity. The automotive battery acid electrolyte viscosity is similar to that of water. This is evident when an acid battery casing has cracked in a collision and acid electrolyte freely leaks out. The NiMH electrolyte differs, in that the viscosity is similar to machine oil and is contained within a fibrous
NiMH Battery Spills and Exposures

continued from page 20

 separator/plate. And, will not normally leak even if the casing is cracked during a crash. High voltage battery packs are also encased in a steel or plastic sheet metal cabinet and securely fastened to the vehicle’s floor pan.

Should there be a catastrophic crash and leakage does occur to a hybrid battery, the leakage should NOT normally warrant declaration of a HazMat incident. This type incident would be classified as an incidental spill. By definition, there is not enough spillable product (electrolyte) to pose a significant risk to health and/or safety for a HazMat.

(NOTE: As a precautionary measure, wherever a spill is encountered (regardless of spill size) responders should always wear the proper PPE to prevent possible exposure or injury.)

In the prismatic Panasonic NiMH HV battery modules utilized by Toyota/Lexus products, there is less than one fluid cup of electrolyte. The viscous electrolyte fluid, for the most part, saturates and will be contained within the fiber separator sheets/plates. Even if an individual module case is breached (cracked or crushed), leakage beyond the module would be rare. In this instance, the local dealership or manufacturer should provide assistance in removal and recovery operations.

NiMH Battery Composition & Ingredient Information

Electrolyte
- Potassium hydroxide
- Sodium hydroxide
- Lithium hydroxide

Positive Electrode
- Nickel hydride

Negative Electrode
- Nickel Metal Alloy
  - Nickel
  - Cobalt
  - Manganese
  - Aluminum
- MISCH Metal Alloy
  - Lanthanum
  - Cerium
  - Neodymium
  - Praseodymium

Spill Control Recommendations

The following is a generic guide that would be beneficial should a NiMH spill occur at an incident involving a hybrid vehicle.

I. Minimum Personal Protective Equipment (PPE)

Containment/recovery personnel should don proper PPE suitable for a strong acid and alkaline, such as but not limited to the following:
- Splash shield or safety glasses (helmet shields are NOT acceptable for electrolyte spills).
- Apron
- Rubber, latex or nitrile gloves.
- Rubber boots or suitable protective boot covers.

(WARNING: NiMH electrolyte CLEANUP page 66

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Recommended Cleanup Materials

continued from page 22

The electrolyte can be absorbed by leather products (such as boots and gloves) and can burn through in time. The electrolyte can also penetrate other natural and manmade articles of PPE/clothing causing exposure to human tissue. Always use proper PPE for chemical spills.

II. Recommended Cleanup Materials

Minimum items recommended for containment of soiled/contaminated materials due to a small NiMH spill:

- Absorbent material such as spill pads/rags suitable for alkali spills.
- Heavy duty plastic bags similar to those used for a small HAZMAT cleanup.
- (5) Gallon plastic disposal container for items or contaminated products that would rupture a plastic bag such as broken plastic NiMH modules.
- Labels and/or marker to identify contaminants.
- Neutralizing agents for acid and NiMH battery electrolytes

III. Neutralizing Agents

A. Auxiliary Acid Batteries: Hybrid auxiliary (automotive acid) batteries are like any (lead) acid type automotive batteries used in conventional vehicles. Precautions are the same as any acid automotive battery.

The acid electrolyte can be absorbed, diluted, and neutralized with a base solution of baking soda and water.

Formula: Base Solution for Acid Electrolyte

A 50/50 mixture of baking soda to water is the ideal solution for cleaning batteries. Chemically, this mixture is a base, which neutralizes the battery acid (Interstate Batteries).

B. High Voltage Battery Pack: Panasonic manufactures all the Toyota/Lexus and other hybrid NiMH batteries, has recommended a weak boric acid solution as a neutralizing agent for NiMH electrolyte.

Using boric acid as a neutralizing agent has two drawbacks; it is not readily available, and the recommended solution needs to be mixed. It should be noted that household vinegar is a suitable substitute for boric acid. This can be used directly from its container without the need for dilution.

Vinegar has several advantages over boric acid:

- Availability; sold at most retail grocery stores.
- Ready to use; does not require mixing.
- Can easily be stored on apparatus in non-breakable plastic containers.

Formula: Boric Acid Solution for NiMH Electrolyte

The author recommends using vinegar as a suitable neutralizing agent. Since boric acid is recommended by the electrolyte manufacturer,
their recommended ingredients and mix proportions are:

- 800 grams boric acid to 20 liters water or 5.5 ounces boric acid to one gallon water

### IV. Acid/NiMH Electrolyte Spill Actions

Prevent any electrolyte from entering watershed or coming in contact with humans and animals. Clean up of an electrolyte on a surface can be done in a three step method:

1. **Absorption**
   - Using a suitable absorbent for an acid, absorb any spillage and properly discard the absorbent.
   - Repeat this step as necessary.

2. **Dilution**
   - Wet suitable rag(s) with water, and wipe/scrub the exposed surface using the wetted rag.
   - Repeat this step as necessary and properly discard the rag(s).

3. **Neutralize**
   - Cover the contaminated surface with a weak boric acid solution or full strength household vinegar.
   - Absorb residue with a clean rag and properly discard.
   - Repeat steps as necessary.

(NOTE: Never apply a neutralizing agent directly to contaminated body part! Doing so can cause further injury due to a chemical reaction, such as heat.)

### V. Disposal

- Place all contaminated articles/materials in a suitable container and properly label container.
- Call the manufacturer’s published hotline, local dealership, or authorized manufacturer’s recycler for HV battery removal.

**First Aid Measures**

Emergency responders may not be familiar with a NiMH electrolyte exposure when rendering aid to a patient. Exposure to the electrolyte is unlikely except in a catastrophic crash or through improper handling. Utilize the following guidelines in the event of exposure.

(WARNING: NiMH battery electrolyte is a caustic alkaline (pH 13.5) that is damaging to human tissues. To avoid injury by coming in contact with the electrolyte, personnel should wear proper personal protective equipment during recovery operations and rendering first aid.)

1. **Minimum Personal Protective Equipment (PPE)**
   - Containment/recovery personnel should don proper PPE suitable for a strong alkaline, such as but not limited to the following:
     - Splash shield or safety glasses (helmet shields are NOT acceptable for electrolyte spills).

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II. Exposures

A. Absorption Through Skin

• Apron.
• Rubber, latex or nitrile gloves.
• Rubber boots or suitable protective boot covers.

B. Inhalation

1) Non-Fire Situation

• No toxic gases are emitted under normal non-fire conditions.
2) Fire Situations

• Toxic gases are given off as by-products of combustion. All responders in the Hot Zone should wear proper PPE for fire-fighting including Self Contained Breathing Apparatus (SCBA).

• Move patient from the hazardous environment to a safe area and administer oxygen.
• Transport patient to the nearest emergency medical care facility.

C. Ingestion

• Do not induce vomiting.
• Allow patient to drink large quantities of water to dilute the electrolyte (never give water to an unconscious person).
• If vomiting occurs spontaneously, keep patient’s head lowered and forward to reduce the risk of asphyxiation.
• Transport patient to the nearest emergency medical care facility.

Conclusion

It should be evident after this four part series, which began in the fall 2007, that responders should have respect for any hybrid vehicle, and NOT fear them. With the proper information and training, hybrid vehicle incidents can safely be mitigated by the local authorities without fear. There is relevant information and training material being offered by the hybrid manufacturers and credible faculties. There is also misinformation that is being circulated. Hopefully the readers of this series will be able to distinguish misinformation and pass along the correct information to other members of the emergency services.

Hybrid Questions and Answers

Question: At a crash evolving a hybrid the incident commander declared a HazMat incident because there was a vapor cloud and an unknown spill on the ground; was this the NiMH electrolyte?

Answer: Upon looking at the facts of the incident, the release of gases was from a chemical reaction related to the release of the acid electrolyte from auxiliary battery (similar to that of a conventional vehicle battery), the HV NiMH battery was not compromised. Even if the total spillable amount of electrolyte for the HV battery pack leaked, there would not be enough product to warrant declaration of a HazMat incident. This incident could have been handled as an incidental spill. Through proper education, responders will learn how to better cope with incidents such as this.

Question: Can responders receive a copy of the NiMH battery MSDS, there is none in the ERGs?

Answer: Recovering/Recycling of NiMH Battery Pack

For Toyota products contact the following numbers: United States: 800-331-4331 Canada: 888-869-6829

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Answer: Toyota/Lexus does have a published Panasonic (battery manufacturer) MSDS that is available through CHEMTREC/CANUTEC during an incident.

It is this author’s opinion that not all responders have been properly trained to interpret information contained in a MSDS, and/or the Department of Transportation (DOT) Emergency Response Guidebook. For this reason it was my recommendation that no MSDS be included in the ERGs.

Instead, all Toyota ERGs provide the necessary safety information for emergency responders to safely mitigate an incident involving a Toyota/Lexus vehicle, including: fire, spills, first aid and extrication. Additionally, each Toyota/Lexus hybrid ERG provides 24-hour emergency numbers where the NiMH HV Battery MSDS can be retrieved if requested.

Should an incident commander in North America, having jurisdiction at incident request a Toyota/Lexus NiMH HV Battery MSDS they may do so through CHEMTREC and CANUTEC.

Question: Where can I obtain more information and training for hybrid vehicles?

Answer: Manufacturers have technical links on the Internet for free downloads online as a public service to emergency responders. You may access these links by going to the following address: http://extrication.com/erg.htm

Toyota Motor Sales does have a free hybrid safety training program. The program contains a complete lesson plan with instructor notes, student handouts, Toyota/Lexus ERGs and slide show presentation. The program was first introduced in 2007 at the FDIC on CD, and has since been available as free download (zip format): https://techinfo.toyota.com/techInfoPortal/staticcontent/en/techinfo/html/prelogin/erg/erg_presentation.zip

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