Exploring the alternatives

Hybrid car developments

The new hybrid-electric cars have generated quite a buzz from the automobile industry, investors, manufacturers and even the general public as we move toward more fuel effecient vehicles. The excitement grew this past year after one car surpassed 100,000 miles on a test track — all powered by the lead-acid battery system. Researchers in Australia have developed what has been called "a lead-acid battery on steroids": The UltraBattery.

Case study: The change in lead-acid batteries

The newer generation of batteries for hybrids has typically included the nickel-metal hydride and lithium-ion chemistries. Most automakers are not interested in making improvements to the standard lead-acid battery and they do not think the results would be that significant or worth the effort. But at the Advanced Automotive Battery Conference, specialists said that in order to truly improve miles per gallon and lower emissions, the only practical solution in terms of cost is to use lead-acid. >>>

>>> The ultimate problem, however, is that the standard lead-acid battery does not have enough power for the high demands of a hybrid car. So the very expensive Nickel-metal hydride is used instead.

The new UltraBattery is said to work just as well as nickel-metal hydride, but for a quarter of the cost. The new battery uses the same technology for lead-acid batteries with the addition of supercapacitors. These are electronic devices that have the capacity to last millions of cycles of absorbing and releasing energy boosts. The UltraBattery, with the latest technology, would last four times longer than the previous lead-acid battery.

In the 1990s, researchers tested supercapacitors by using them in addition to the lead battery pack. It worked, but was not efficient. So then they built the supercapacitors directly into the battery. One of the lead plates was made of half lead and half carbon.

And then the UltraBattery was born. This development is monumental because it could provide the efficiency that the hybrid cars need and yet still remain affordable. One element, however, has not changed with this new form of technology: Lead.

Hybrid hazards

With the growing production of hybrid cars and lead batteries, we could see significant environmental consequences and more lead release into the air. Since 1950, every category of lead consumption has decreased except for batteries and munitions. In 1976, the process of lead removal from gasoline began, and in 1978 lead was banned from paint. Overall, the U.S. has become more concerned for protection from the very severe consequences of lead exposure. Yet this does not seem to be the case with batteries, even though the dangers of lead have not disappeared.

The majority of lead emissions in 1997-2001, according to the National Emmisions Inventory, came from lead's industrial process: Lead mining and smelting are the greatest factors of lead emissions. Therefore, the question is whether the hybrids are actually saving the air with their fuel efficiency or causing more lead release with the increased lead production.

Case study: Chevrolet Silverado, a micro-hybrid car

- Improved fuel efficiency from 16 miles per gallon to 18
- With the use of unleaded gas, the car still emites 40% of lead from gas into the air
- If one car is driven for 20,000 miles per year, it loses 11.3 mg of lead emissions due to its better fuel economy
- However, the overall lead release per vehicle is 1400 mg

Conclusion

Even though the hybrids are more fuel efficient, which in turn decreases lead emissions, there is actually a major increase in lead emissions when considering the release from the production and replacement of battery packs. In 2015, micro-hybrid vehicles are predicted to actually increase lead release to the air and land by 26 tons. This is 1.4 times more than the rate of lead emissions right now caused by fuel combustion. Emissions are also of the greatest health hazard because the particles are so tiny that they can be easily inhaled.

The use of lead-acid can be considered the safest chemistry, despite the toxicity, because the hazards lie within the plants, which are in a limited area and cannot be widely spread. However, as the automobile industry continues to grow, along with the production of hybrid cars, the demand for lead increases and cannot be met by recycling. Even at the intial stages of developing the hybrid car, there is a drastic need for continued mining and processing of lead ore. This proves to be an extremely high health hazard for our society.

Aluminum-air

Advantages
- Mechanically rechargeable battery system, outlasts lead-acid by 15-20 cycles

Disadvantages
- Parts must be replaced frequently
- Water has to be added and sludge removed
- Re-processing aluminum is too costly — this system is not going to be widely used

Lithium-ion

Advantages
- High number of hours of power for a given weight
- Great for cell phones, laptop computers and cameras
- Solid, no liquid electrolyte
- Low self-discharge rate

Disadvantages
- More expensive than lead
- Price difference is not that big for smaller items, like phones and computers, but is large for cars
- No form of recycling
- Could overheat, catch fire

Sodium-sulfur

Advantages
- Efficient as lead-acid, but three to four times more hours of work for given weight

Disadvantages
- Only one commercial use after 27 years of study: load balancing electric power in Japan

Nickel-cadmium

Advantages
- Reliable
- Can handle a range of temperatures, even as low as -20 degrees Celsius
- Not affected by an overcharge
- Can be recharged and charged about twice as many times as lead-acid
- Can be stored completely discharged
- Sealed; operates at any altitude
- No maintenance

Disadvantages
- Three to five times more expensive than lead-acid
- Toxic materials
- Recycling system is limited
- Heavy
- Self-discharges fast if stored

Nickel-metal hydride

Advantages
- Reliable and lightweight
- Very long cycle life in hybrid cars (expected to equal 100,000 miles)

Disadvantages
- Metals are 25 times more expensive than lead
- Nickel can cause cancer
- Hybrid vehicles are new, so lifespan is only an estimate and not actually known
- No recycling system

Nickel-zinc

Advantages
- Good energy density
- Can handle a wide range of temperatures
- Can outlast long periods of storage

Disadvantages
- Expensive
- Mediocre lifespan