Thursday afternoon at Clean Tech 2007

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Topic: Miscellaneous
Tags: batteries, bill davis, clean cars, clean tech, li-ion, nanoexa, sanjeeta kumar, syngas, traction batteries, waste gasification, ze-gen [list all tags]

After an overpriced lunch which was redeemed by the interesting company, it was time for the afternoon sessions. I only got good notes on two of the speakers, but man, one of them was a doozy!

Bill Davis, Ze-Gen

The 2 PM session began with what may be the biggest non-traditional concept for the next ten years, Ze-Gen. Bill Davis ran through the potential of waste gasification for us.

The untapped potential is enormous. The current electric production from waste is less than 3800 megawatts (not sure if this is USA or worldwide). The potential is closer to 110 GW (110,000 MW) and $26 billion/year. It also reduces the environmental cost of transport, and something like 1.8 tons of CO_2 equivalent per ton of waste processed (including fugitive methane emissions from landfills). Depending on the policy details, there may also be renewable energy credits available (people differ on the renewability of waste).

A flow of 450 tons/day of waste (I did ask about the time units) can yield a continuous 30 megawatts of electricity. The first systems will not process municipal solid waste (MSW), but construction and demolition (C&D) debris. This is a much less troublesome feedstock because it is drier and far less variable. Construction debris is taken through transfer stations where it is processed to remove materials like ferrous metals; what's left after the shredding and sorting process is a prepared fuel. Other companies have tried to tackle MSW first, and failed to overcome all the difficulties involved. Davis intends to pick the low-hanging fruit first.

The Ze-Gen reactor bears a familial resemblance to other, older metal-handling furnaces. It contains a pool of molten iron through which waste, air and steam are blown. The combustible parts of the waste are pyrolized and the remaining carbon reacts with iron oxide to make iron and carbon monoxide. The steam reacts with iron to make iron oxide and hydrogen, and the non-combustible portions of the waste melt to slag. Once frozen, the slag is deemed "non-leachable" by the EPA and can be used as aggregate or disposed of in unlined (cheap) landfills. This can be an enormous cost advantage over conventional disposal.

The primary product of the reactor is a syngas, composed largely of carbon monoxide and hydrogen but also containing carbon dioxide, other trace gases and contaminants. Per Davis, the primary toxic contaminants are mercury from MSW (batteries and fluorescent bulbs, I guess) and arsenic from C&D debris (probably from CCA-treated lumber).

One of the byproducts of the process is metal, absorbed into the melt from the iron and steel remaining in the shredded debris. This metal is worth approximately $170/ton. Davis didn't talk about value-added processing, but I wonder if it might not be possible to continuously cast bar stock from the excess metal tapped off the melt.

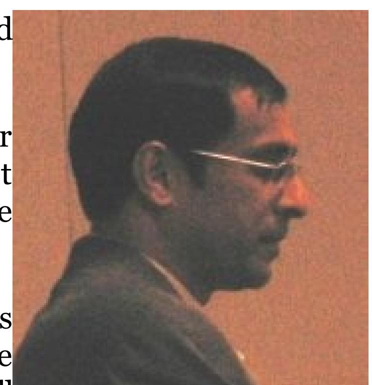
When tipping fees, slashed disposal fees and energy and materials sales are considered, this technology has the potential to pay off big. Davis said there is the potential for a 60% internal rate of return. He mentioned licensing to vertical industries (the details of which I've forgotten).

There are still some hurdles involved:

- Behavior modification is tough.
- There's the public impression that Waste-To-Energy = Incineration = Smokestacks = Pollution. Convincing people otherwise is an uphill battle.
- The public may also be convinced that recycling is always the answer, even when ultimately consumes more energy. Overcoming this could be difficult.

I don't recall Davis mentioning this during his talk, but one of the features of the molten-iron processes is that the carbon-reacting and hydrogen-generation phases of the process can be alternated, and the process can be tuned to adjust the composition of the syngas. This may allow e.g. the production of hydrogen for industrial purposes while the carbon is routed elsewhere, perhaps even to sequestration. The conversion of waste into an energy source ***and*** a carbon sink is one of the most tantalizing possibilities of Ze-Gen.

Sajeeta Kumar, Nanoexa



The last session where I picked up anything significant was presented by Sajeeta Kumar of Nanoexa.

Kumar spoke on batteries and clean cars. He noted that hybrid-car manufacturers are moving from NiMH to lithium ion cells for cost reasons alone. The safety issues with the classic cobalt-oxide cells have been solved.

Traction batteries are still small potatoes. The Li-ion market is currently dominated by cell phones, which constitute roughly half the total market. Power tools are a rapidly growing segment, but still small at about 5%. Hybrid vehicles aren't even a visible presence yet.

Toyota is moving fast, and is going to change this.

He went over the trend in capacity for the standard 18650 cell. The curve has risen from a bit under 1000 mAh/cell in 1992 to the technology limit for $LiCoO_2$ of ~2600 mAh/cell in 2006. New cathode and anode technologies promise to push this to ~3000 mAh/cell in 2008. (Unfortunately, the graph ended there.)

Future improvements depend upon:

- High-capacity anodes
- High-capacity cathodes
- New electrolytes
- Safety technology

Nanoexa's contribution is a polymer-electrode cell. He drew a comparison between 18650 cells used in power tools, which I shall try to reproduce here.

Property	**Company A**	**Company B**	**Nanoexa**
Cathode material	$Li(Ni\text{-}Mn\text{-}Co)O_2$	$LiCoO_2$ + $Li(Ni\text{-}Mn\text{-}Co)O_2$	L333
Cell Type	18650	18650	18650
Weight	44 gm	46 gm	43.3 gm
Capacity	1030 mAh At 10 C	1300 mAh At 10 C	1700 mAh At 10 C
Std. Operating voltage	4.2 V - 2.5 V	4.2 V - 2.5 V	4.2 V - 2.5 V
Energy density	220 Wh/l	260 Wh/l	339 Wh/l
Power density	1200 W/kg Continuous	1400 W/kg Continuous	1800 W/kg Continuous
Cycle life	500	700	> 900

Nanoexa's technology looks considerably better than the reference companies (though perhaps not so good for cycle life and lifetime kWh thoughput compared to e.g. A123Systems or AltairNano). 900 cycles is about two and a half years of use at one cycle per day (PHEV), or six months at five cycles per day (professional power tools).

What are the prospects for Nanoexa? I can't tell you. I dodged out to catch a presentation which turned out to be about natural-gas conversions of diesel engines (a questionable effort in an era of shrinking NG supplies), so if Kumar had any durability comparisons to $LiFePO_4$ or the lithium titanium spinel electrodes, I missed them. But if these units have a high enough scrap value to be cheap to exchange, Nanoexa could have a future helping to replace gasoline with electricity.

And that's all I had time for. I seldom see such concentrations of capability and intelligence, and I can only hope that what comes out of these gatherings is at all close to the potential I felt.