

The boys with the black stuff

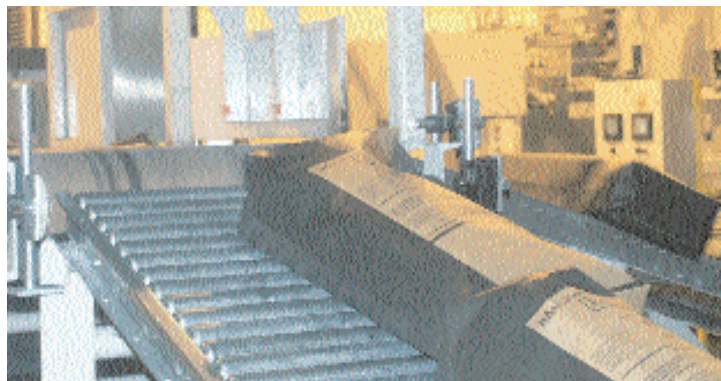
Following a major fire at its US operation in August 2001, Hammond Expanders has built major new lines along with a new research and test laboratory. As the lines come on stream this month, Editor Gerry Woolf paid a visit to see the operation.

None of us like to be undervalued. But in the lead acid battery industry, when all is said and done, negative plate expander is certainly that. It's the lowest cost ingredient in every SLI battery — but it makes all the difference to batteries functioning well (delivering sufficient cranking current) and those that will fail automakers tests.

David Boden, consultant to Hammond, estimates there's about \$US0.06 worth in each battery. "We ought to get double that," he says, but of course in the days of commodity batteries, there's fat chance of that happening."

There's no secret to what expander is — a mixture of naturally occurring lignosulphonate—an almost magical organic molecule which increases the surface area of the active material, then there's barium sulphate — a look-alike to lead sulphate and whose role it is believed is to preventing lead sulphate being deposited all over the active material and finally, carbon, whose role is to improve conductivity.

You, the battery maker, can buy in these raw materials and make up your own expander and quite a few of you do, but it's a dirty business and can you really



Better than ready made cake mix... Hammond's ready made Expander rolls off the line.

afford to get the mix even slightly wrong? Because getting the mixture absolutely right really is the difference between good and bad product.

There's been plenty of lip service paid to improving battery quality over the last few years and it seems adding the right amount of expander to the negative plate mix is crucial to ensuring uniformity in the finished product— why else was a process engineer making the final adjustments to packing system's three part checking weighing operation, accurate to three decimal places?

Certainly not because the company doesn't want you, the customer to get a couple of grams more mate-

rial than you've paid for.

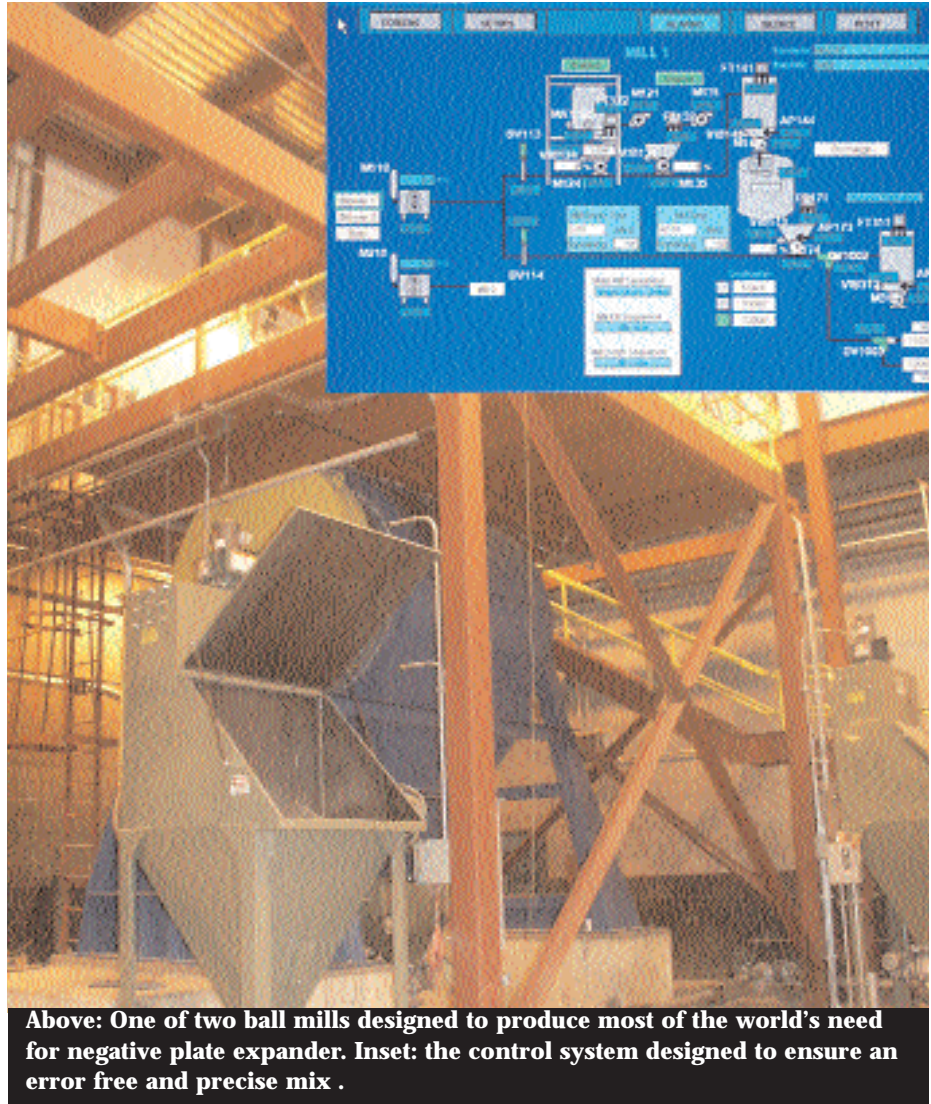
This is the electrochemical equivalent of making a Victoria sponge cake right every time. The problem is however, there's not just a single sponge mix— there are over 70. Expanders for SLI, industrial traction, VRLA, mixes for hot climates, mixes for temperate climates and mixtures custom made for “bloggs batteries”, according to a recipe laid down thirty or forty years ago.

“This isn't rational, I argue. “Surely there should be no more than perhaps half a dozen mixtures to fulfil the major battery roles and that would be sufficient? And Vice President Carlos Barreneche and David Boden nod in agreement. The problem is of course that how do you persuade your customers to change from something that they know works to something that you will say will do just the same job, when you can't really explain exactly how it works?

“We just have to show them by building batteries with our new mixes of expander and comparing the results,” says Boden.

The new plant is essentially, two fully automated ball mills and the whole process will be quite capable of producing perhaps 20M lbs of expander per annum — 2/3 of the potential world supply requirements. One bag of the stuff weighs 24lbs and in the average past mixer, is sufficient to make enough mix for around 343 batteries. “We can tell our customers exactly how much material to add to a mix precisely”, says Boden, “the one thing we can't be sure of is that they follow our instructions to the letter.”

Persuading their customers to switch to one of Hammond's recommended mixtures, rather than one of



Above: One of two ball mills designed to produce most of the world's need for negative plate expander. Inset: the control system designed to ensure an error free and precise mix .

the special custom-made varieties, will greatly simplify production — the mills will not have to be cleaned so rigorously between mixes.

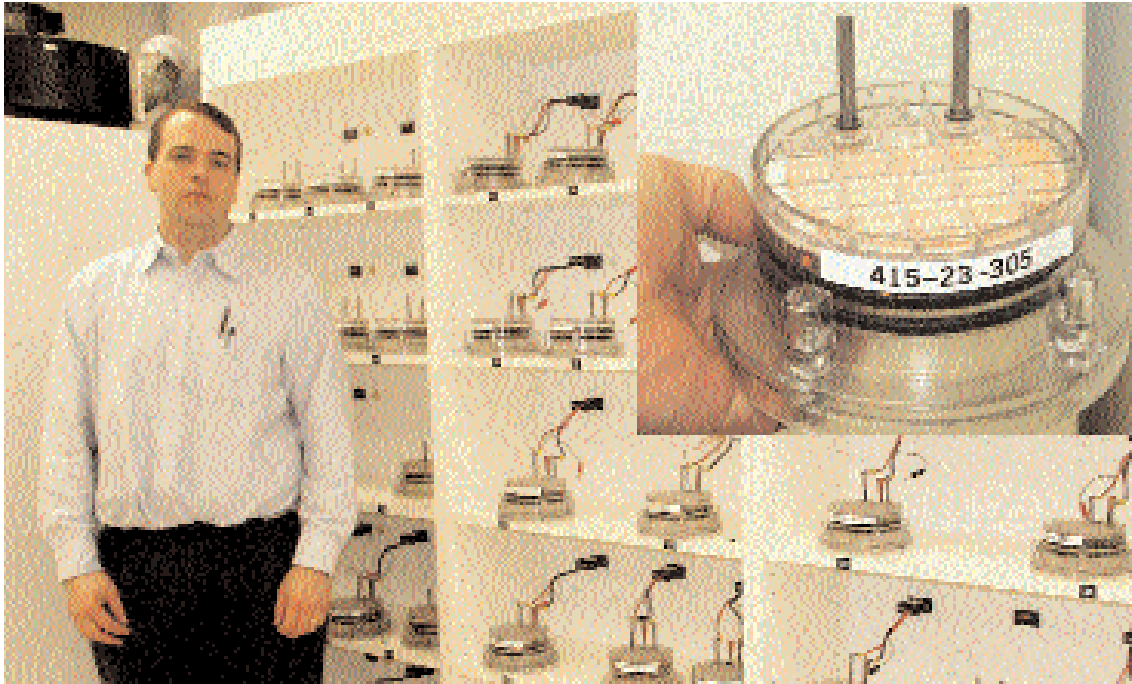
Negative plate expander was discovered by accident and refined by trial and error in the 1940s and '50s. The elimination of wooden separators from automotive batteries more than half a century ago lead to the discovery

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ery that it was the lignin — the cellulosic organic molecule in wood, which actually enhanced battery performance.

Even today it is impossible to explain precisely why this happens.

“It was the US national lead company that first



One of the Hammond lab team stands in front of a series of test cells where new negative expander materials are under investigation at Hammond for the latest ALABC programme. Insert: a close up of one of the test cells which are essentially miniature VRLA designs.

offered expander as a service and as consultant Sal Cangelosi, who worked with the recently deceased Orsino, “it was later than we found we could make money from it, by producing special blends of expander for the multitude of battery companies.”

It really was a black art. The acquisition and merger of various businesses into Hammond has meant that Carlos Barreneche, with the help of consultants like Boden, has been working hard at turning the black art into a hot science.

And it’s coincided with the work of the Advanced Lead Acid Battery Consortium, which having solved so many of the weaknesses of lead acid — premature capacity loss and grid corrosion, turned its attention to the negative plate, which is where the expander is used.

Says Boden, “with SLI batteries being squeezed into smaller hotter spaces, the increasing cause of failure is now negative plate failure — essentially sulphation. And the negative plate is also the focus of the ALABC4 programme because hybrid vehicle operation (and we’d add, PV hybrid operations), places the lead acid in the partial state of charge state.

With improved expanders, it should be possible to raise the working temperature in which lead acid batteries work, (beyond+ 40°C) which has always been a

limitation in terms of life and performance. But how does one go about identifying and selecting better expander mixtures, when there are already so many recipes? Surely it would involve battery building and evaluation on a massive scale to show any true statistical significance?

It can be done, using a powerful statistical method to see the wood from the trees and to avoid the cost of building and testing whole batteries by using as small three plate VRLA cells, which can be formed, cycled and easily stripped down to facilitate access to the plate material.

A hundred or so of these cells take up little more than a reasonable collection of books in the Hammond test laboratory.

Previous ALABC work has

shown that in the PSOC state, there is precipitation of lead sulphate on the surface of the negative plate and continued cycling exacerbates the problem.

In the programme being headed by Boden, the NAM contains prospective additives which will not only diminish the formation of the crystals but also improve the conductivity of the material.

But isn’t that what Expander does already? Well quite, but the experiments here are different. Today, we have these materials mixed uniformly throughout the negative active material. But the problem starts from

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Top left: to bottom right, David Boden, Sal Cangelosi, Carlos Barreneche, and bottom right CEO Peter Wilkie, bringing uniformity and saving to the use of negative plate expander

the outside and works its way in. So the experiments are being designed to load the additives to the surface of the active material not only adding them to the NAM mix, but also spraying them onto the surface. It's already been shown that the lead sulphate can actually be reduced when it comes into contact with an electronic conductor so it stands to reason that if this is more available at the surface, then the sulphation can be reduced if not entirely eliminated.

But there are intrinsic difficulties — increasing conductivity of the material musn't be done at the expense of active material. Altogether, there are 35 variables in the matrix of materials under test.

While the material will be sprayed on to the surface of the negative plates, it is expected that the dispersed material will penetrate the surface so that there is a concentration gradient with the highest conductivity on the surface.

At the time of writing (March 2003) quite a lot of the experimental cells have already been eliminated and as result of the cycling experiments.

Because of the easy to disassemble cells., the negative plates are readily accessible for analysis by techniques such a scanning electron microscopy and X ray diffraction, which show, in great detail the morphological changes at the crystal level.

And the combinations of materials that are of benefit? Some of that evidence will be made known at the ALABC contractors meeting which takes place in May 2004. Undertaking the research has a number of

benefits for Hammond. First of all, the company has been able to grow its team of in house chemists and give them something more than the routine quality evaluations they already undertake.

More importantly, it's a huge boost to the technical credibility of the company. "We're not just seen as merchants of this black stuff, says Boden, "we really can offer consultancy and advice, particularly to makers who want to supply OEMs with batteries but whose product doesn't yet meet those company's rigorous specs.

The key to modern battery making is uniformity. Mixing your own expander is not unlike home cooking, OK but not necessarily the same dish every time and sometimes it's just a disaster. By going for the packaged formula, you should get it right every time.

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