

## Breakthrough in lead-acid battery technology: Composite lignin delivers high charge acceptance with minimal water loss

Enqin Gao, R&D director, and John Miller, Leadership Innovation Council senior advisor, explain Hammond's approach to reducing water loss and improving charge acceptance.

In the ever-evolving world of energy storage, lead-acid batteries remain a cornerstone for automotive, industrial, and renewable energy applications. Yet, as demands for higher performance and longer life grow, so do the challenges, especially when it comes to balancing charge acceptance and water loss. Enter LIGN3X™, a new composite lignin innovation that promises to rewrite the rules for battery expanders.

### The challenge: performance boost without compromise

For years, battery engineers have sought ways to maximize the negative plate's charge acceptance, particularly under partial state-of-charge conditions. Traditional approaches, like using high-conductivity or high-surface-area carbons, have improved charge acceptance. However, these methods often come with a costly trade-off: increased water loss, which

can shorten battery life and reliability. Water loss isn't just a nuisance; it's a technical hurdle. While impurities such as nickel, copper, or antimony can be minimized using better materials and processes, water loss caused by the surface of carbon materials is much harder to control. The culprit? More active sites on high-surface-area carbons catalyze the hydrogen evolution reaction (HER), leading to greater water loss.

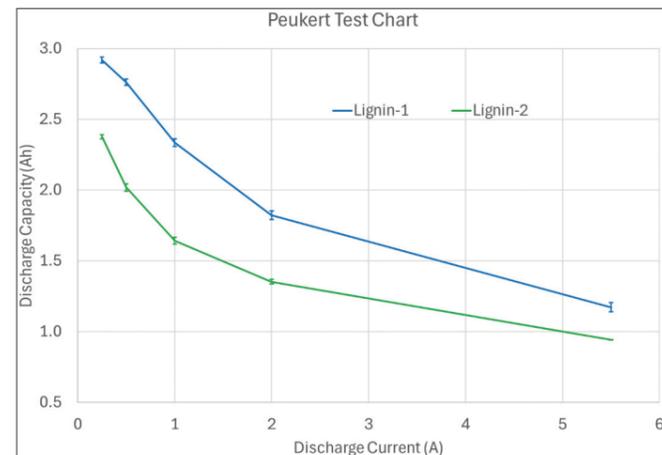
### The LIGN3X™ solution: science meets innovation

Hammond's research team tackled this problem head-on. Their breakthrough is a composite lignin that selectively covers the active sites on carbon, drastically suppressing HER. The result is a new class of expanders that not only boost charge acceptance but also significantly reduce water loss — without sacrificing other critical performance attributes.

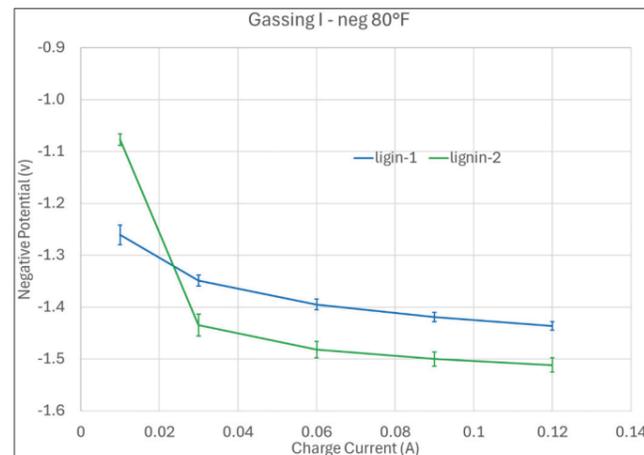
### Head-to-head: Lignin performance example lignin's offer different performance results

The team compared two types of lignin expanders:

- Lignin-1: Delivered higher overall cell capacity.
- Lignin-2 (LIGN3X™): Excelled at reducing gassing and water loss, especially at medium to high charge currents.
- Both types performed equally well in high-rate cold cranking (CCA) tests
- Blending performance characteristics of different lignins in the right amount, Hammond developed a new composite lignin that doesn't force a trade-off between power and longevity.



**Figure 1, Peukert Test Chart:** In this Cell Capacity test Lignin-1 and Lignin-2 are two expanders with same content of BaSO<sub>4</sub> and carbon material, but different lignin. The expander with Lignin-1 exhibits higher capacities than that with Lignin-2.



**Figure 2, Gassing/Water Loss Chart:** This graph shows the potential of the negative electrode at a given current. The more negative the potential the less gassing. The expander with Lignin-2 exhibits lower gassing and water loss characteristics than Lignin-1 at medium to higher charge currents.

### Real-world results: EFB testing

The innovation was put to the test in Enhanced Flooded Battery (EFB) expanders. Both standard and composite lignin expanders showed similar capacities and cycle life, but

Test	Measurement	Lignex vs Control
C20-1	%	105%
CCA-1	10 s V	pass
	time to 6v	pass
C20-2	%	101%
CCA-2	10 s V	pass
	time to 6v	pass
CA	%	330%
SAE J2801	Cycle	pass
Water loss	G/Ah	23.0%

**Figure 3, 12V Battery Demonstration:** The EFB expander with LIGN3X composite lignin demonstrated superior charge acceptance performance with significantly lower water loss than the control.

the composite lignin expander (EFB-B) stood out for its lower gassing and water loss. In fact, the LIGN3X™ EFB formulation demonstrated superior charge acceptance with significantly lower water loss compared to the control group.

### A versatile solution for modern energy needs

What does this mean for the industry? Expanders with the LIGN3X™ composite lignin enable a wide range of applications for battery manufacturers, start-stop vehicles, energy storage systems, auxiliary power, and deep-cycle batteries, across various technology platforms

(Flooded, EFB, AGM). Wherever high charge acceptance and low water loss are required, LIGN3X™ offers a compelling solution.

### Why it matters

LIGN3X™ Composite Lignin is more than just a material innovation; it's a leap forward for lead-acid battery technology. Solving the long-standing challenge of balancing charge acceptance and water loss, it paves the way for more reliable, efficient, and longer-lasting batteries. Hammond's approach could set a new standard for lead-acid batteries, benefiting consumers, manufacturers, and the environment. 🌱