金科力
JINKELI

THE NEW GENERATION OF EFB ADDITIVE SOLUTIONS

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CO-CREATION
WIN-WIN

WHO ARE WE ?

For **43** years,Jinkeli has been dedicated to the research, production, sales and technical services of lead-acid battery additives .

70%
Market share in China

30+
Countries

300+
Customers

WHAT ARE WE DOING ?

30+

R&D Professionals

1200+

Battery Test Circuits






WHAT ARE WE DOING ?

E-bike battery life **doubled** through innovation of materials.

1000+

Cycle life

Start-stop


Motive


Standby


Energy storage

WHAT ARE WE GOING TO DO IN THE FUTURE ?

BUILD AN INTERNATIONALLY LEADING COLLABORATIVE INNOVATION PLATFORM

PROVIDE CUSTOMERS WITH ADVANCED BATTERY SOLUTIONS

Joint Laboratories

Borregaard

CABOT

YUNNAN TIN GROUP

GORE

- Advanced Battery Materials Industry Innovation Institute
- CBI Jinkeli Technology Center

Internationally Leading Collaborative Innovation Platform

Collaboration with universities

CAS SNU SUT GDUT

- International Demonstration Base for New Battery Materials in Shandong Province
- Engineering Research Center for New Batteries and Key Materials in Shandong Province

INTERNATIONALLY LEADING COLLABORATIVE INNOVATION PLATFORM

SHARED PLATFORM, SHARED RESOURCES
MUTUAL EMPOWERMENT, GROWTH TOGETHER

FASTER INNOVATION AND BETTER FUTURE

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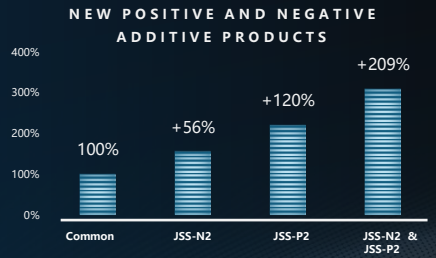
THE NEW GENERATION OF EFB ADDITIVE SOLUTIONS

The New Generation of EFB Additive Products

Negative Additive ： JSS-N2

Positive Additive ： JSS-P2



Why Develop the New Generation of Additives for EFB ?

The EFB has been in mature application for many years, and the performance tests in the laboratory have all met the standard requirements.

- Based on the market research conducted, it was found that the high discharge depth during vehicle use, and the low charging voltage are the main reasons for insufficient charging, which leads to battery return.

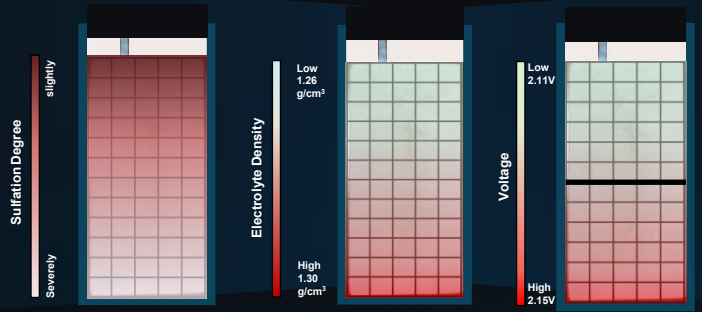
- Dissection analysis of the returned batteries revealed that the plates had undergone sulfation, and there was a significant difference in density between the upper and lower parts of the electrolyte.

The product is developed to address the practical problems encountered in vehicle usage, and to create a new generation of additive for EFB.

Deep Analysis of Failure Mode-Inconsistency of active material is the main cause of the decline in cycling performance.

Why does it stratify?

Normal electrolyte does not stratify, so it is easily overlooked by people. However, in the use or testing of the battery, this situation is quite different. The stratification becomes very serious as the battery is charged and discharged.



The chemical reactions during the battery's charging and discharging process

$Pb + PbO_2 + 2\ H_2SO_4 = 2PbSO4 + 2\ H_2O$

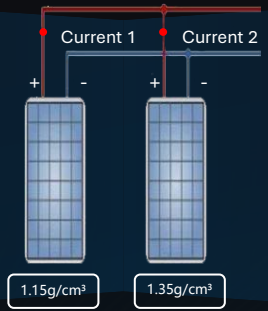
$2\ PbSO_4 + 2\ H_2O = Pb + PbO_2 + 2\ H_2SO_4$

The stratification occurs during the charging and discharging processes.
During discharging, pure water (1.0d) is generated, which is lighter than the electrolyte (1.30d), and the water moves upwards.
During charging, pure sulfuric acid (1.84d) is generated and overflows from the plate holes and enters the electrolyte.

To verify this idea, we conducted an experiment.

Stratification simulated with different densities of sulfuric acid

Two cells with different sulfuric acid densities (1.15 g/cm³ and 1.35 g/cm³) were connected in parallel to simulate the layered structure of the cell's upper and lower parts. They were discharged at a current of 6 A, and a charge test was conducted with a constant voltage of 2.67 V and a current limiting of 15 A.



The influence of electrolyte stratification on battery performance

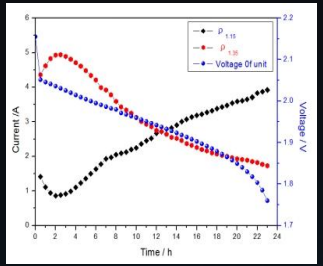
Measure the changes in voltage and current of two batteries respectively during the charging and discharging processes to reflect the conditions of the upper and lower parts of the battery with electrolyte stratification during charging and discharging, and study the impact of electrolyte stratification on battery performance.

Verification of R&D Ideas

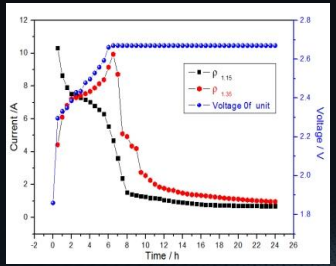
Current and voltage changes during the charging and discharging of parallel batteries

- During the charging and discharging process of the cell, the sulfuric acid electrolyte undergoes stratification, resulting in a higher density of sulfuric acid at the lower part of the cell and a lower density at the upper part. During the cell charging and discharging process, the lower part of the plates has a deeper discharge depth and poorer charging acceptance;

- while the upper part has a shallower discharge depth and better charging acceptance. As the sulfation at the lower part intensifies, the utilization rate of the active materials in the upper part increases and it undergoes mudification. The sulfation at the lower part gradually worsens and spreads to the upper part of the plates.



Constant current discharge of 6 A



Constant voltage of 2.67 V, with a current limit of 15 A for charging

Why Choose a Continuous 17.5% DOD Cycle ?

Battery manufacturers have reported that the battery tests have met the laboratory standards of EN, IEC and JIS, but the market return rate remains very high

- During actual use, the battery enters a starved state. It is difficult to recharge the battery by applying a constant current or a high voltage.
- The conventional testing method includes a 16.0V supplementary charging step.

14.4 V

Charge voltage

17.5%

Discharge depth

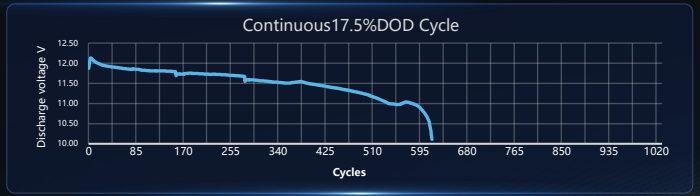
No supplementary charging is required

During the cycle process

Why Choose a Continuous 17.5% DOD Cycle ?

After analysis, it is found that there is a gap between the conventional testing methods and practical application.

The conventional 17.5% DOD cycle, with supplementary charging for each unit, alleviated the discharge attenuation during the cycle process.



Based on the continuous 17.5% DOD cycle standard set by VW, this design is more in line with actual usage patterns.

The Shortcomings of Commercially Available Products

Purchase the EFB of the manufacturer from the market and test their continuous 17.5% DOD cycling performance.

- The number of cycles for the conventional 17.5% DOD cycle and the continuous 17.5% DOD cycle varies significantly.
- Even for the battery with the best charging acceptance, its continuous 17.5% DOD test can only be conducted for approximately 700 times.

Manufacturer		X	H	S	G
Nominal capacity	Ah	70	70	60	65
Weight	Kg	19.78	19.17	15.61	19.45
CCA	A	1005	955	715	1040
Measured capacity	%	111.7%	114.7%	114.4%	114.3%
Charge acceptance	/	4.53	3.19	4.62	5.84
Specific charge acceptance	As	388	662	360	540
Conventional 17.5% DOD	cycle	1020		340	1870
Continuous 17.5% DOD	**cycle**	**618**	**195**	**139**	**765**

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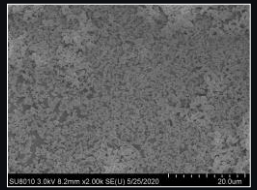
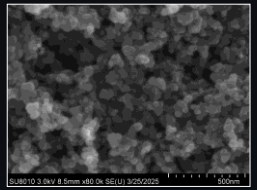
NEGATIVE ADDITIVE
JSS-N2

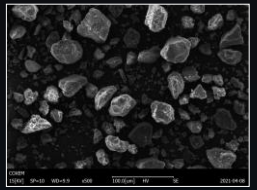
Common Materials for the Negative Plate



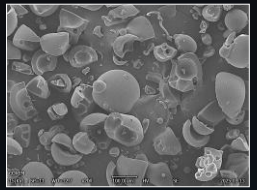
BaSO4



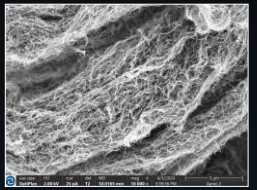
Carbon black



Humic acid



Lignin



CNTs

Performance Comparison of Different Carbon Materials

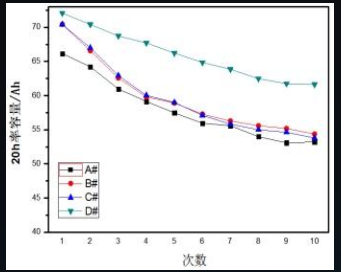
- Measure the differences in properties such as hydrophilicity, specific surface area, and electrochemical active area of carbon materials, and select the suitable carbon black materials from the results.
- ECSA pays more attention to the area that can participate in electron exchange during electrochemical reactions. The larger the ECSA, the more active sites are exposed on the plate material or catalyst surface, and the broader the actual contact area for the electrochemical reaction.

Carbon black	BET	ECSA	pore size	resistivity	contact angle
C7	40.60	419.6	23-26	0.0699	33.4
C8	76.78	503.8	29-34	0.0446	11.9
C9	220.05	737.2	19-24	0.0806	34.4
C10	144.83	773.0	19-10	0.2469	89.1
Unit	m^2/g	cm^2_{ECSA}	nm	mΩ•cm	°

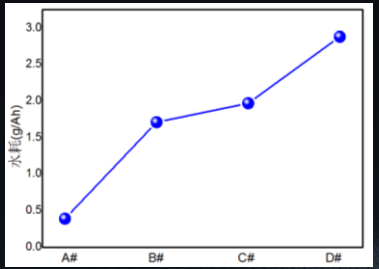
Capacity Cycle Testing of Different Carbon Materials

The content and type of carbon materials will affect the water consumption of cells to varying degrees;

- The rate of capacity attenuation of A#、B#、C# cells is basically the same.
- The capacity loss of D# cell is significantly lower, which may be related to its relatively high water consumption, effectively slowing down the stratification of the cell's electrolyte.



Capacity data of different carbon material schemes

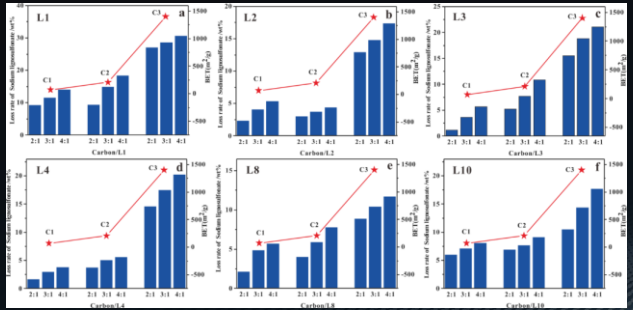


Water consumption data of different carbon material schemes

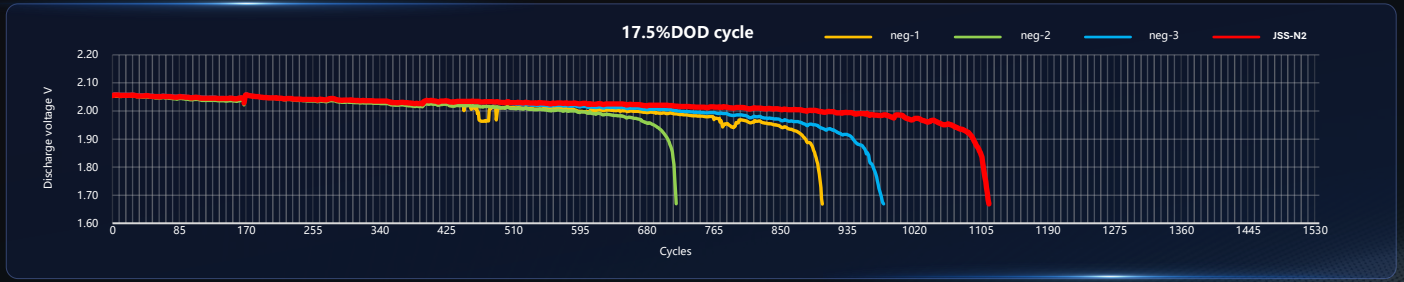
Research on Adsorption of Different Lignins and Carbon Materials

Lignin and carbon black exhibit adsorption phenomena during use. The higher the BET value of the carbon black, the more obvious the adsorption effect will be.

- Adjust the lignin grade and dosage by matching the carbon black to ensure that the low-temperature performance does not deteriorate.



Assembly and Testing of Cells with Negative Composite Additives



Based on the research of negative additive materials, different schemes were designed, and cell tests were conducted. The life of the JSS-N2 formula increased by more than 50%.

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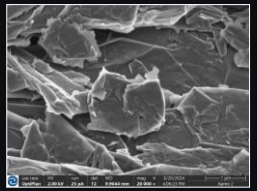
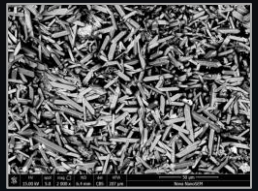
POSITIVE ADDITIVE
JSS-P2

Common Materials for the Positive Plate

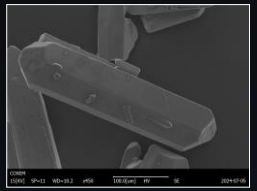
Select different metal compound additive materials and research on their low-temperature cranking and cycling performance



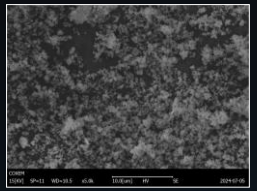
Graphite



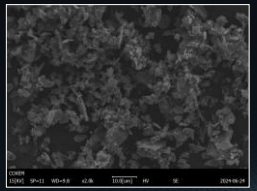
4BS



Metallic compound A



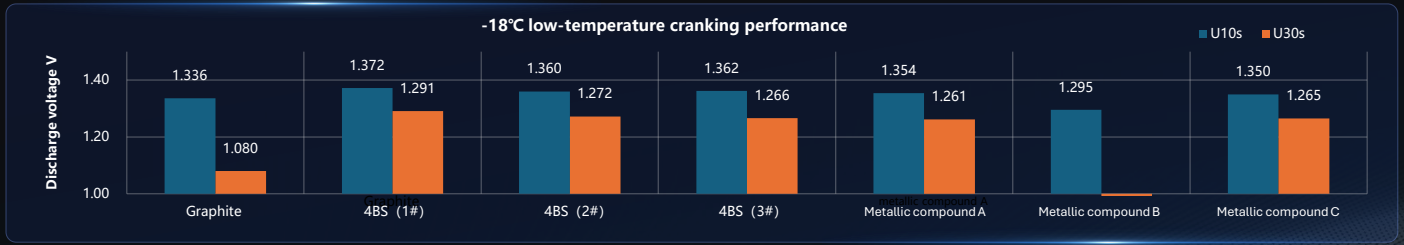
Metallic compound B



Metallic compound C

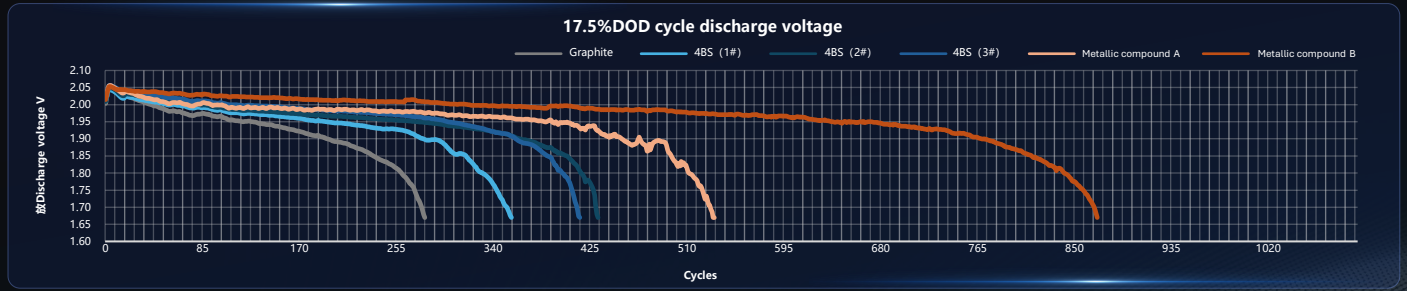
Effect of Different Single Materials on Cranking Performance

Assemble cells using different positive additives, and test the low-temperature cranking capability according to the SAE method



Comparing the voltages during discharge for 10 s and 30 s, the 4BS scheme is clearly superior, while the voltages of the metallic compounds vary significantly.

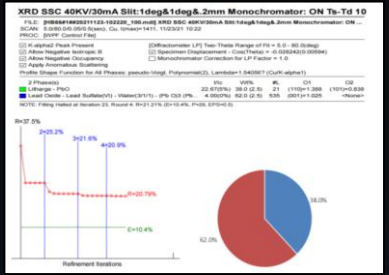
Effect of Different Single Materials on Cycling Performance

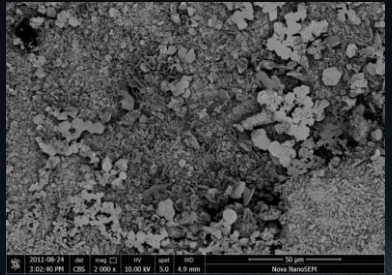


Although the new metallic compounds have a lower cranking performance compared to the 4BS scheme, their cycle performances have improved significantly.

Simple Mixture Affect the performance

- **Adding the metallic compound mixture will interfere with the growth of 4BS during the curing process, thereby reducing the cell's low-temperature cranking performance.**

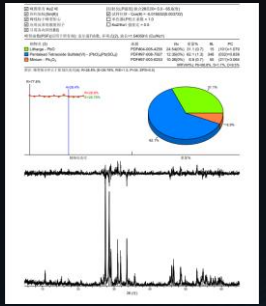


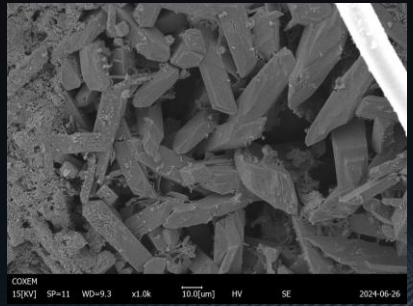


New Type of Positive Composite Additive JSS-P2

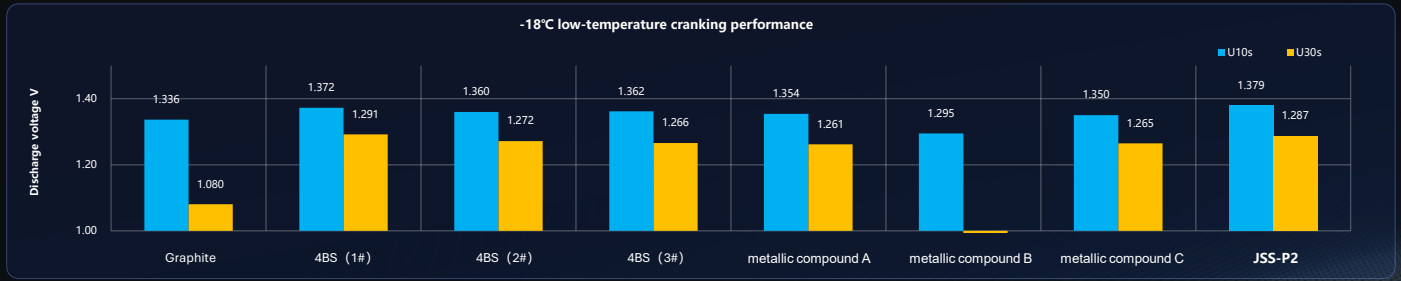
A series of studies were conducted on the aforementioned metallic compounds, successfully resolving the interference in the production of 4BS.

- The positive plates use the JSS-P2. After curing, the content of 4BS in the plate was detected to be 62.1%.



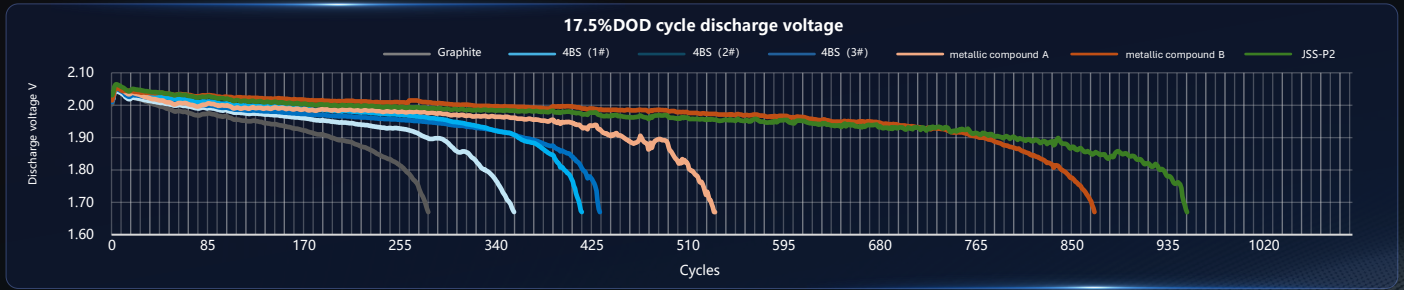


The Cranking Performance of the Positive Composite Additives



Compared with the traditional scheme, the voltage of JSS-P2 did not decrease during low-temperature discharge for 10 s or 30s.

The Cycling Performance of the Positive Composite Additives



JSS-P2 has an improvement of over 120% in the continuous 17.5% DOD life compared to the traditional 4BS.

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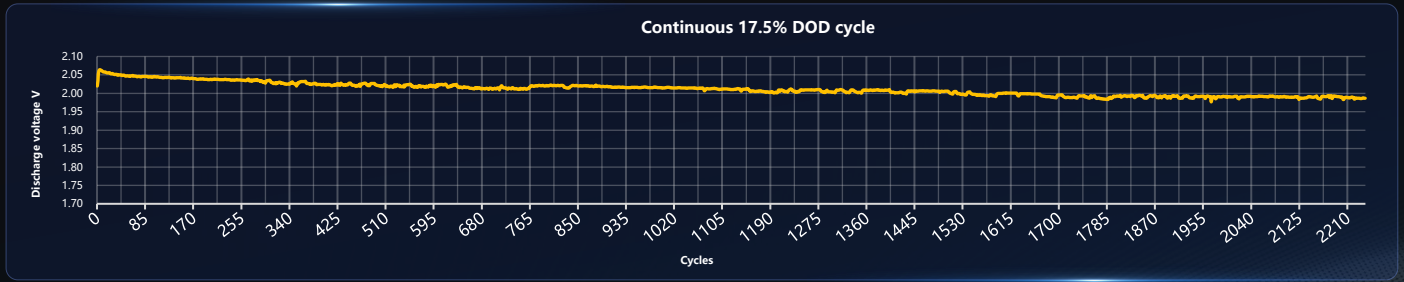
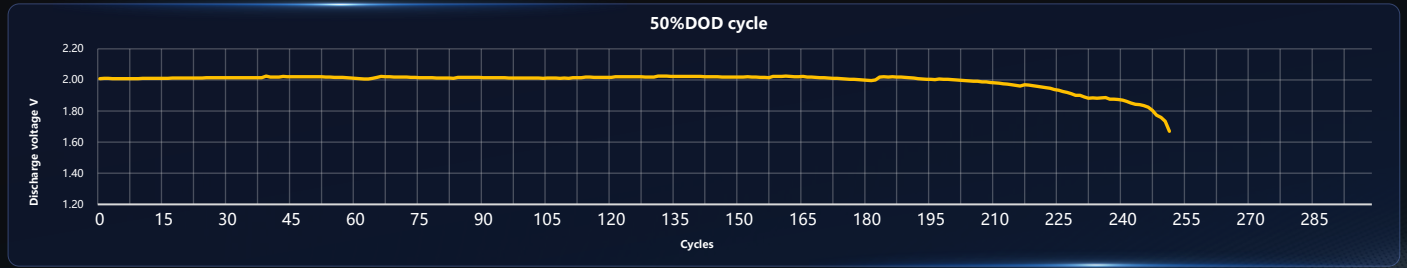
THE COMPREHENSIVE PERFORMANCE OF JSS-N2 AND JSS-P2

2V Cell Test Cycle Data



The cell test was conducted with a continuous 17.5% DOD cycle. The test was stopped after 2300 cycles, which exceeded the requirements of the VW standard.

2V Cell Test Cycle Data



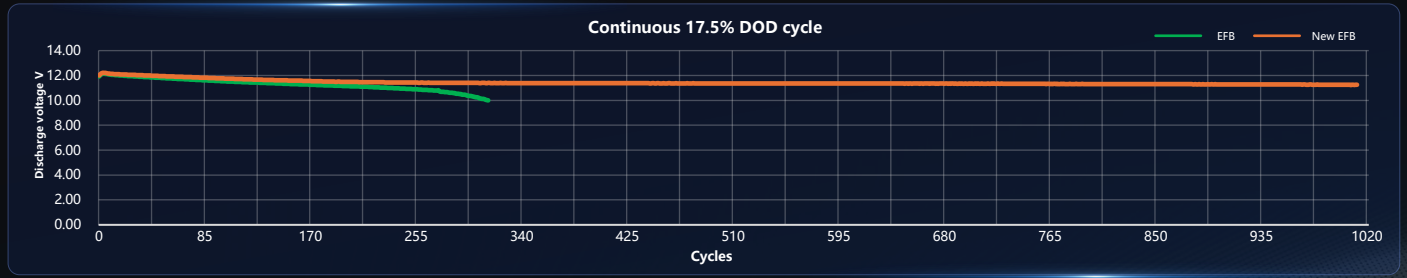
The cell test was conducted at 40°C with a 50% DOD cycle (only constant voltage charging was performed, without constant current recharging), and it stopped after 252 cycles, exceeding the requirements of the VW standard.

Battery Application Test Data

The battery manufacturers used Jinkeli's JSS-N2 and JSS-P2 to assemble the EFB-L3 batteries.

		Unit	Traditional EFB	JSS-N2 and JSS-P2
Weight	/	kg	19.807	19.908
CCA	≥ 700	A	779	771
20hr capacity	≥ 70	Ah	79.63	79.49
-18℃ low-temperature cranking	≥ 7.5	V	7.510	7.926
	≥ 90	s	145.2	143.6
Charge acceptance	≥ 2.0	/	4.24	4.39
Continuous 17.5% DOD cycle	/	cycle	313	1000+

Battery Application Test Data



During the 17.5% DOD continuous cycle test, the discharge voltage of the new EFB additive was stable, and the improvement compared to the original product was over 200%.

ADVANTAGES OF THE JSS-N2 AND JSS-P2

After laboratory verification and customer application tests,
the cycle life has increased by more than 200%.

JINKELI HOPES TO WORK TOGETHER WITH INDUSTRY COLLEAGUES TO JOINTLY PROMOTE THE LEAD ACID BATTERY INDUSTRY

THANKS

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