Independable Power Sources
March 2024,Moscow

金科力
JINKELI

Research & Development of Paste Additives for Enhanced Flooded Batteries(EFB)

山 东 金 科 力 电 源 科 技 有 限 公 司

Shandong Jinkeli Power Sources Technology Co., Ltd.

CATALOG

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CATALOG

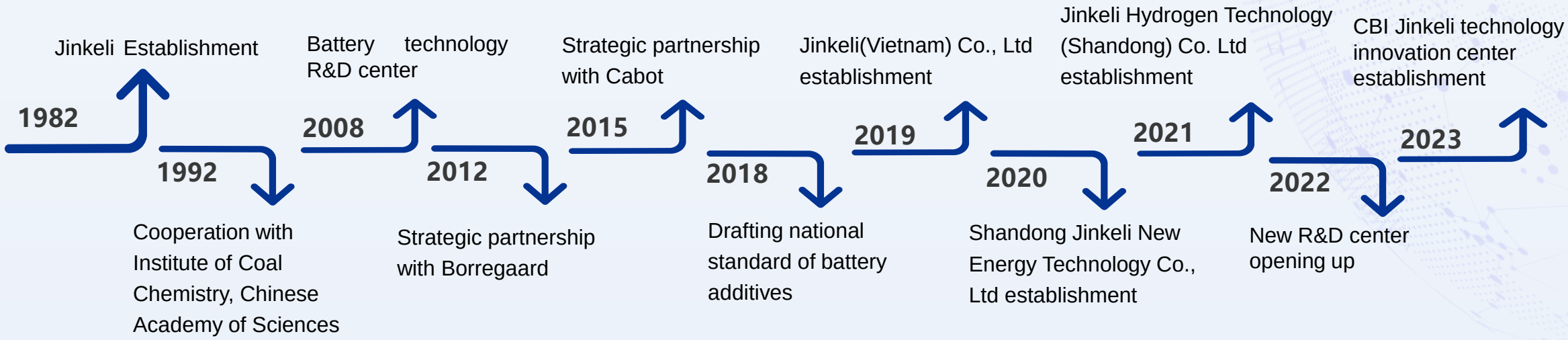
PART 01

ABOUT JINKELI

Introduction

- A leading high-tech supplier, specialized in the battery additives R&D, production, sales and service
- Headquartered in Zibo , Shandong , China. Three major production bases in Zichuan, Gaoqing, and Vietnam, with global sales and service networks

History



- **Member of CBI and CEEIA battery branch, drafter of national standard**
- **Customers centered, Jinkeli provides more valuable products and services to global customers with deep technical support and joint innovation**
- **Jinkeli has always adhered to the two core strategies of "technology innovation and internationalization", and is committed to becoming the " global leader providing complete solutions for battery additives."**

Company Structure

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Shandong Jinkeli Power Sources Technology Co., Ltd.

- **Battery Test Center**
- **Battery Technology R&D Center**

- **Jinkeli（Vietnam）Co.,Ltd.**

- **Zibo Jinkeli Special Fiber Co., Ltd.**

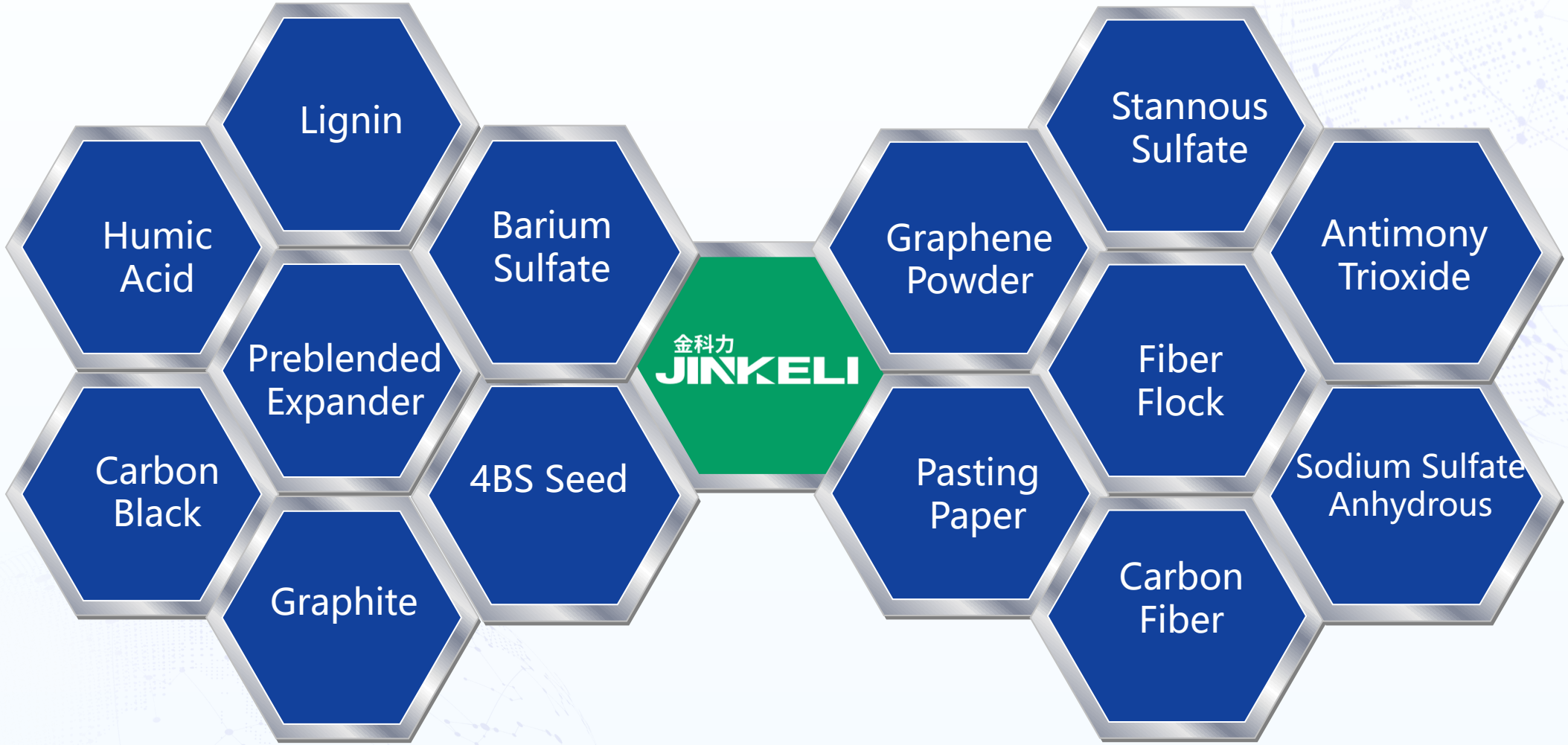
- **Jinkeli Hydrogen Technology Co. Ltd.**

- **Shandong Jinkeli New Energy Technology Co., Ltd.**

Management System Certificates

- IATF 16949
- ISO9001:2015, ISO 14001:2015, OHSAS 18001:2007

Products and Solutions of Additives



Jinkeli Battery Technology R&D Center

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2008

Establishment
CMA/CNAS certified

International R&D team

20+ battery engineers
10+ global experts & consultants

TECHNOLOGY R&D CENTER

R&D Platform

Research of New Materials And Technology To Provide Customers With Advanced Battery Solutions

All Applications

Automotive & start-stop
Motive
Energy storage
Stationary Backup

Typical Research Procedures

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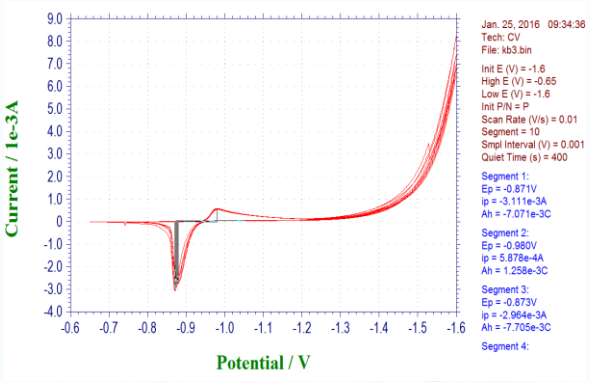
Materials Selection



Cell Testing

Battery Testing

Sample Making Procedures


Mixing


Pasting


Curing


Welding

Assembling


Formation

Battery Performance Testing

900+
TESTING CIRCUITS

66
TESTING
ITEMS/PARAMETER

Physical Testing and Chemical Analysis

Laser particle size analyzer

Detect and characterize the nanoparticle size and molecular size in different dispersion systems such as colloidal solutions, polymer solutions, microparticles, and nanoparticle suspensions and emulsions

Atomic absorption spectrometer

Materials quantitative analysis and impurity content analysis

BET

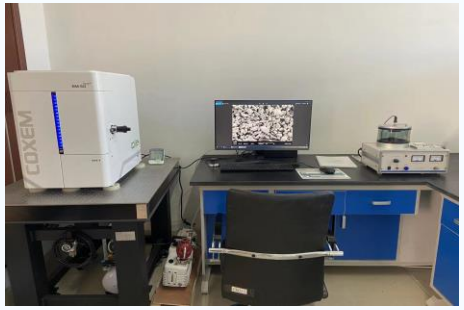
Determination of the specific surface and porosity of various powders, granules and sheet materials

DSC/TGA

Analyze the content of single materials in compound additives and the heat absorption, heat release, melting point and weight loss of other single materials

XRD

Test peak finding, phase identification, quantitative and linear analysis of powder samples



SEM

Observe the microstructure and morphology of materials, and to analyze the types and contents of components in the micro-regions of materials

PART 02

RESEARCH ON ADDITIVES

Optimization Design of Overall Performance

1.Improvement of negative plate performance

2.Improvement of positive plate performance

3.Optimization of overall design

Jinkeli has conducted systematic research on the optimization design of EFB batteries and the improvement of positive and negative paste formulas, ultimately achieving the overall performance requirements. Here is an introduction to the research and development process of negative paste additives

Material Screening Platform

Cell case size

Case size	Length/mm	Width/mm	Height/mm
Overall	66.0	30.4	107.5
internal	56.0	20.5	100.0

Plate size and quantity of paste

Grid size	Width /mm	Height /mm	Thickness /mm	Active material /g	Quantity /Pieces
Positive	44.5	72.0	2.8	27	3
Negative	44.5	72.0	1.9	19	2

Test standard：

Refer to IEC 60095-1，VDA AGM:2011-12

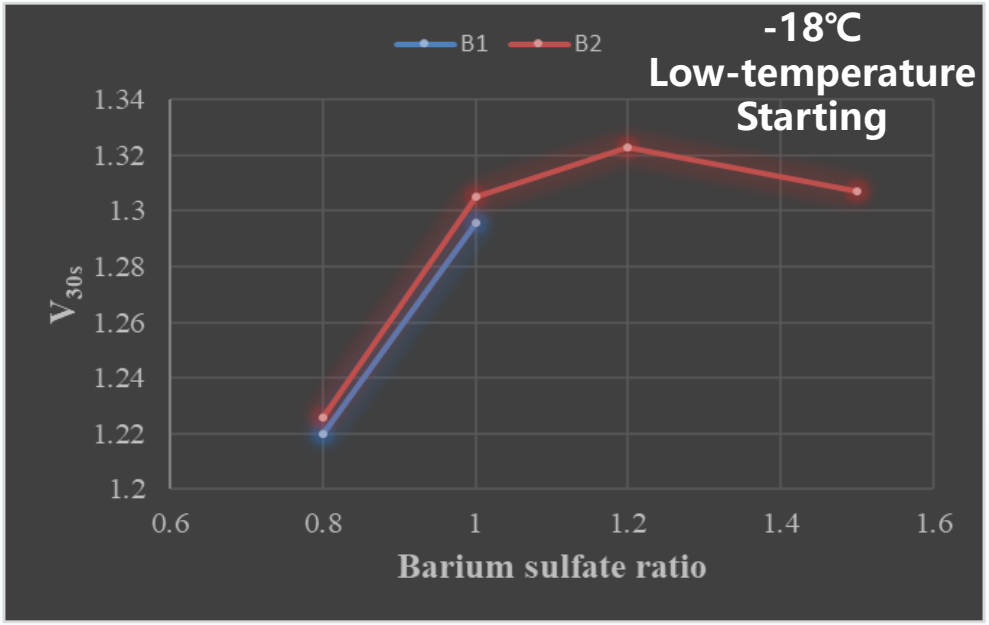
Additives for Negative Plate

Barium Sulfate

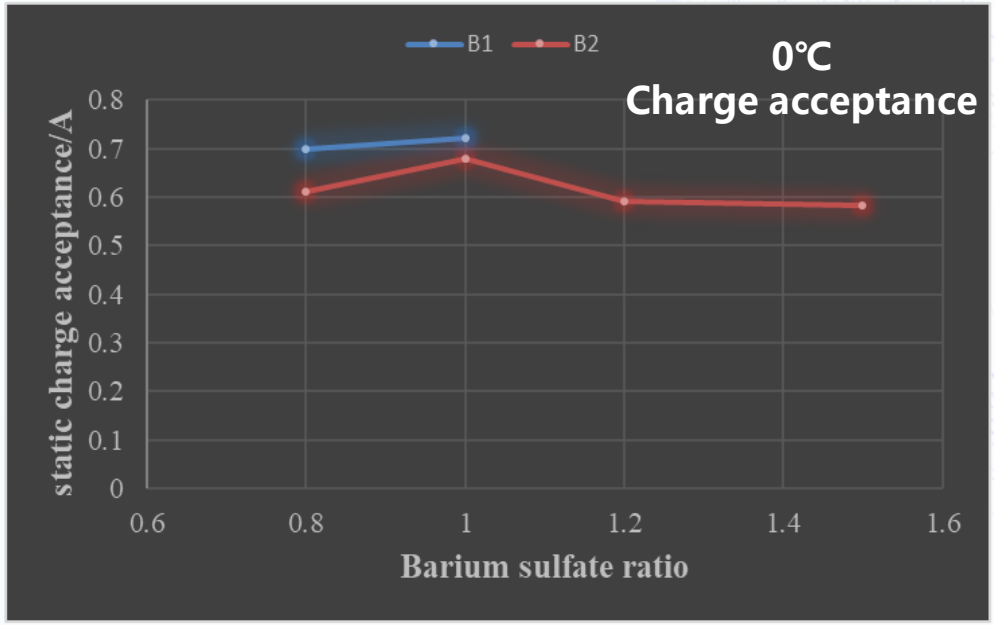
Carbon Black

Lignin

Barium Sulfate Effects

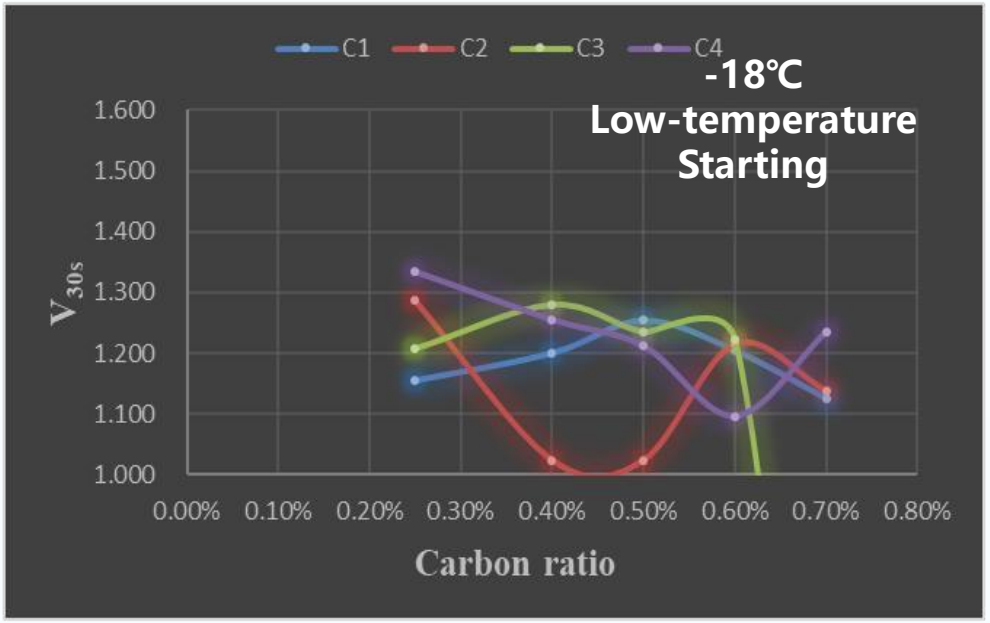


Comparison of cold cranking
(Different barium sulfate ratios)

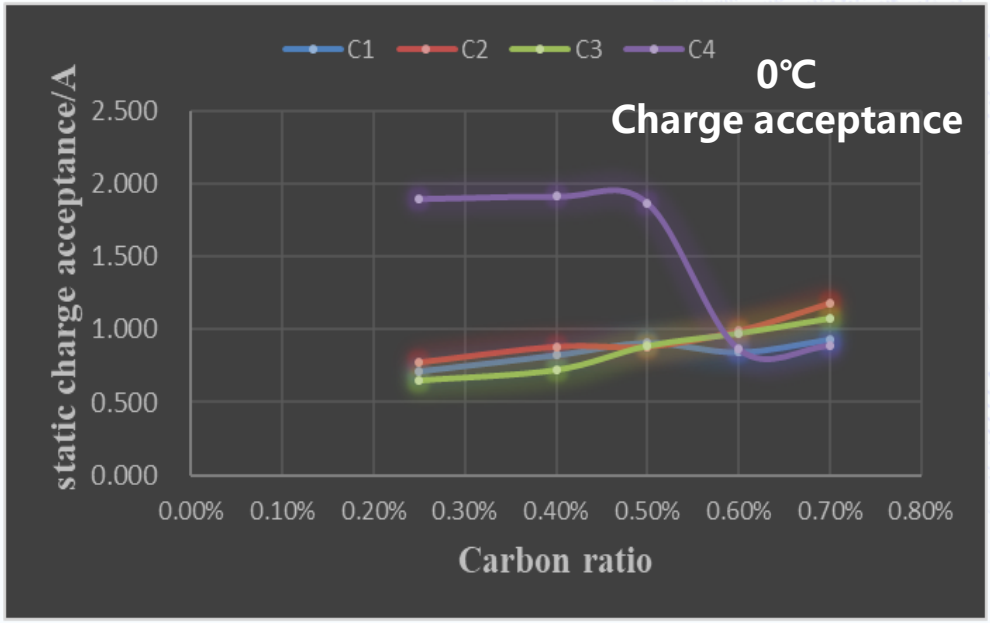


Comparison of charge acceptance
(Different barium sulfate ratios)

Carbon Black Effects

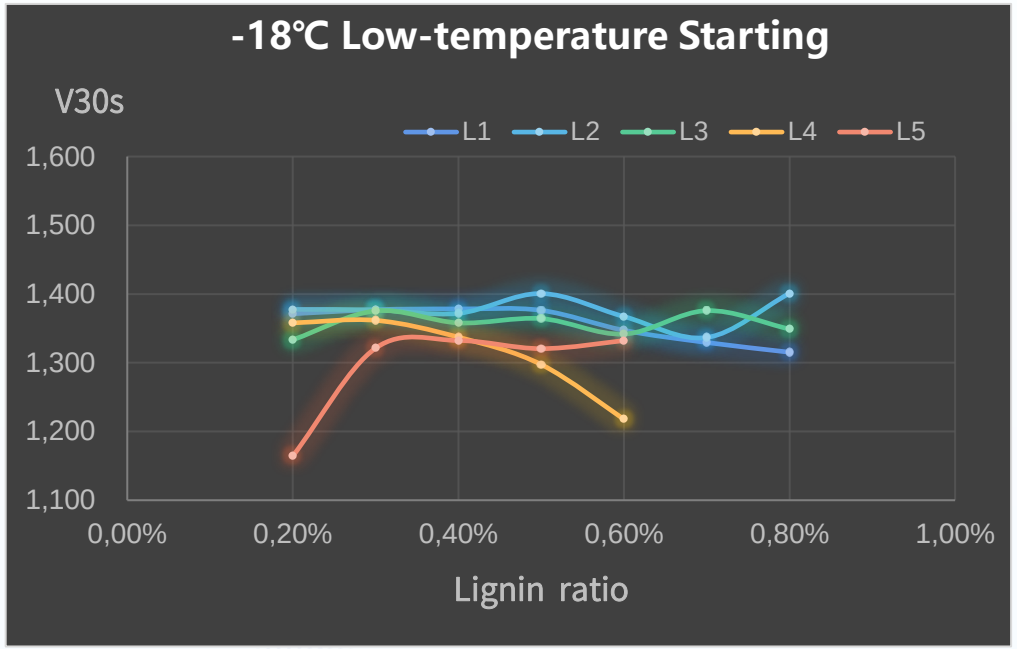


Comparison of cold cranking
(Different carbon black ratios)

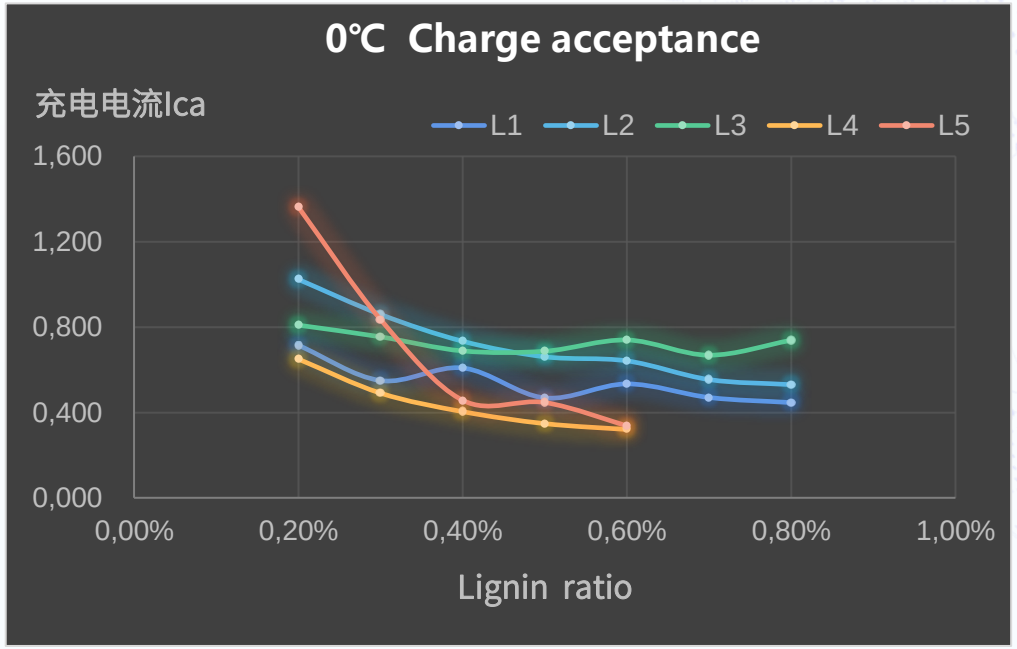


Comparison of charge acceptance
（Different carbon black ratios）

Lignin Effects

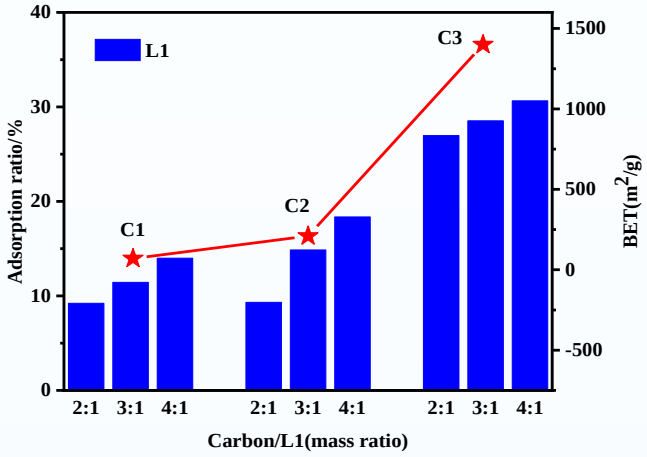


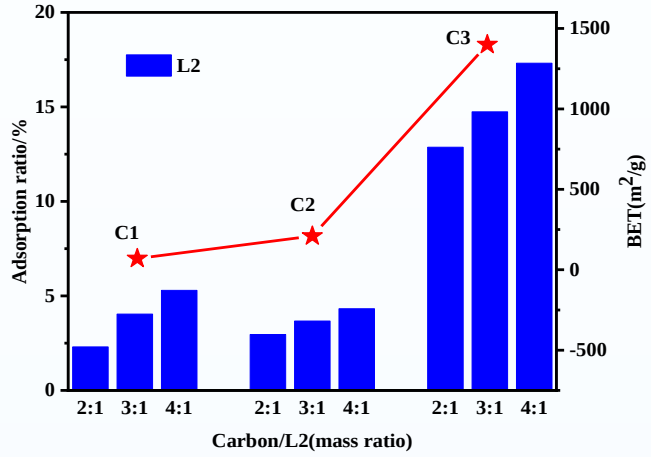
Comparison of cold cranking
(Different lignin ratios)

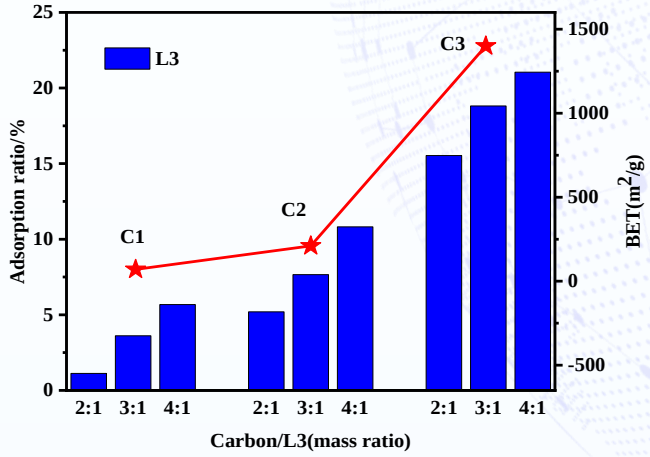


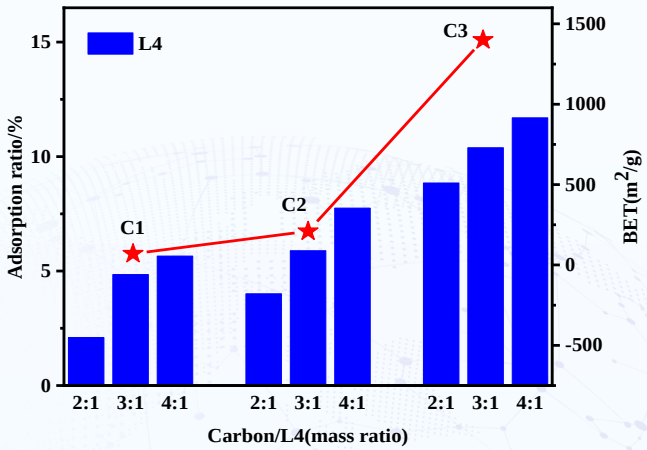
Comparison of charge acceptance
(Different lignin ratios)

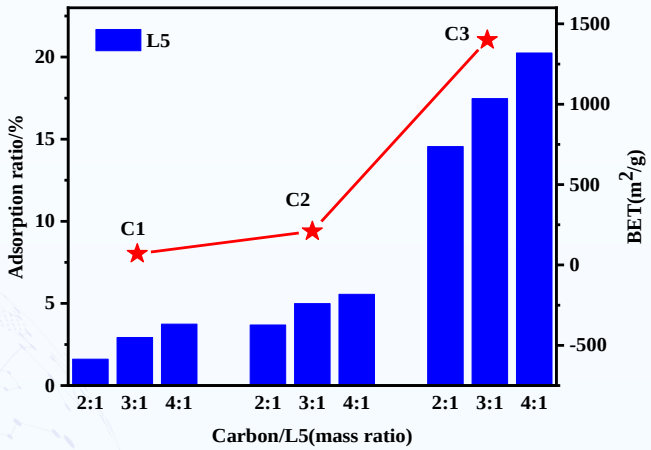
The Interaction Between Lignin and Carbon Black



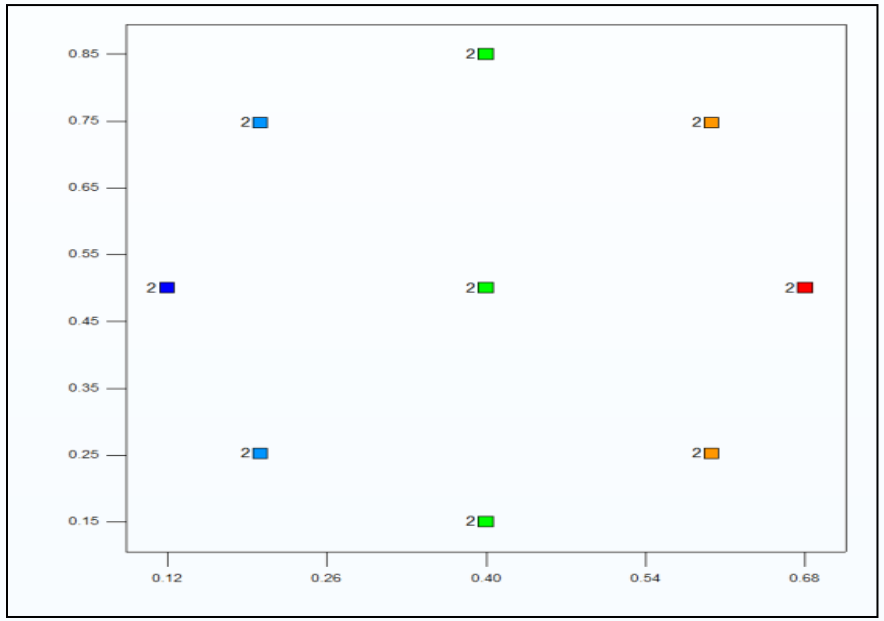




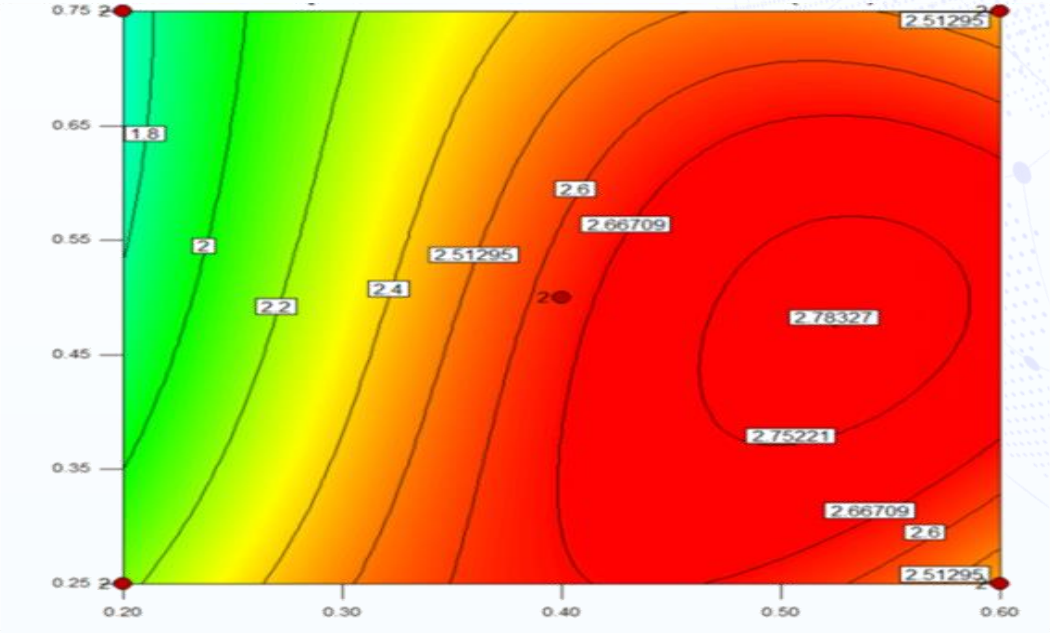




Verification of Additive Material Ratio Combination



Response surface optimization design experimental plan



Trend of ratio optimization

Brief Summary

1. Materials were optimized by studying the main negative electrode additive materials such as barium sulfate, carbon black, and lignin.
2. Material matching relationships were determined by analyzing interaction between them.
3. Multiple basic formulas were designed through response surface optimization solutions.
4. Validate the initial performance of the designed formula with laboratory cells(60Ah).

PART 03

Development of Negative Paste Additives Formula

Single Cell Test Platform

Plate size and quantity

Grid size	Height /mm	Height /mm	Grid type	Separator	Quantity /Pieces
Positive	143	102	Expanded	PE	6
Negative	143	102	Expanded	/	7

Test standard：

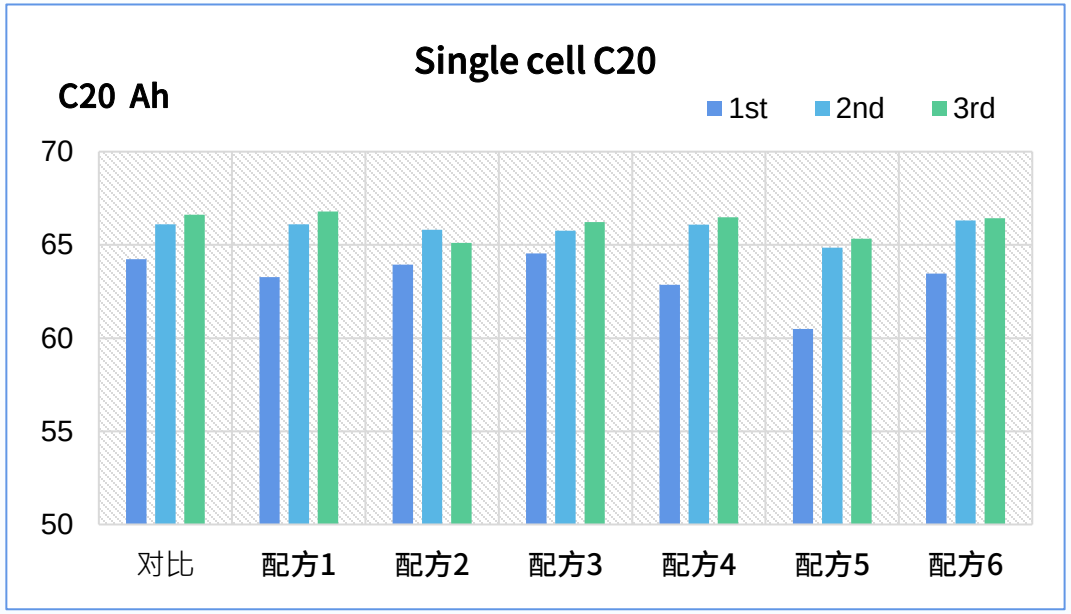
Refer to IEC 60095-1, VDA AGM:2011-12

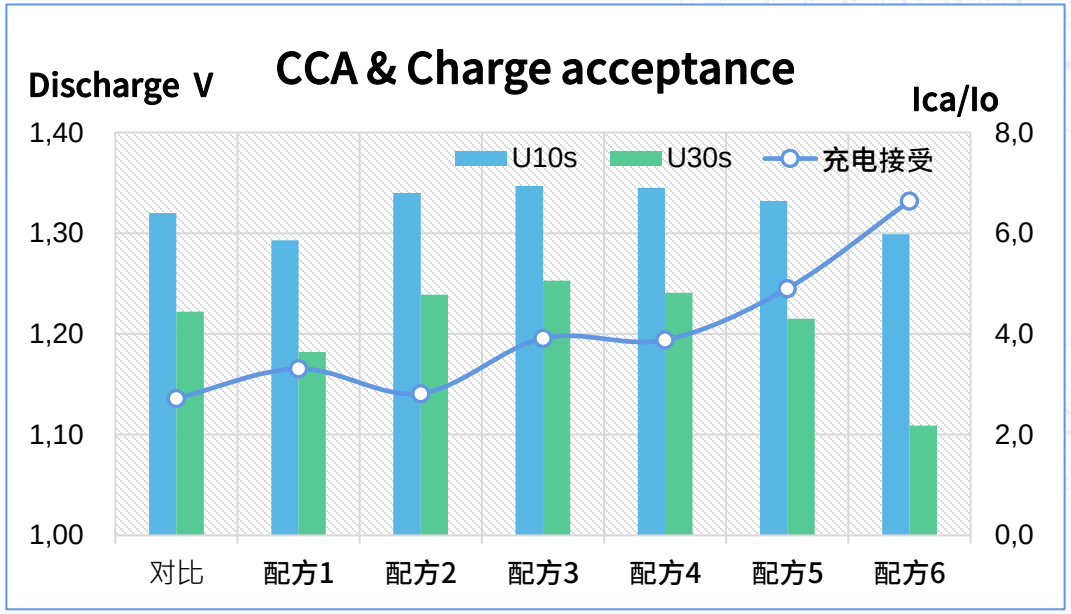
Single Cell Test

		Blank	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	Formula 6
Cell weight（g）		3518.4	3529.2	3512	3538.7	3516.8	3507.3	3497.4
OCV （V）		2.137	2.127	2.131	2.129	2.128	2.120	2.135
IR（mΩ）		0.760	0.765	0.785	0.76	0.745	0.700	0.720
C20（Ah）	1st	64.237	63.264	63.935	64.542	62.866	60.491	63.452
	2nd	66.111	66.105	65.819	65.76	66.086	64.859	66.314
	3rd	66.623	66.795	65.100	66.219	66.481	65.327	66.431
-18°C CCA (V)	U10s	1.320	1.293	1.340	1.347	1.345	1.332	1.299
	U30s	1.222	1.182	1.239	1.253	1.241	1.215	1.109
Charge acceptance Ica (A)		18.110	22.095	18.340	25.930	25.810	32.025	44.105

1. The C_{20} has increased to varying degrees.
2. After 10 seconds of cold cranking discharge, the voltage of the experimental formula has increased, and result of formula 2 to 4 are more significantly .
3. The charge acceptance of experimental formula has generally improved, with results of formula 5 and 6 being the most significant .

Single Cell Test





The test data shows an overall advantage, but the range value is greatly affected by manufacturing consistency.

Choose a formula that balances low-temperature and charge acceptance performance, and have customers conduct on-site manufacturing verification .

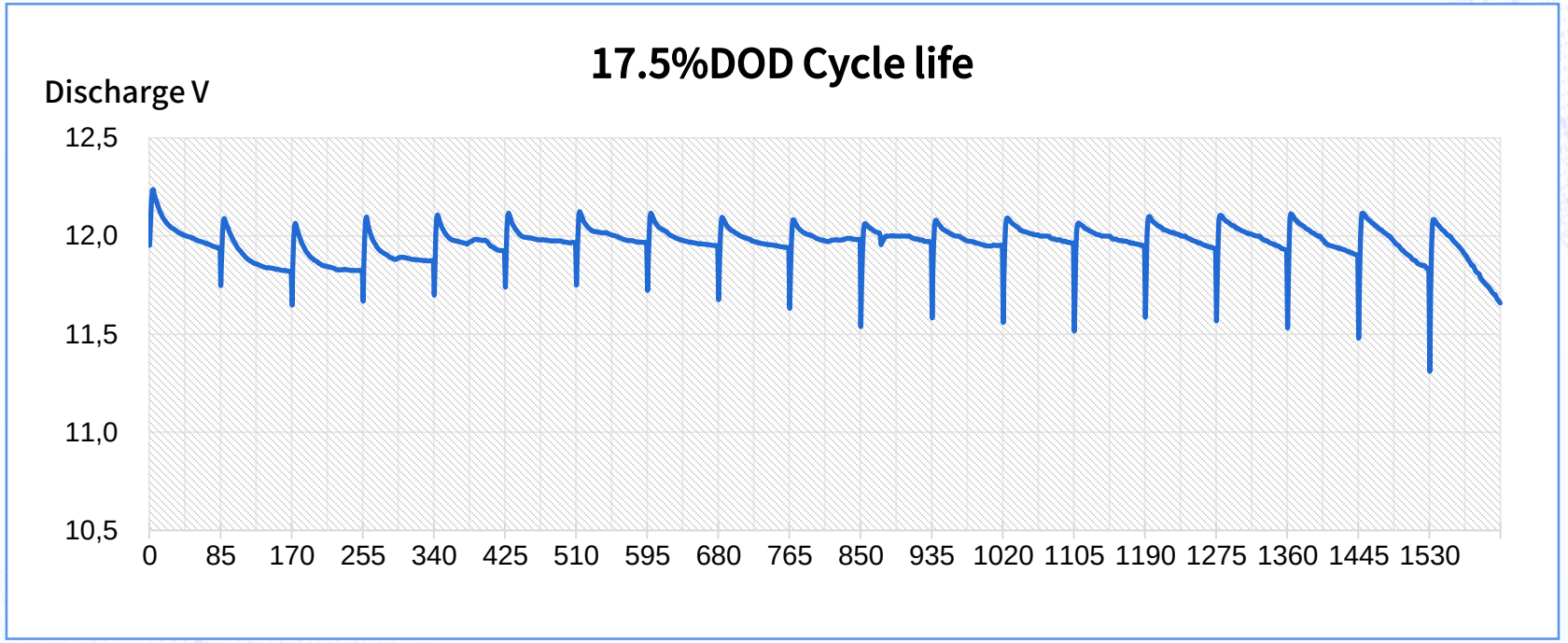
Initial Performance Data of Test Batteries

Factories		/	A	V	T	L	Jinkeli
Test item		Standard	12V65Ah	12V65Ah	12V60Ah	12V60Ah	12V60Ah
Weight（kg）		≤18.5	16.435	16.940	17.580	17.415	17.410
I.R.（mΩ）		/	3.580	4.700	4.100	3.900	3.55
C_{20}（Ah）		≥Cn	60.095	73.444	66.093	63.743	70.164
-18℃ Cold cranking (640A)	U10s（V）	≥7.50	7.843	7.738	7.835	8.151	8.398
	U30s (V)	≥7.20	7.408	7.206	7.312	7.674	7.745
Charge acceptance Ⅰ		≥ 2.5	4.70	4.35	5.35	4.89	5.02
Charge acceptance Ⅱ (As)		≥Cn/360*3600	508	325	494	339	610
Notes			Battery in the market				Customer testing

The customer assembled a 12V60Ah battery and conducted a series of performance tests, comparing it with similar products in the market.

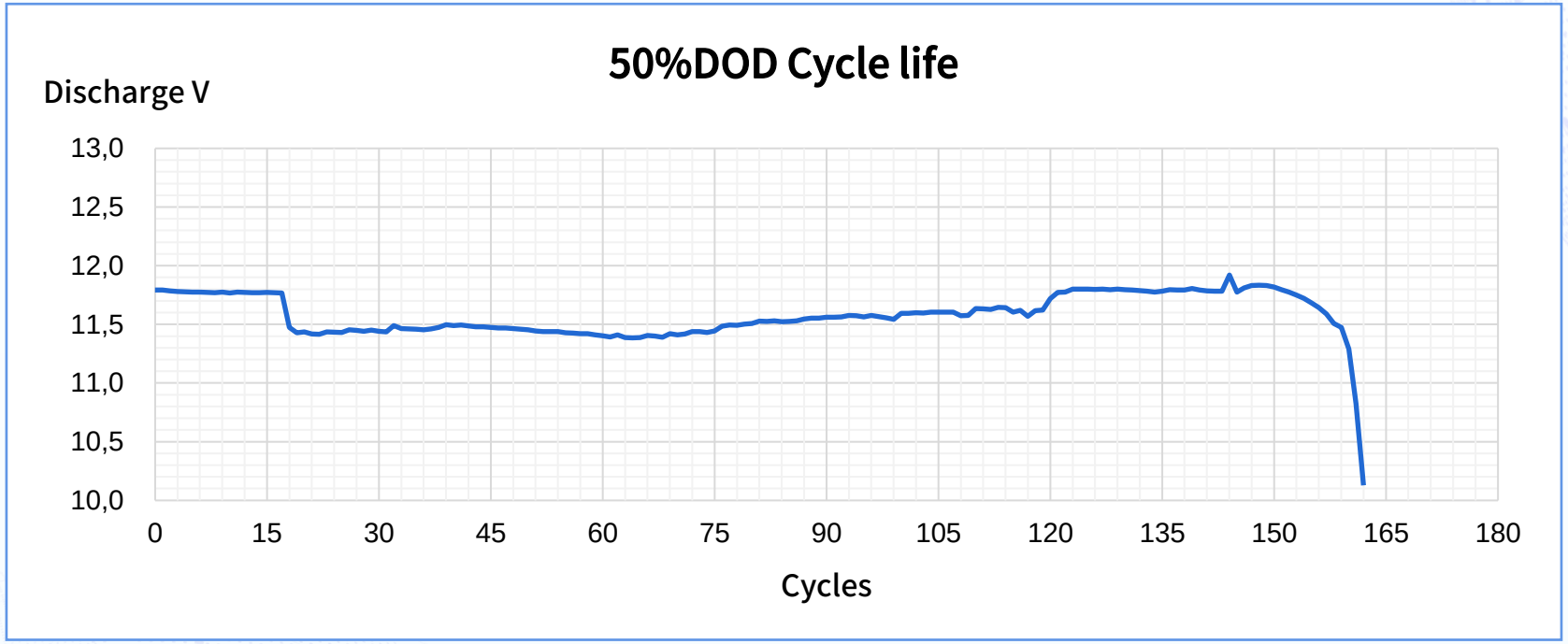
The formula shows significant advantages in terms of capacity,cold cranking performance and charge acceptance.

Battery Cycle Curve



Test 17.5% DOD cycle and terminate the test after 18 units.
(Testing standard requirement ⩾ 9 units)

Battery Cycle Curve

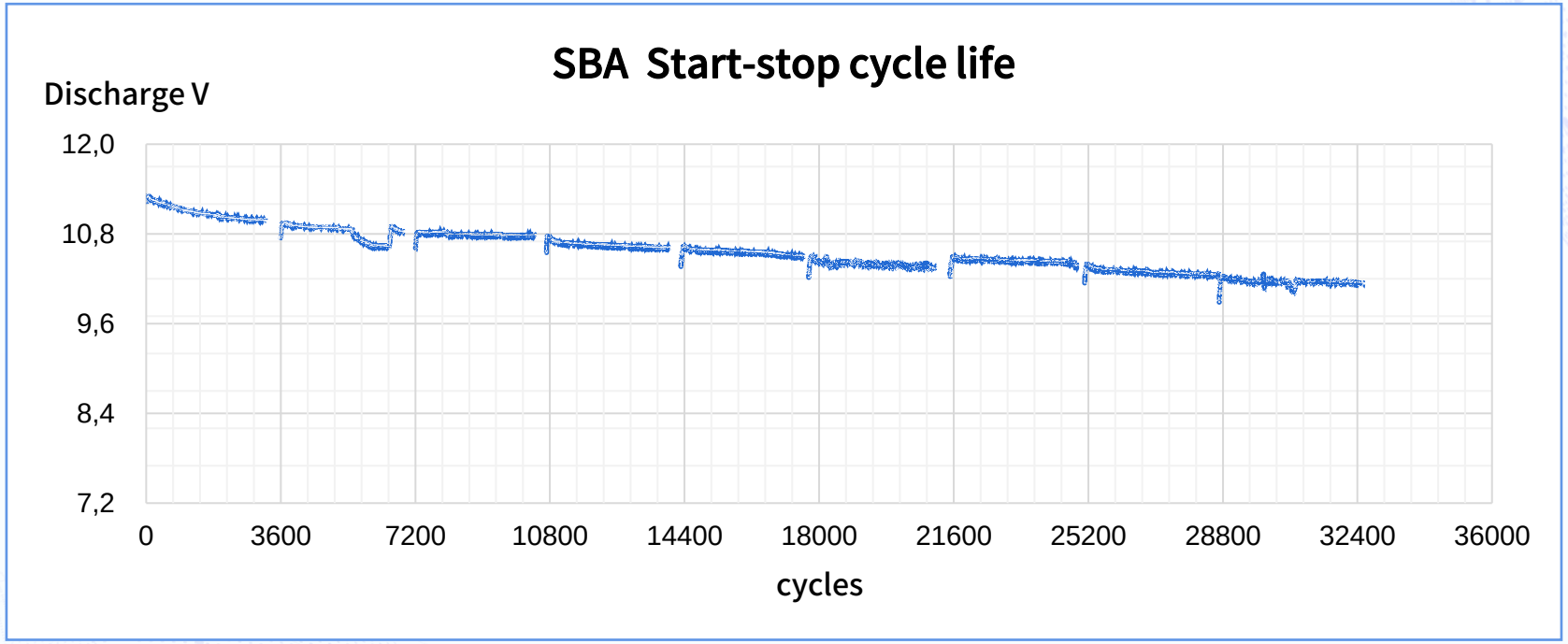


Test 50% DOD cycle at 40 ℃, end after 162 cycles.

(Testing standard requirement ⩾ 120 cycles)

The reason is positive plate softening and grid corrosion.

Battery Cycle Curve



Test the start stop cycle according to the SBA method and terminate the test 32500 times.

Meets the requirement of ⩾ 30000 times.

Brief Summary

1. The experimental formula has been tested in a single cell and all performance has been improved under the same design. The selected formula has a relatively balanced cold cranking performance and charge acceptance performance ;
2. The JSS-06 formula has been verified by actual battery samples and has advantages over similar products in the market in terms of initial low-temperature starting and charge acceptance ;
3. The JSS-06 formula test meets the standard in terms of 17.5% DOD cycle, 50% DOD cycle, and SBA start stop cycle.

PART 04

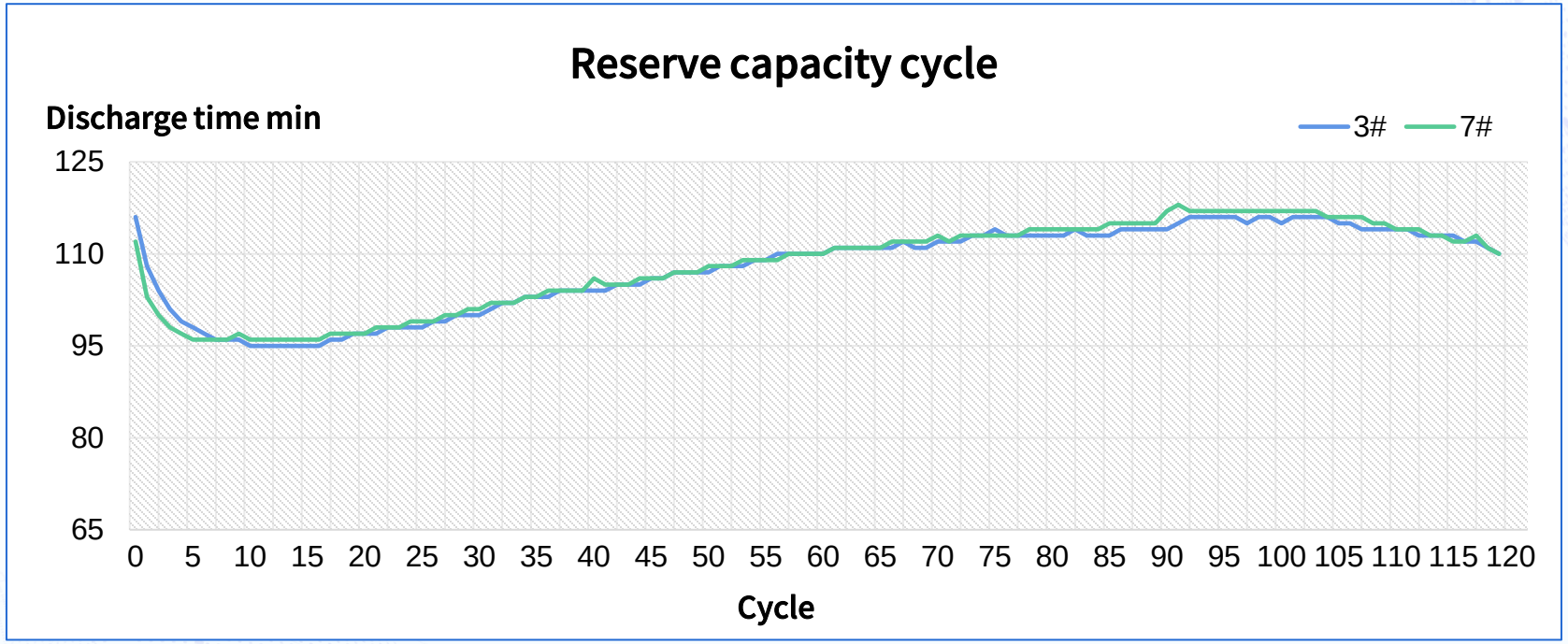
FEEDBACK ON FORMULA APPLICATION

Customer's test data

The customer used Jinkeli formula to test the initial and cycling performance of S95 batteries.
The data is shown in the table below:

Item		Standard	1#	2#	3#	4#	5#	6#	7#	8#
OCV （V）		⩾12.80	12.97	12.97	12.98	12.97	12.97	12.97	12.97	12.96
Weight （kg）		⩽21.0	19.75	19.80	19.85	19.80	19.85	19.80	19.80	19.75
Midtronic CCA		⩾645	1019	1035	1027	1031	1031	1031	1023	1023
IR		/	3.15	3.16	3.13	3.13	3.09	3.15	3.13	3.13
RC（min）		⩾110	122	124	120	121	123	121	123	120
C20 （Ah）		⩾64.0	68.80	69.55	67.04	67.84	67.15	67.41	67.68	66.51
-18℃ Cold cranking (V)	U10s	⩾7.50	8.63	8.50	8.64	8.60	8.61	8.63	8.61	8.59
	U30s	⩾7.20	8.26	8.03	8.25	8.23	8.22	8.24	8.23	8.23
Charge acceptance		⩾2.5	4.73				5.35			
17.5%DOD Cycle（unit）		⩾9		22				23+		
50%DOD Cycle（cycle）		⩾120				259				255
RC Cycle（cycle）		/			120				120	

Customer's test data



After 120 cycles reserve capacity by the customer, battery can still discharged for 110 minutes, and the low-temperature performance meets the requirements.

Summary

- **Fives series of negative paste additives for various battery application**

JS Series	JSS Series	JV Series	JSP Series	JEV Series
Automobile and motorcycle batteries	Start-stop battery	Telecom battery, UPS battery	Energy storage battery	Motive battery

- **The JSS-06 negative paste additive can significantly improve the comprehensive performance of EFB and has the following advantages：**

1. Optimized composition, excellent performance in improving low-temperature discharge, charge acceptance, and cycle life；

2.The formula is accurately weighed, stable and reliable, and does not require special process adjustments during use, making it convenient to use at any time；

3.Paired with positive paste additives JSS-1002 and high-strength short fibers, better results can be achieved.

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Thank you!

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