

Letter of Attestation

Document: 80008629

Master Contract: N/A

Project: 80008629

Date Issued: August 27, 2019

Issued to: Contemporary Amperex Technology Co., Limited
No. 2 Xingang Road, Zhangwan Town, Jiaocheng District
Ningde City, Fujian Province 352100, P. R. China
Attention: Ms Sandy Lv

*CSA Group hereby confirms that it has completed an evaluation of:
Li-ion Battery Cell, model 001CB310*

*CSA Group hereby attests that the products identified above and described
in test report 80008629 dated Aug 27, 2019 complies with the following test, to the extent applicable:*

*UL 9540A Test Method for Evaluating Thermal Runaway Fire
Propagation in Battery Energy Storage Systems, 3rd edition, Revision Date Jun 15, 2018*

Section 6 Cell Level testing without lower flammability limit of the cell vent gas.



Issued by:



CSA Group

THIS LETTER OF ATTESTATION DOES NOT AUTHORIZE THE USE OF THE CSA MARK ON THE SUBJECT PRODUCTS.

QUOTATIONS FROM THE TEST REPORT OR THE USE OF THE NAME OF THE CANADIAN STANDARDS ASSOCIATION AND CSA GROUP OR ITS REGISTERED TRADEMARK, IN ANY WAY, IS NOT PERMITTED WITHOUT PRIOR WRITTEN CONSENT OF CSA GROUP.



Descriptive Report and Test Results

MASTER CONTRACT: N/A

REPORT: 80008629

PROJECT: 80008629

Edition 1: August 27, 2019; Project 80008629
Issued by Joseph Zhou

Contents: Letter of Attestation - Page 1 to 1
Description and Tests - Pages 1 to 23

PRODUCTS

Li-ion Battery Cell, model 001CB310, nominal voltage 3.2V, 280Ah

APPLICABLE REQUIREMENTS

UL 9540A - Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems,
3rd edition

This report shall not be reproduced, except in full, without the approval of CSA Group.

DESCRIPTION AND TEST REPORTS

Testing Laboratory Name:	CCIC-CSA International Certification Co., Ltd. Kunshan Branch		
Address:	Building 8, Tsinghua Science Park, No. 1666 Zu chongzhi Rd (S) , Kunshan, Jiangsu (215347)		
Testing Program:	Custom Test:	Latter of Attestation <input checked="" type="checkbox"/>	Testing Only <input type="checkbox"/>
Note: Mark " X " in applicable test program block			

If tests were performed at another facility, then described below:

Testing Laboratory Name:	Contemporary Amperex Technology Co., Limited
Address:	No. 2 Xingang Road, Zhangwan Town, Jiaocheng District Ningde City, Fujian Province 352100, P. R. China
Facility Qualification Number:	N/A

Customer:	<i>As above / or describe otherwise</i> Contemporary Amperex Technology Co., Limited
Address:	No. 2 Xingang Road, Zhangwan Town, Jiaocheng District Ningde City, Fujian Province 352100, P. R. China

Tested By:	Yupin Li, Test Engineer	
	<i>Name, Title</i>	
	Yupin Li, Test Engineer	2019-06-19
	<i>Signature</i>	<i>Date (YYYY-MM-DD)</i>
<input type="checkbox"/> Reviewed by:	Joseph Zhou/Giggle Pei, Certifier	
<input checked="" type="checkbox"/> Witnessed by:	<i>Name, Title</i>	
	Joseph Zhou	2019-08-13
	<i>Signature</i>	<i>Date (YYYY-MM-DD)</i>

Version: 2019-05-09

Product Details	
Test Request:	<input checked="" type="checkbox"/> Cell Level Testing <input type="checkbox"/> Module Level Testing <input type="checkbox"/> Unit Level Testing <input type="checkbox"/> Installation Level Testing
Manufacturer	<input checked="" type="checkbox"/> Cell: Contemporary Amperex Technology Co., Limited <input type="checkbox"/> Module: <input type="checkbox"/> Unit:
Brand name / Trademark	<input checked="" type="checkbox"/> Cell: N/A <input type="checkbox"/> Module: <input type="checkbox"/> Unit:
Model Number	<input checked="" type="checkbox"/> Cell: 001CB310 <input type="checkbox"/> Module: <input type="checkbox"/> Unit:
Date of receipt of test sample(s)	2019-06-07
Cell/Battery Type	Li-ion, LFP
Approximate Dimension (mm)	<input checked="" type="checkbox"/> Cell: 174.0*207.2*71.7mm <input type="checkbox"/> Module: <input type="checkbox"/> Unit:
Mass (g)	<input checked="" type="checkbox"/> Cell: see page 5 <input type="checkbox"/> Module: <input type="checkbox"/> Unit:
DUT Sample/Serial Number	<input checked="" type="checkbox"/> Cell: See page 5 <input type="checkbox"/> Module: <input type="checkbox"/> Unit:
DUT Nominal Voltage Rating (V)	<input checked="" type="checkbox"/> Cell: 3.2V <input type="checkbox"/> Module: <input type="checkbox"/> Unit:
DUT Nominal Charge Capacity Rating (Ah)	<input checked="" type="checkbox"/> Cell: 280Ah <input type="checkbox"/> Module: <input type="checkbox"/> Unit:
Fire Mitigation Strategies: (For installation level testing)	<input type="checkbox"/> Water: <input type="checkbox"/> Other (Specify): <input checked="" type="checkbox"/> N/A
Additional Information	N/A

THE TESTING SPECIFIED IN THIS PROCEDURE IS INHERENTLY DANGEROUS

DO NOT ATTEMPT TO PERFORM THIS TEST UNLESS YOU HAVE BEEN PROPERLY TRAINED REGARDING SAFELY WORKING WITH THE HAZARDS INVOLVED

Important Test Consideration:

- As some batteries expose in test described above, it is important that personal be protected from the flying fragments, explosive force, and sudden release of heat, chemical burns, and noise result from such explosions. The test area is to be well ventilated to protect personal from possible harmful fumes or gases.
- Temperature of the surface of the battery casing shall be monitored during the tests described above. All personal involve in the testing of batteries are to be instructed never to approach a battery until the surface temperature return to ambient temperature.
- Test shall be conducted in separate room or equipped with an adequate safety barrier separating the test area from observer.

UL 9540 A – Definition

- **“BATTERY ENERGY STORAGE SYSTEM (BESS)”** - Stationary equipment that receives electrical energy and then utilizes batteries to store that energy for later use in order to supply electrical energy when needed. The BESS consists of one or more modules, a power conditioning system (PCS) and balance of plant components.

a) **INITIATING BATTERY ENERGY STORAGE SYSTEM UNIT (INITIATING BESS)** – A BESS unit which has been equipped with resistance heaters in order to create the internal fire condition necessary for the installation level test (Section 8).

b) **TARGET BATTERY ENERGY STORAGE SYSTEM UNIT (TARGET BESS)** – The enclosure and/or rack hardware that physically supports and/or contains the components that comprise a BESS. The target BESS unit does not contain energy storage components, but serves to enable instrumentation to measure the thermal exposure from the initiating BESS.

- **“CELL”** -The basic functional electrochemical unit containing an assembly of electrodes, electrolyte, separators, container, and terminals. It is a source of electrical energy by direct conversion of chemical energy.

- **“DUT”** – Device under test.

- **“ELECTRICAL RESISTANCE HEATERS”** – Devices that convert electrical energy supplied from a laboratory source into thermal energy.

- **“FLEXIBLE FILM HEATERS”** – Electrical resistance heaters of a film, tape or otherwise thin sheet like construction that easily conform to the surface of cells.

- **“MODULE”** – A subassembly that is a component of a BESS that consists of a group of cells or electrochemical capacitors connected together either in a series and/or parallel configuration (sometimes referred to as a block) with or without protective devices and monitoring circuitry.

- **“STATE OF CHARGE (SOC)”** – The available capacity in a BESS, pack, module or cell expressed as a percentage of rated capacity.

- **“THERMAL RUNAWAY”** – The incident when an electrochemical cell increases its temperature through self-heating in an uncontrollable fashion. The thermal runaway progresses when the cell’s generation of heat is at a higher rate than the heat it can dissipate. This may lead to fire, explosion and gas evolution.

- **“UNIT”** – A frame, rack or enclosure that consists of a functional BESS which includes components and subassemblies such as cells, modules, battery management systems, ventilation devices and other ancillary equipment.

UL 9540A Third Edition, Dated June 15, 2018 - Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

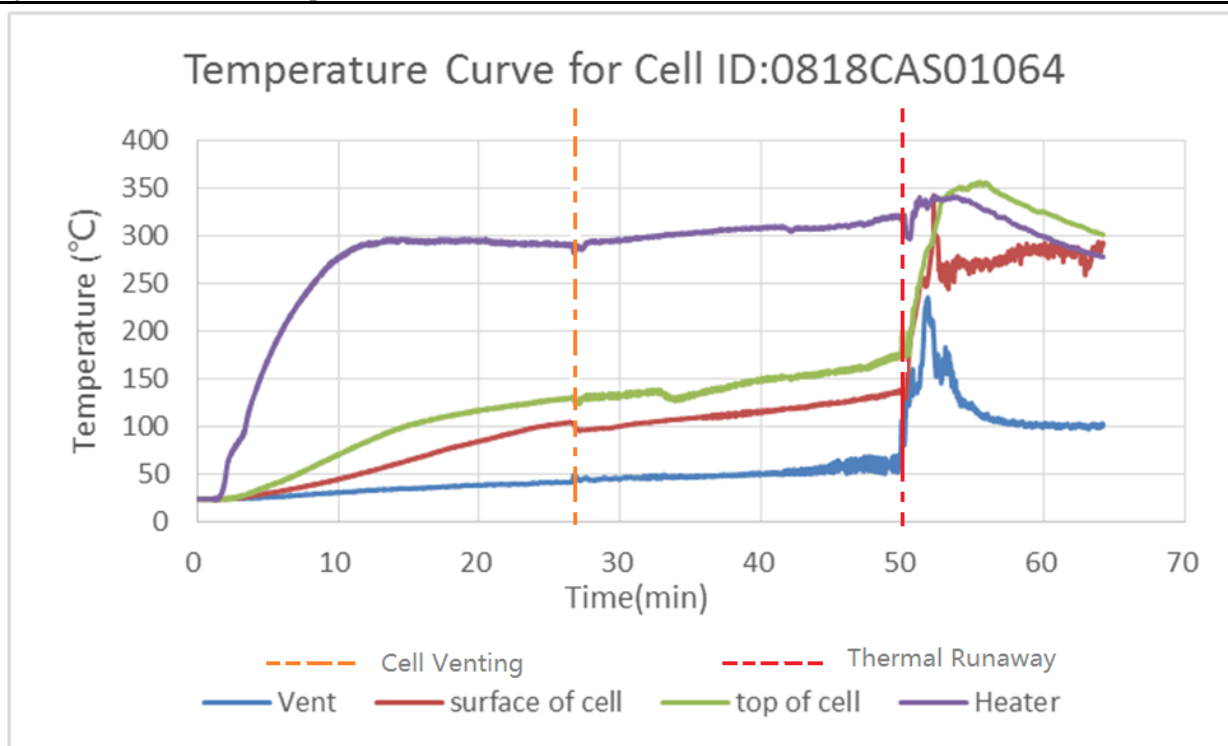
Section	Requirement	Test (T) / Waive (W) / Not App. (N/A)	Comments																
1	Scope: The test methodology in this document evaluates the fire characteristics of a battery energy storage system that undergoes thermal runaway. Fire protection requirements not related to battery energy storage system equipment are covered by appropriate installation codes.																		
	Section 6: Cell Level Test	T	Chemistry: Li-ion Physical Format: Prismatic Capacity (Whr): 896 Energy (Ahr): 280 Nominal Voltage (Vdc): 3.2 Approximate Dimension (mm): 174.0*207.2*71.7mm Weight (g): See below: <table><thead><tr><th rowspan="2">Sample ID</th><th colspan="2">Weight, g</th></tr><tr><th>Before Test</th><th>After Test</th></tr></thead><tbody><tr><td>0818CAS01064</td><td>5412.4</td><td>4153.6</td></tr><tr><td>0818CAS01045</td><td>5399.6</td><td>4146.1</td></tr><tr><td>0818CAS01180</td><td>5391.1</td><td>4149.0</td></tr><tr><td>0818CAS01047</td><td>5414.1</td><td>4153.2</td></tr></tbody></table> Cell Comply With UL 1973 Requirement (Yes/No) : Yes Cell with UL approval under File MH62898, Vol.1, Project number 4789054368.	Sample ID	Weight, g		Before Test	After Test	0818CAS01064	5412.4	4153.6	0818CAS01045	5399.6	4146.1	0818CAS01180	5391.1	4149.0	0818CAS01047	5414.1
Sample ID	Weight, g																		
	Before Test	After Test																	
0818CAS01064	5412.4	4153.6																	
0818CAS01045	5399.6	4146.1																	
0818CAS01180	5391.1	4149.0																	
0818CAS01047	5414.1	4153.2																	
	Section 7: Module Level Test	N/A	Module Level testing not requested by manufacturer																
	Section 8: Unit Level Test	N/A	Unit Level testing not requested by manufacturer																
	Section 9: Installation Level Test (With fire mitigation strategies)	N/A	Installation Level testing not requested by manufacturer																

UL 9540A Third Edition, Dated June 15, 2018 - Section 6 Cell Level Testing

Section	Requirement	Comments	Verdict
Possible test case verdicts:			
Test case does not apply to the test object: N/A (Not Applicable)			
Test object does meet the requirement: P (Pass)			
Test object does not meet the requirement: F (Fail)			
6	Cell Level Testing		P
6.1	Cell Sample conditioned for min 2 charge (100% SOC) - discharge (Specified end of discharge voltage) cycle as per manufacturer specified method.	Manufacture recommended charge/discharge method: Charging Procedure: CC-CV Charging Voltage (V): 3.65 Charging Current (A): 140 Charging End Condition (A): 14 Discharging Procedure: CC Discharging Current (A): 140 End of Discharge Voltage (V): 2.5	P
	Cells under test are functional after charge discharge cycle.	<input checked="" type="checkbox"/> Conformed	P
	Ambient temperature during cell conditioning and during test..... Note: Ambient indoor laboratory conditions shall be 25 ±5°C (77 ±9°F) and 50 ±25% RH at the initiation of the test.	Temperature(°C): 24.5 to 24.5 Humidity (% RH): 60 to 70	P
	The tested cells have 100% SOC at the start of the test. The samples were allowed to stabilize for a minimum of one hour prior to testing.	<input checked="" type="checkbox"/> Conformed	P
6.2	Propensity of cell to exhibit thermal runaway demonstrated by externally applied Film Heater	<input checked="" type="checkbox"/> Additional method used: External heating method with ceramic heater 1 PCS, rated 220/230V, 500W.	N/A
	Surface heating rate maintained at 5°C (9°F) to 7°C (12.6°F) per minute	The heating rate is greater than 7°C per minute, thermal runaway was triggered, with total 4 cell samples tested.	N/A
	Other alternate method used to exhibit thermal runaway	Thermal runaway was triggered on total 4 cells using external heating methods in a 82L vessel one by one, with initial gases inside the vessel measured, released gases after thermal runaway were collected, temperature in which the cell first vented and thermal runaway triggered monitored and also gas composition measured.	P

Section	Requirement	Comments	Verdict		
Possible test case verdicts:					
Test case does not apply to the test object:		N/A (Not Applicable)			
Test object does meet the requirement:		P (Pass)			
Test object does not meet the requirement:		F (Fail)			
	Temperature measurement recorded using thermocouple junction formed from 30-gauge Type-K thermocouple wire.	<input checked="" type="checkbox"/> Conformed See below for the thermocouple locations: CH-3: Vessel upper inside CH-4: Vessel inside(above the cell venting hole) CH-5: Cell container (near the venting hole) CH-6: Cell container(side) CH-7: Vessel bottom inside CH-8: Heater surface	P		
Section 6.2		TABLE: Determination of thermal runaway methodology			
Sample No	Open Circuit Voltage Before Test (Vdc)	Cell Failure method	Cell Surface Temperature at which gases are first vented (°C)	Cell Surface Temperature prior to thermal runaway (°C)	Location of Maximum Temperature prior to thermal runaway
0818CAS01064	3.38	External Heating	130.3	193.4	Cell Side enclosure
0818CAS01045	3.39	External Heating	147.8	223.4	Cell Side enclosure
0818CAS01180	3.39	External Heating	149.3	211.2	Cell Side enclosure
0818CAS01047	3.36	External Heating	145.9	211.2	Cell Side enclosure
Supplementary information:					
Temperature Curve and test sample figure:					

Section	Requirement	Comments	Verdict
Possible test case verdicts:			
Test case does not apply to the test object:	N/A (Not Applicable)		
Test object does meet the requirement:	P (Pass)		
Test object does not meet the requirement:	F (Fail)		



Sample ID: 0818CAS01064



Before Test



After Test

Temperature Curve and test sample figure:

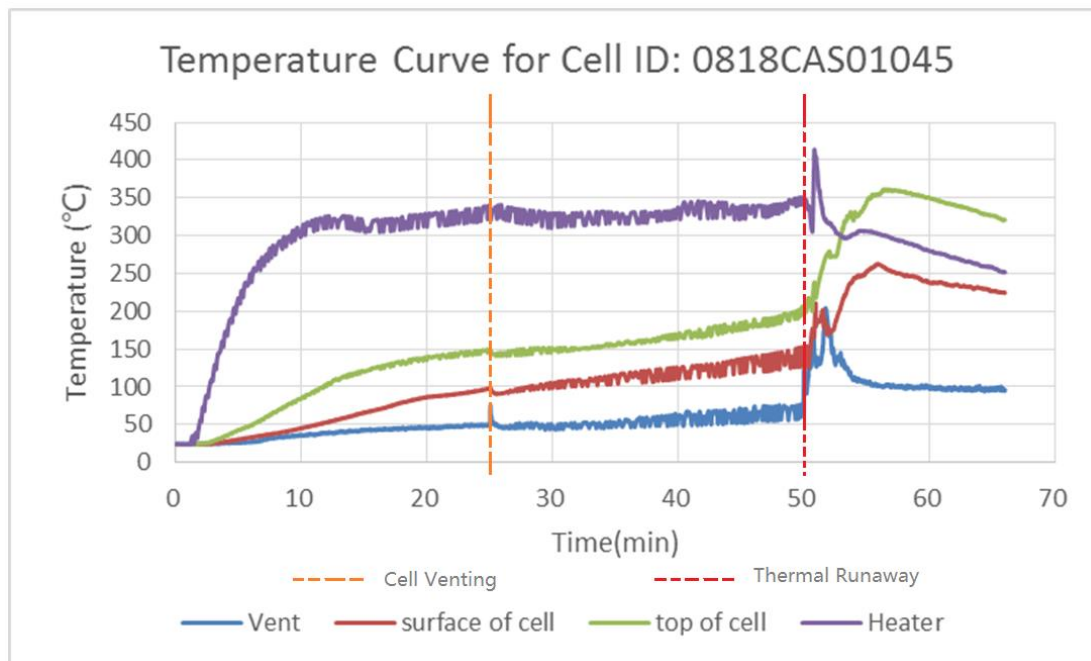
Section	Requirement	Comments	Verdict
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Possible test case verdicts:

Test case does not apply to the test object: N/A (Not Applicable)

Test object does meet the requirement: P (Pass)

Test object does not meet the requirement: F (Fail)



Sample ID : 0818CAS01045



Before Test



After Test

Temperature Curve and test sample figure:

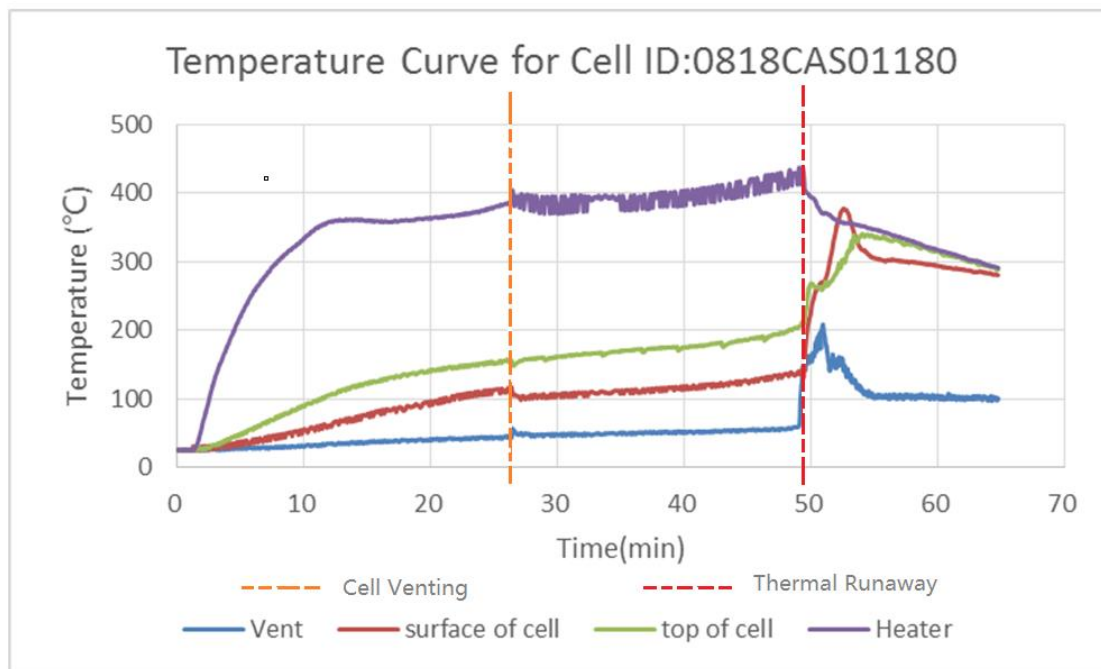
Section	Requirement	Comments	Verdict
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Possible test case verdicts:

Test case does not apply to the test object: N/A (Not Applicable)

Test object does meet the requirement: P (Pass)

Test object does not meet the requirement: F (Fail)



Sample ID : 0818CAS01180



Before Test



After Test

Temperature Curve and test sample figure:

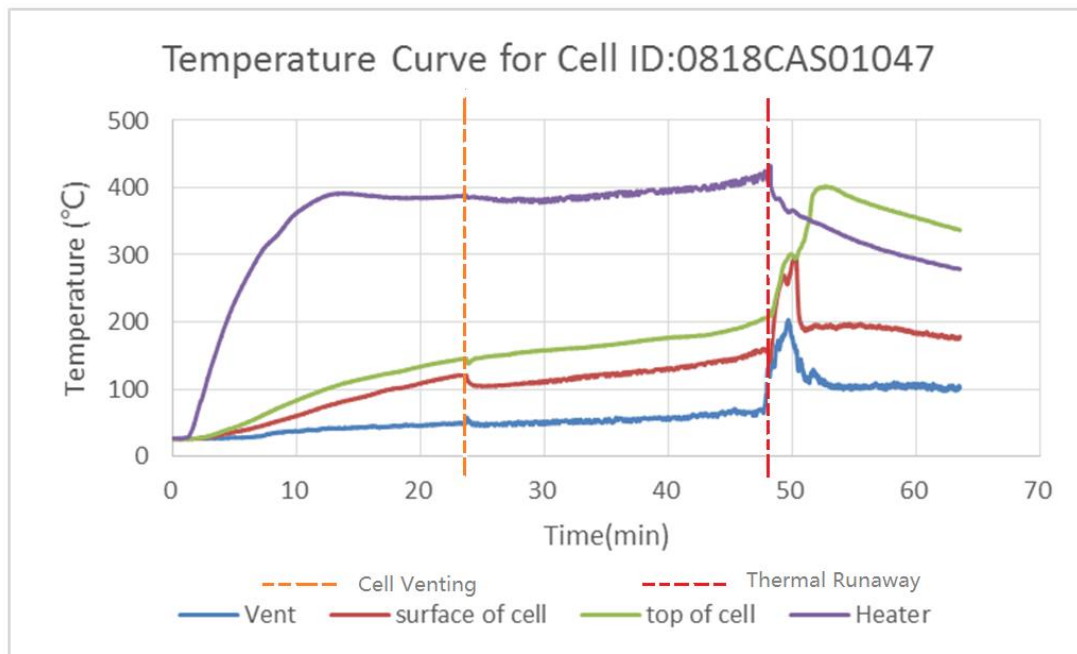
Section	Requirement	Comments	Verdict
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Possible test case verdicts:

Test case does not apply to the test object: N/A (Not Applicable)

Test object does meet the requirement: P (Pass)

Test object does not meet the requirement: F (Fail)



Sample ID : 0818CAS01047



Before Test



After Test

Test Apparatus Picture:

Section	Requirement	Comments	Verdict
Possible test case verdicts:			
Test case does not apply to the test object:	N/A (Not Applicable)		
Test object does meet the requirement:	P (Pass)		
Test object does not meet the requirement:	F (Fail)		
<p>a) b) c)</p> <p>Figures. a), b) overall view of the reactor; c) inside view of the reactor</p>			
Equipment Used: Item no. 1,2,3,4,5,6 Date Start: 19/06/13 (YY/MM/DD) Date End: 19/06/19 (YY/MM/DD)			
6.3	Cell vent gas generated and captured inside an 82-L (21.7-gal) pressure vessel. The test initiated with an initial condition of atmospheric pressure and less than 1% oxygen by volume.	<input checked="" type="checkbox"/> Conformed	P
	Cell vent gas composition determined using following method.	See below	P
	1. Fourier-Transform Infrared Spectrometer with a minimum resolution of 1.0 cm ⁻¹ and a path length of at least 6.6 ft. (2 m), or	Other equivalent method used	N/A
	2. Equivalent gas analyser	<input checked="" type="checkbox"/> Conformed GC-MS was used for Gas composition analysis.	P
	Hydrogen gas was measured with a sensor capable of measuring in excess of 30% by volume.	<input checked="" type="checkbox"/> Conformed GC-MS was used for Hydrogen gas measurement	P

MASTER CONTRACT: N/A

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Date Issued: August 27, 2019

Section	Requirement	Comments	Verdict
Possible test case verdicts:			
Test case does not apply to the test object: N/A (Not Applicable)			
Test object does meet the requirement: P (Pass)			
Test object does not meet the requirement: F (Fail)			
	The lower flammability limit of the cell vent gas was determined in accordance with ASTM E681	The lower flammability limit for the gas released was not tested, further evaluation will considered, confirmed and agreed by the client.	N/A

Section 6.3	TABLE: Cell vent gas composition test			
Sample No	0818CAS01064	0818CAS01045	0818CAS01180	0818CAS01047
Open Circuit Voltage Before Test (Vdc):	3.380	3.389	3.390	3.360
Cell Failure method:	External Heating			
Pressure Vassal Volume (liter):	82	82	82	82
Cell Surface Temperature at which gases are first vented (°C):	130.3	147.8	149.3	145.9
Cell Surface Temperature prior to thermal runaway (°C):	193.4	223.4	211.2	211.2
Location of Maximum Temperature prior to thermal runaway:	Cell Side Enclosure			
Atmospheric Pressure Before Test (kPA):	8	3.75	8.75	14
Oxygen volume in pressure Vessel Before Test (%):	0.76	0.80	0.38	0.59
Gas Composition				
<p>Note: Test was performed on 4 cell samples individually in a 82L reactor with an initial temperature condition 24.2 °C, initial pressure lower than 9 KPa. For each cell samples, 3 bags of gas samples were collected, 1 before the thermal test to make sure the initial oxygen volumn lower than 1%, and 2 bags of gas samples collected after the thermal runaway test, gas composition were measured using the GC-MS.</p> <p>Gas volumn released was measured using the gas components data of the cell sample 0818CAS01045 for calculation.</p>				
<p>Lower Flammability Limit(LFL) = N/A</p> <p>Volum: 82L</p>				
Supplementary information:				
<ul style="list-style-type: none">Sample ID Instruction(Cell VS Gas Sample)				
Gas Sample ID	Note	Cell Sample ID		
S1-20190619-1521-01	Initial gas sample(before test)	0818CAS01064		
S1-20190619-1522-05	Gas sample A after test	0818CAS01064		
S1-20190619-1521-03	Gas sample B after test	0818CAS01064		
S1-20190619-1522-02	Initial gas sample(before test)	0818CAS01045		
S1-20190619-1522-06	Gas sample A after test	0818CAS01045		
S1-20190619-1521-06	Gas sample B after test	0818CAS01045		
S1-20190619-1522-03	Initial gas sample(before test)	0818CAS01180		
S1-20190619-1522-01	Gas sample A after test	0818CAS01180		
S1-20190619-1521-04	Gas sample B after test	0818CAS01180		
S1-20190619-1522-04	Initial gas sample(before test)	0818CAS01047		
S1-20190619-1521-02	Gas sample A after test	0818CAS01047		
S1-20190619-1521-05	Gas sample B after test	0818CAS01047		
<ul style="list-style-type: none">The composition for the gas released.(%)				

气体成分气相色谱分析

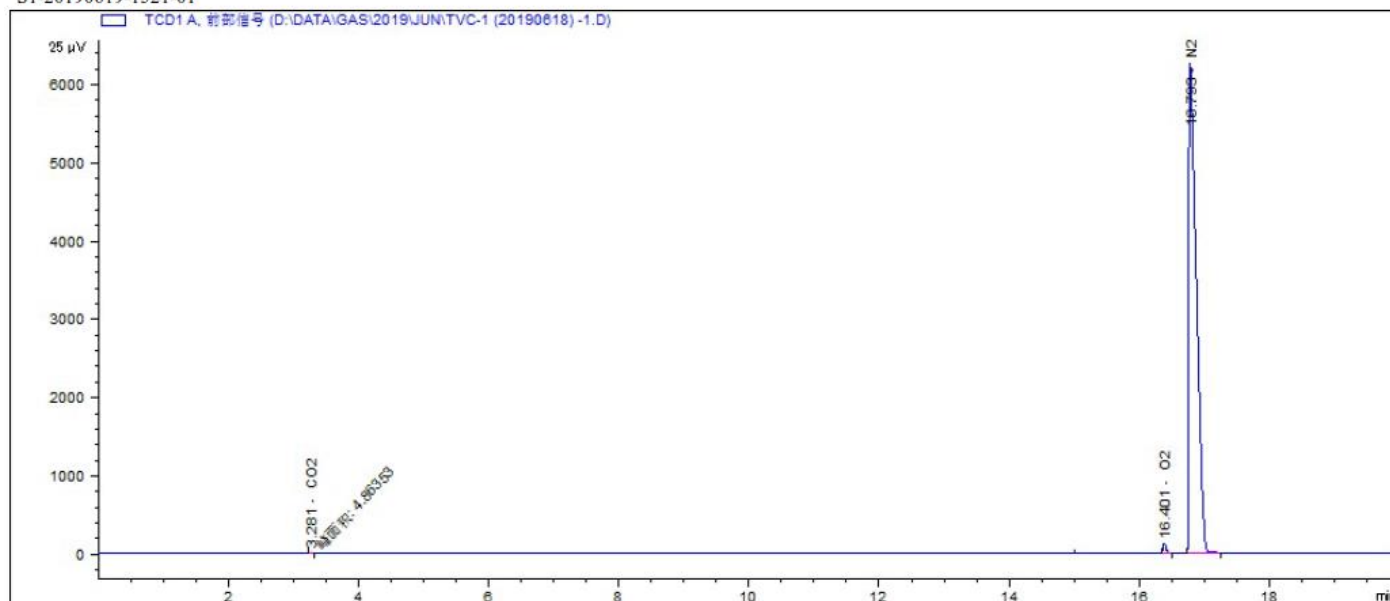
样品编号 Sample No.	气体成分 Gas Components									
	CO2	C2H4	C2H6	C3H6	C3H8	H2	O2	N2	CH4	CO
S1-20190619-1521-01	0.01	/	/	/	/	/	0.76	99.23	/	/
S1-20190619-1521-02	20.09	3.38	0.92	1.07	0.26	30.28	0.44	33.58	3.29	6.68
S1-20190619-1521-03	21.04	3.65	1.00	1.09	0.33	25.66	0.68	35.79	3.53	7.23
S1-20190619-1521-04	19.63	3.28	0.92	1.09	0.27	33.30	0.25	31.36	3.16	6.74
S1-20190619-1521-05	20.15	3.51	0.94	1.12	0.28	30.82	0.37	32.67	3.24	6.90
S1-20190619-1521-06	18.09	3.12	0.82	0.98	0.24	37.40	0.43	30.03	2.94	5.94

气体成分气相色谱分析

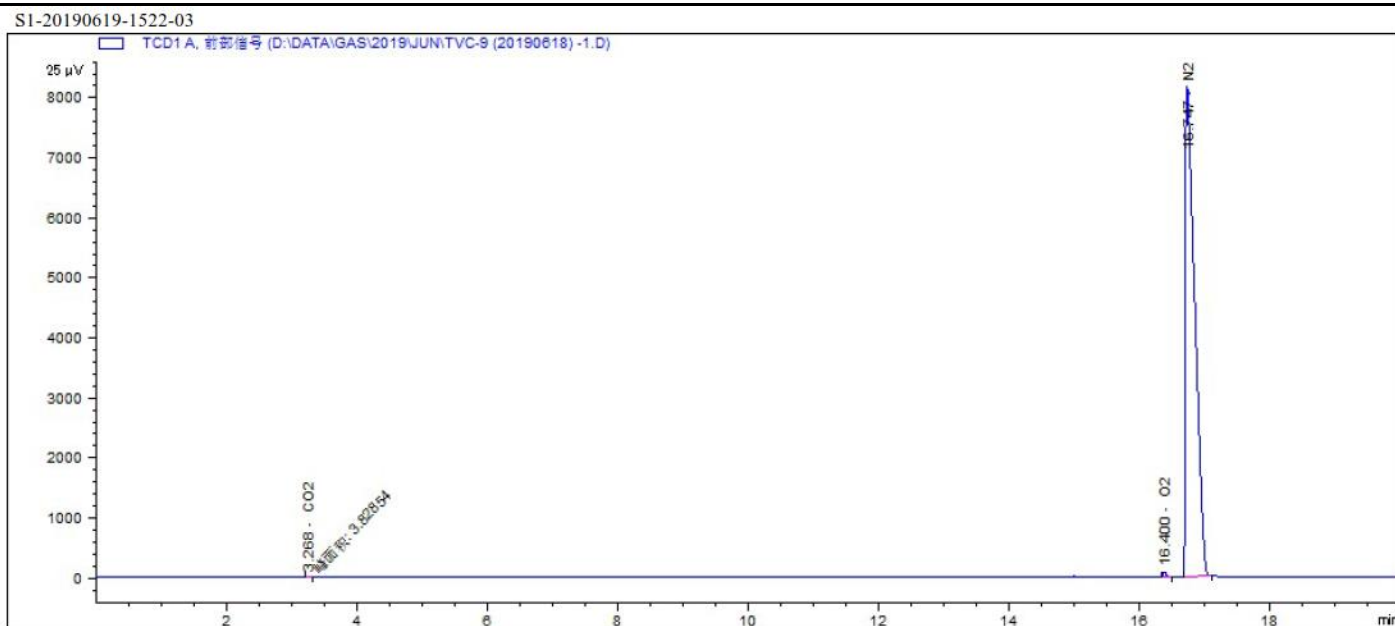
样品编号 Sample No.	气体成分 Gas Components									
	CO2	C2H4	C2H6	C3H6	C3H8	H2	O2	N2	CH4	CO
S1-20190619-1522-01	19.90	3.48	0.95	1.06	0.27	30.15	0.62	33.48	3.31	6.77
S1-20190619-1522-02	0.02	/	/	/	/	/	0.80	99.19	/	/
S1-20190619-1522-03	0.01	/	/	/	/	/	0.38	99.62	/	/
S1-20190619-1522-04	0.01	/	/	/	/	/	0.59	99.40	/	/
S1-20190619-1522-05	19.79	3.23	0.93	1.06	0.28	30.69	0.51	34.30	3.10	6.11
S1-20190619-1522-06	19.43	3.14	0.91	1.04	0.28	32.31	0.53	33.42	3.02	5.93

- GC-MS spectrogram analysis for gas before test : cell sample ID: 0818CAS01064

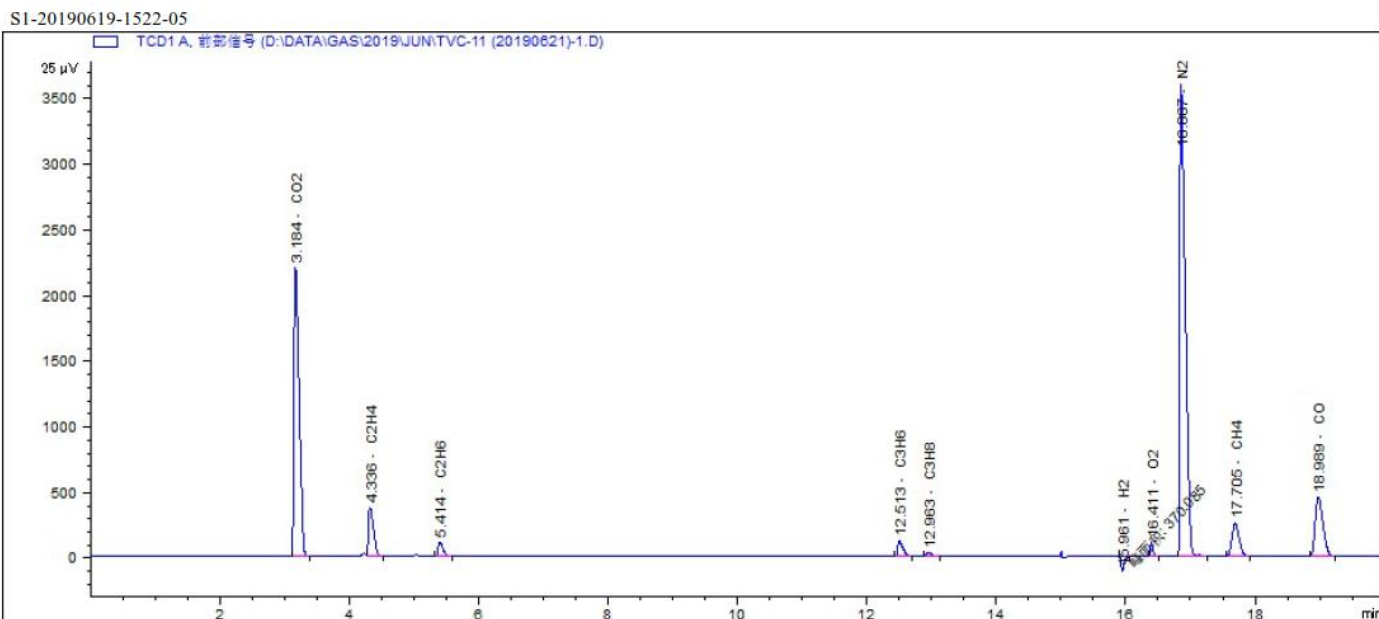
S1-20190619-1521-01



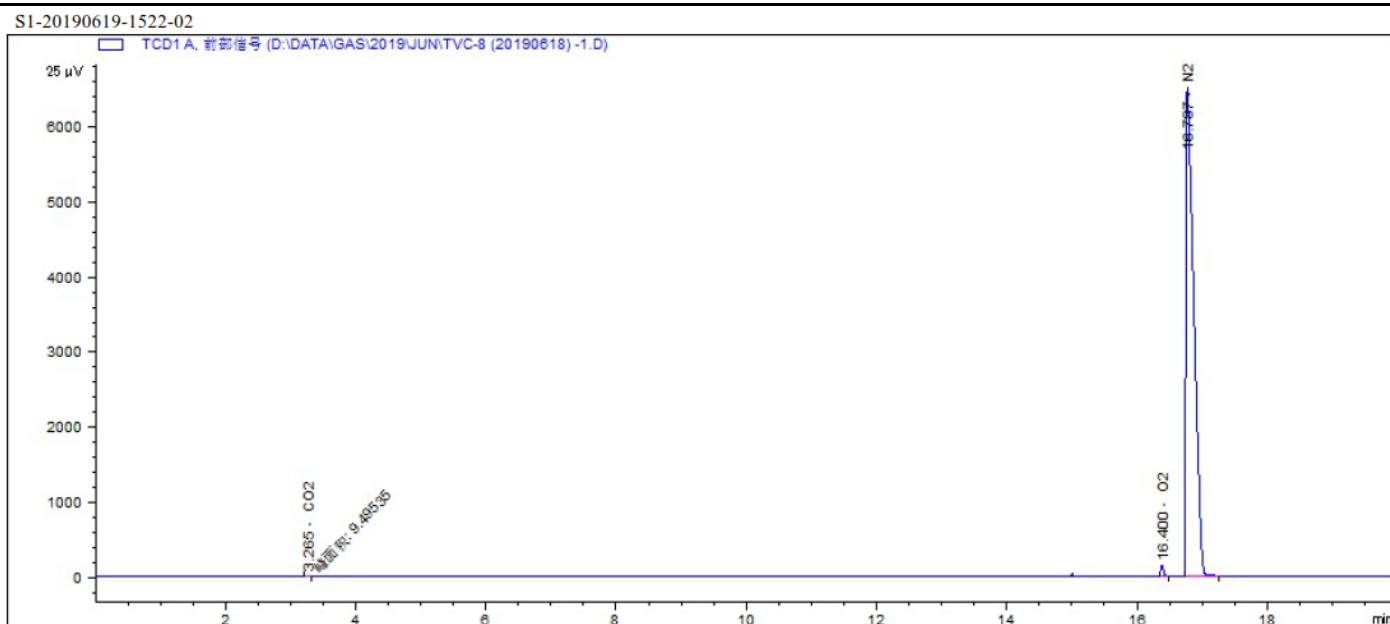
- GC-MS spectrogram analysis for gas released after test: cell sample ID: 0818CAS01064



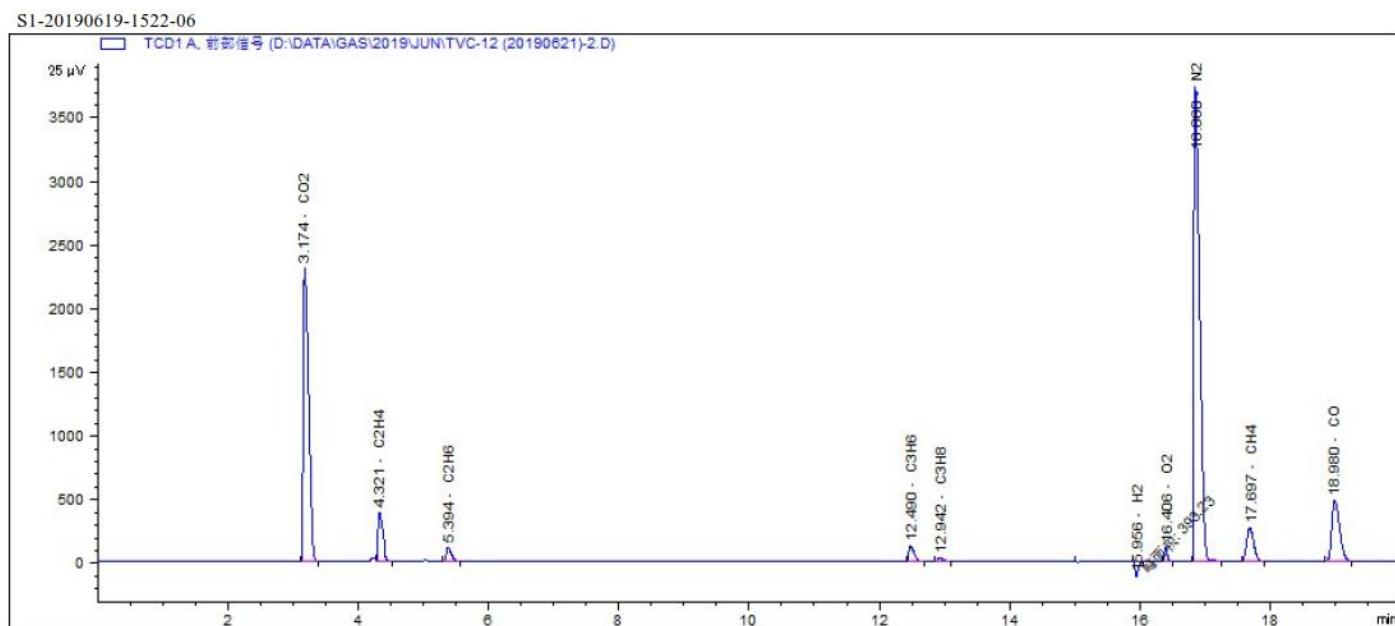
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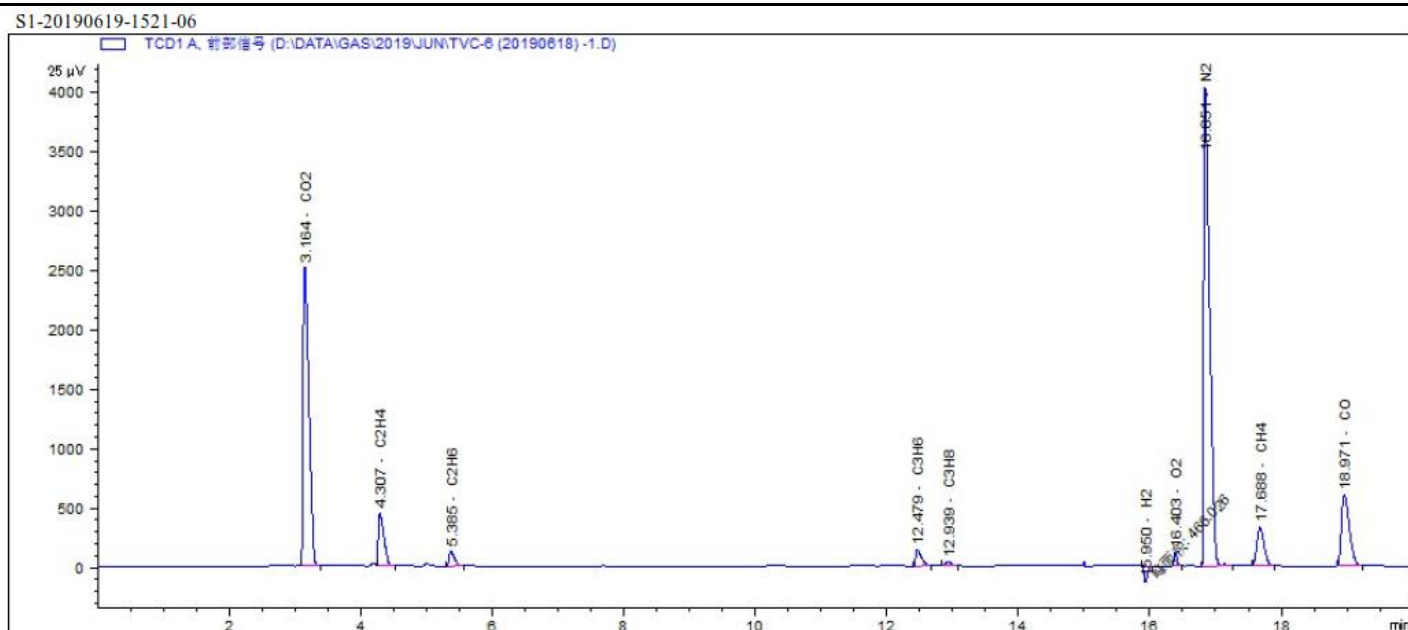
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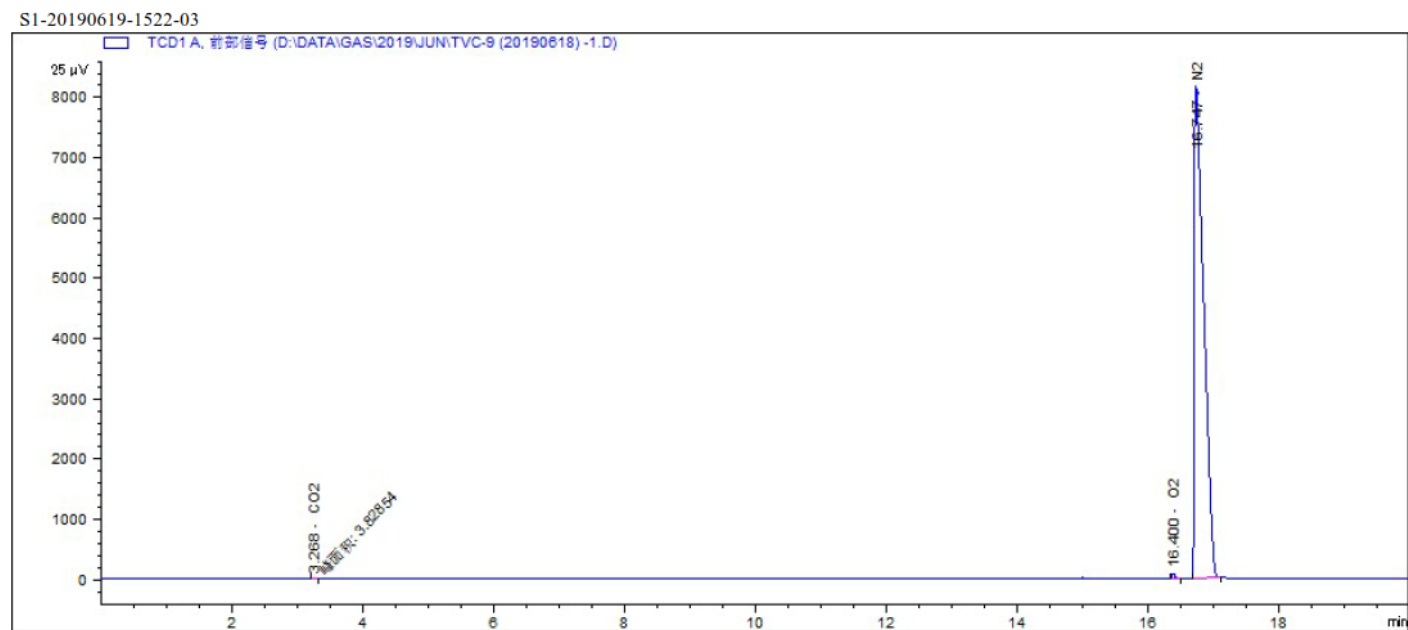
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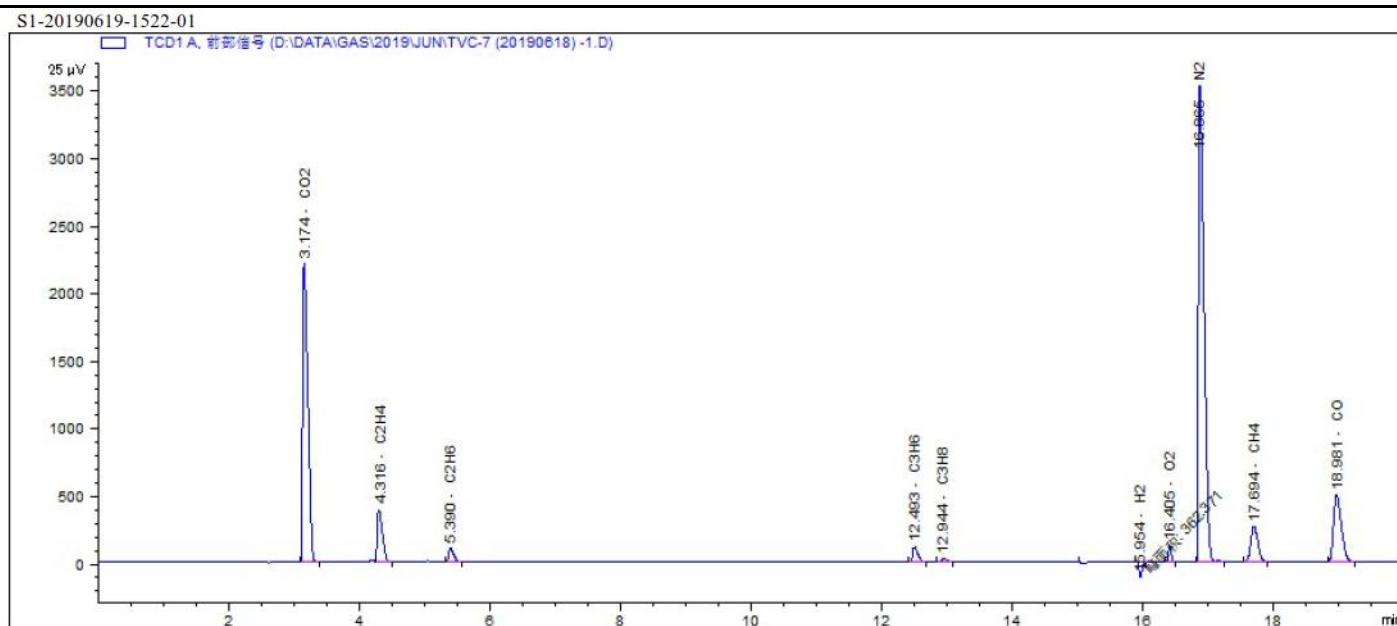
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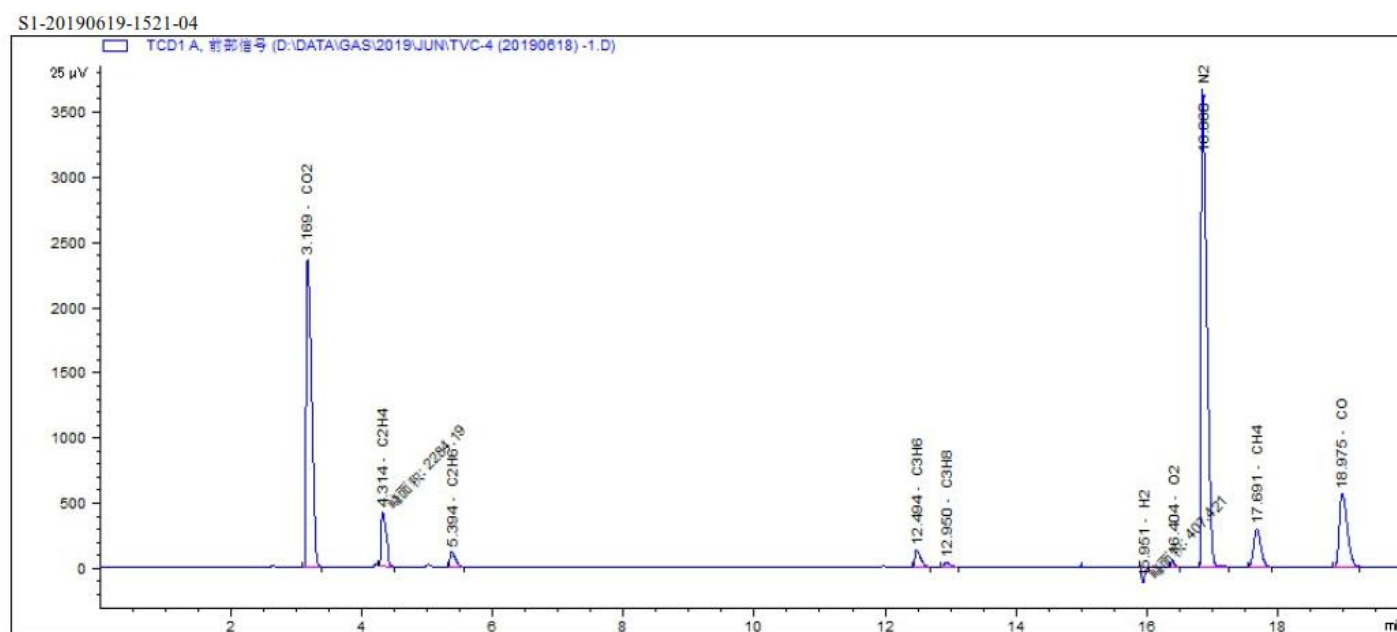
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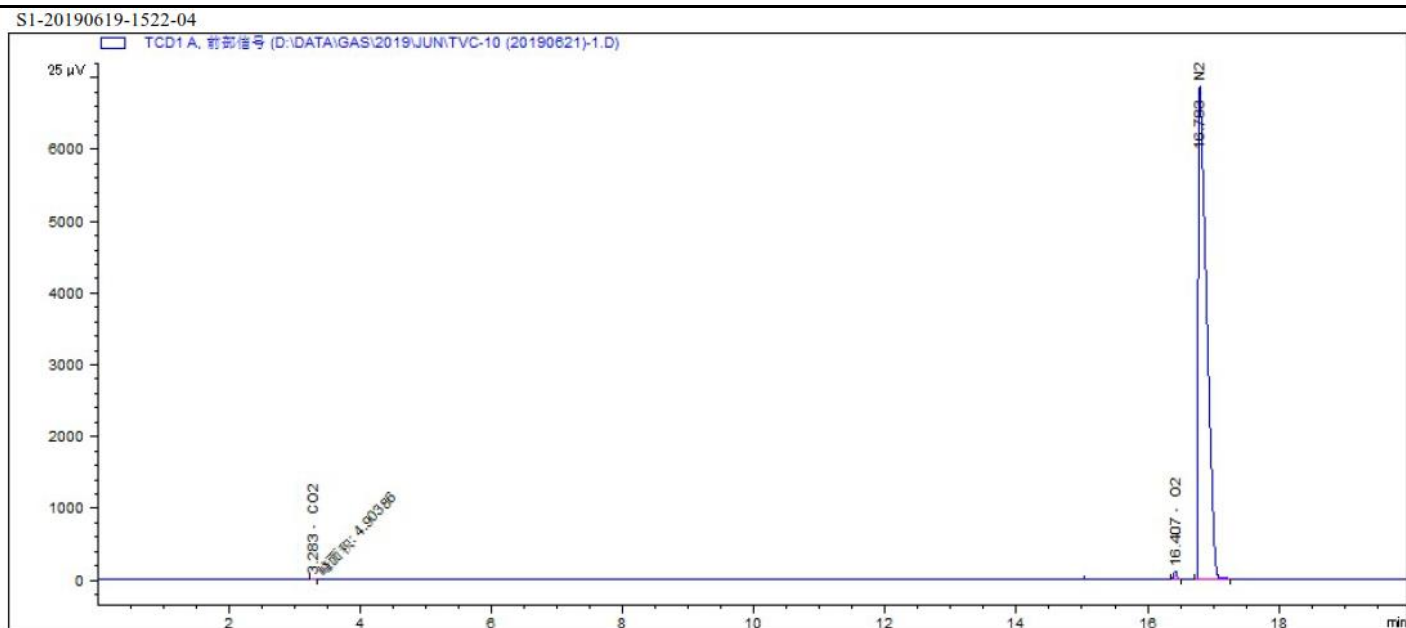
- GC-MS spectrogram analysis for gas released after test: cell sample ID: 0818CAS01180



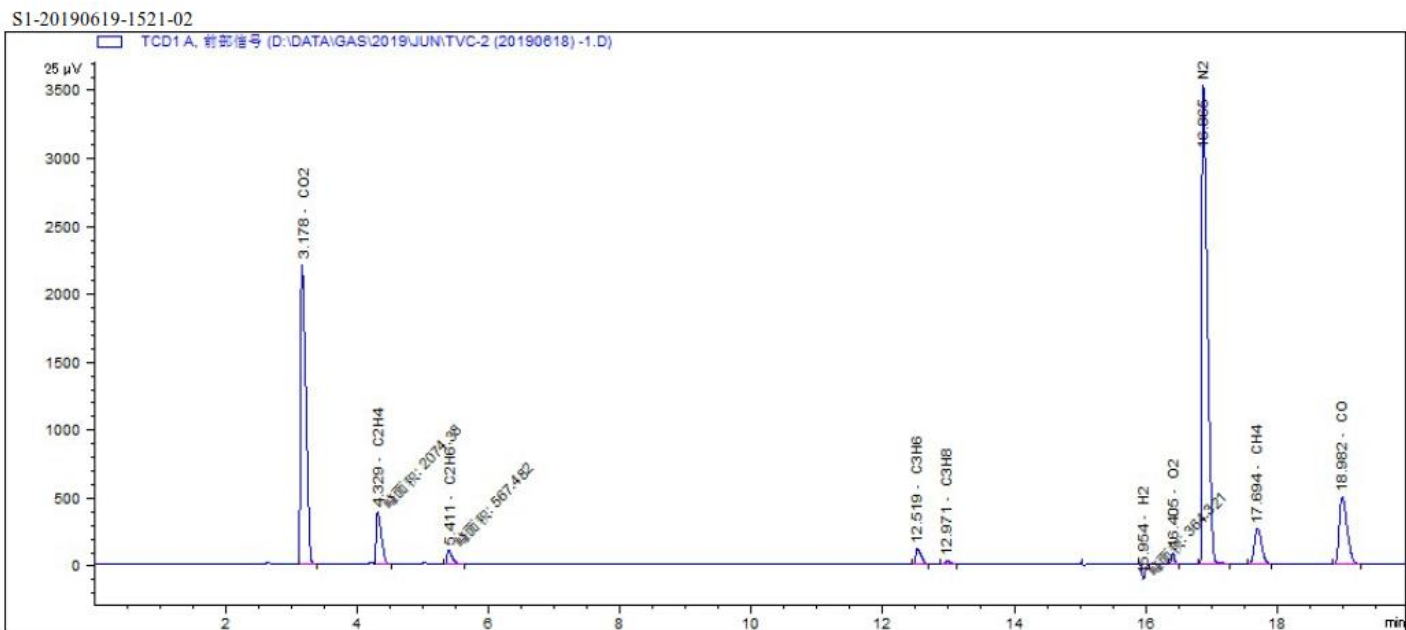
- GC-MS spectrogram analysis for gas released after test: cell sample ID: 0818CAS01180



- GC-MS spectrogram analysis for gas before test : cell sample ID: 0818CAS01047



- GC-MS spectrogram analysis for gas released after test: cell sample ID: 0818CAS01047



- GC-MS spectrogram analysis for gas released after test: cell sample ID: 0818CAS01047

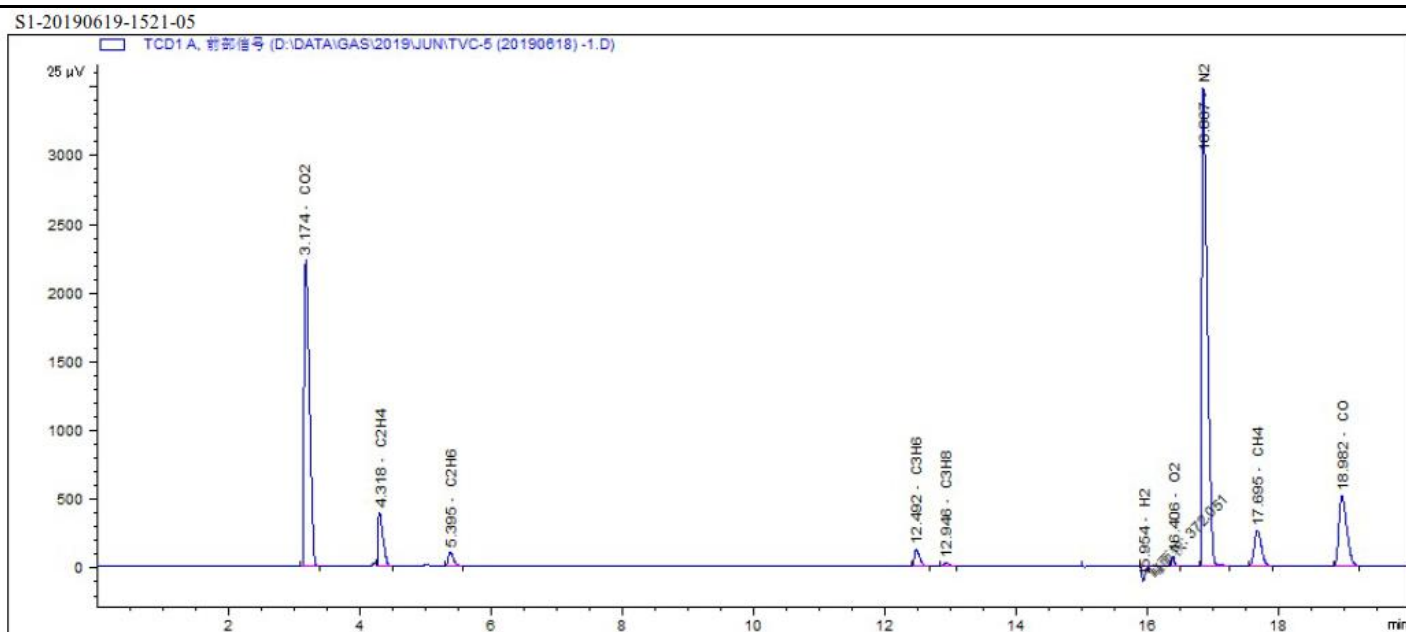
MASTER CONTRACT: N/A

REPORT: 80008629

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Date Issued: August 27, 2019



Equipment Used: Item no. 6

Date Start: 2019-06-03 (YY/MM/DD)

Date End: 2019-06-19 (YY/MM/DD)

TEST EQUIPMENT:

Item No.	Inventory Code / ID	Description	Manufacturer	Model	Range Used	Calibration Date (YYYY-MM-DD)	Next Calibration Due Date (YYYY-MM-DD)
1	74XWE00104	Battery Cyclor	Xinwei	5V200A	0~5V, 0~200A	2019-05-16	2020-05-15
2	L103319	Chamber	Hading	HLT702P	-35~80 °C	2019-05-19	2020-05-18
3	72BAQ00382	Electronic Scale	Yingzhan	ALH-30	0~2.5kg	2018-11-20	2019-11-19
4	74OTE01427	Data Logger	HIOKI	LR8431	0~500 °C, 0~10V	2019-04-08	2020-04-07
5	78BME00005	Perssure Conversion Equipment	Guangxi Xisen	BST6600-20TG	0~5MPa	2019-05-16	2020-05-18
6	L108248	GC-MS	Agilent	5977-7890B	-	2018-10-19	2020-10-18

---End of Report---