Detection Method for Toxicity of REESS Vehicle Thermal Runaway Leakage

GTR Phase 2, EVS-GTR 19th

China

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Detection Method for Toxicity of REESS Vehicle Thermal Runaway Leakage

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1.1 Background

1.2 Bases

1.3 Conclusion

2 Hardware construction

2.1 Laboratory requirements

2.2 Scope of instruments and equipment

3 Implementation

3.1 Cell level

3.2 Module level

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Detection Method for Toxicity of REESS Vehicle Thermal Runaway Leakage

1Introduction

1.1 Background

1.2 Bases

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Possible occurrence scenes of REESS Vehicle Thermal Runaway Toxic Leakage and Fire
Scene 1: Traffic accident, the car body was violently hit, and the battery compartment was crushed and deformed. A limb or brain injury to the driver or crew who unable to evacuate from crew compartment. The rescue takes 20 to 60 minutes. During this time, the driver or crew did not die from mechanical injuries caused by violent collisions but was poisoned by the smoke.
Scene 2: During driving, other appliances such as cell phones are charging in the car. While the failure of the cell phone battery caused fire. Then lead to the REESS thermal runaway leakage of toxic smoke, which causes damage to occupants and the environment.
Scene 3: During driving or parking, a fire outside the car causes the car to catch fire, which then causes the REESS thermal runaway leakage of toxic smoke, which causes damage to occupants and the environment.
Scene 4: During Charging indoors or outdoors, the charging pile line aging or quick charging causes lines to overheat to a fire, which then causes the REESS thermal runaway leakage of toxic smoke, which causes damage to occupants and the environment.
Scene 5: Vehicles requiring maintenance or ever encountering visual invisible car body damage, when encountered cooling system failure, which may cause REESS thermal runaway leakage of toxic smoke, which causes damage to occupants and the environment.
Scene 6: Vehicles requiring maintenance or ever encountering visual invisible car body damage, when encountered rain, snow, thunder or typhoon weather, water into battery compartment, which may cause REESS thermal runaway leakage of toxic smoke, then causes damage to occupants and the environment.
Scene 7: Vehicles requiring maintenance or ever encountering visual invisible car body damage, when encountered high temperature ground or strong sun, the battery compartment temperature is too high to cause the cooling system fails and lock locking, which may cause REESS thermal runaway leakage of toxic smoke, then causes damage to occupants and the environment.

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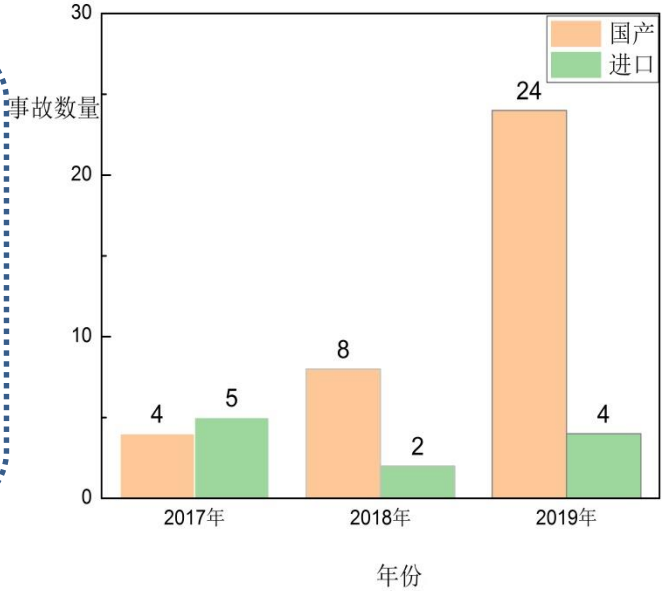

The base from ECE/TRANS/WP.29/2017 /138 for conducting Toxic leakage analysis	Conclusion
I. A. 2. I. A. 4. I. A. 5. I. B. 6. I. C. 1. 14. I. C. 1. 15. I. C. 3. 21 I. F. 1. 238. I. F. 1. 240. II. 7.3	1. GTR Phase 2 need to qualitative and quantitative analysis to toxic smoke, and to standardize the analysis and detection methods for the single cell, module, pack and vehicle. 2. The reasonable trigger method for battery thermal runaway should be flame burning/electric heating.

Detection Method for Toxicity of REESS Vehicle Thermal Runaway Leakage

2 Hardware construction

2.1 Laboratory requirements

2.2 Scope of instruments and equipment

2.1.1 Monitoring facilities

a) Environmental monitoring equipment

b) Video monitoring equipment

c) Laboratory display equipment

d) Data storage device

2.1.2 Fire procedure and equipment

a) Put out a fire

b) Quarantine

c) Cooling

2.1.3 Individual protective equipment

Detection Method for Toxicity of REESS Vehicle Thermal Runaway Leakage

2 Hardware construction

2.1 Laboratory requirements

2.2 Scope of instruments and equipment

2.2.1 Battery chargers and dischargers

2.2.2 Video recorder

2.2.3 Combustion chamber

2.2.4 Electric heating chamber

2.2.5 Gases analyzer

2.2.6 GC-Mass

2.2.7 CO detector

2.2.8 HF detector

2.2.9 Composite gas detector

2.2.10 Solid smoke detector

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3 Implementation

3.1 Cell level

3.2 Module level

3.3 System level

3.4 Vehicle level

3.1.1 Samples

3.1.2 Thermal runaway trigger method

3.1.3 Detection method of thermal runaway leakage products

3.1.4 Toxicity classification of thermal runaway leakage products

3.1.5 Cell level test report

Each kind of sample should be tested for thermal runaway combustion and leakage products in three charging states, that is ,three identical batteries should be selected and the batteries should be in charging states of 30%, 50% and 100% respectively through charge-discharge instrument.

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3.1.4 Toxicity classification of thermal runaway leakage products

3.1.5 Cell level test report

A) Flame trigger

- Place the cell with good charging state in combustion chamber, fixed ,and ignited to triggers the thermal runaway.
- Position of the cell in contact with flame: front end of soft-pack battery, sealing position of the 18650 battery.

B) Electric heating trigger

- Place the cell with good charging state in combustion chamber, fixed ,and use electric heating to triggers the thermal runaway.
- Thermal runaway trigger reference conditions
- Programmed heating conditions:
- heating rate: 3℃-10℃/min
- Heating plate to 150℃-180 ℃

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3.1.4 Toxicity classification of thermal runaway leakage products

3.1.5 Cell level test report

A) Sampling
- Volatile organic gas sampling
- Solid smoke sampling

B)Product analysis
- Solid product analysis
- Gas product analysis

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3.1.5 Cell level test report

The toxicity of thermal runaway leak product was classified according to GB5044-1985、GB/Z230-2010 and WHO/IPCS the classification standard of acute toxicity of chemicals.

Classification	Rat oral LD_{50}/mg·kg^{-1}	Rat skin LD_{50}/mg·kg^{-1}	Rat inhalation LC_{50}/mg·cm^{-3}
Very Toxicity	(0,25]	(0,50]	(0,200]
Highly Toxicity	(25,200]	(50,400]	(200,500]
Toxicity	(200,2000]	(400,2000]	(500,2500]
Low Toxicity	(2000,20000]	(2000,20000]	(2500,20000]

Detection Method for Toxicity of REESS Vehicle Thermal Runaway Leakage

Order	Name	Chinese Name	Formula	CAS	Classification
0016	Hydrazine, 1,1-dimethyl-	1,1-二甲基肼	C2H8N2	57-14-7	Highly Toxicity
0017	Trichloromethane	三氯甲烷	CHCl3	67-66-3	Highly Toxicity
0018	Ethylene oxide	环氧乙烷	C2H4O	75-21-8	Highly Toxicity
0019	Propylene oxide	环氧丙烷	C3H6O	75-56-9	Highly Toxicity
0020	2-Propanamine, 2-methyl-	叔丁胺	C4H11N	75-64-9	Highly Toxicity
0021	2-Propenoic acid	丙烯酸	C3H4O2	79-10-7	Highly Toxicity
0022	Naphthalene	萘	C10H8	91-20-3	Highly Toxicity
0023	Phenol, 2,5-dimethyl-	2,5-二甲基酚	C8H10O	95-87-4	Highly Toxicity
0024	2-Propanol, 1,3-dichloro-	1,3-二氯丙醇	C3H6Cl2O	96-23-1	Highly Toxicity
0025	Furfural	糠醛	C5H4O2	98-01-1	Highly Toxicity
0026	Benzenemethanol, .alpha.-methyl-	甲基苯甲醇	C8H10O	98-85-1	Highly Toxicity
0027	Oxirane, ethyl-	1,2-环氧丁烷	C4H8O	106-88-7	Highly Toxicity
0028	2-Propen-1-amine	烯丙胺	C3H7N	107-11-9	Highly Toxicity
0029	2-Propenenitrile	丙烯腈	C3H3N	107-13-1	Highly Toxicity
0030	Ethylenediamine	乙二胺	C2H8N2	107-15-3	Highly Toxicity
0031	2-Propen-1-ol	丙烯醇	C3H6O	107-18-6	Highly Toxicity
0032	Methyl formate	甲酸甲酯	C2H4O2	107-31-3	Highly Toxicity
0033	Phenol	苯酚	C6H6O	108-95-2	Highly Toxicity
0034	1-Butanamine	正丁胺	C4H11N	109-73-9	Highly Toxicity
0035	Piperidine	六氢吡啶	C5H11N	110-89-4	Highly Toxicity
0036	Butane, 1-isocyanato-	异氰酸正丁酯	C5H9NO	111-36-4	Highly Toxicity
0037	Carbonyl sulfide	羰基硫	COS	463-58-1	Highly Toxicity
0038	Acetophenone, 2-chloro-	α-氯乙酰苯	C8H7ClO	532-27-4	Highly Toxicity
0039	1,3-Cyclopentadiene	茂	C5H6	542-92-7	Highly Toxicity
0040	Phenol, 2,6-dimethyl-	2,6-二甲基苯酚	C8H10O	576-26-1	Highly Toxicity
0041	Methane, isocyanato-	异氰酸甲酯	C2H3NO	624-83-9	Highly Toxicity
0042	EGDN	乙二醇二硝酸酯	C2H4N2O6	628-96-6	Highly Toxicity
0043	2,2'-Bioxirane	双环氧化丁二烯	C4H6O2	1464-53-5	Highly Toxicity
0044	2-Butenal	巴豆醛	C4H6O	4170-30-3	Highly Toxicity

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3.1 Cell level

3.2 Module level

3.3 System level

3.4 Vehicle level

3.1.1 Samples

3.1.2 Thermal runaway trigger method

3.1.3 Detection method of thermal runaway leakage products

3.1.4 Toxicity classification of thermal runaway leakage products

3.1.5 Cell level test report

A) Manufacturer Name and Battery Model
B) Rated storage capacity of batteries (e.g. Ah)
C) OCV and SOC obtained during battery adjustment
D) OCV at the beginning of battery testing
E) Trigger method of thermal runaway selected by demanders
F) Surface temperature at first emission of gas
G) Surface temperature before thermal runaway (and the position of highest temperature)
H) Formation and composition measurement of toxic products
I) Toxicity classification of battery exhaust

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3 Implementation

3.1 Cell level

3.2 Module level

3.3 System level

3.4 Vehicle level

3.2.1 Samples

3.2.2 Thermal runaway trigger method (Same as 3.1.2)

3.2.3 Detection method of thermal runaway leakage products (Same as 3.1.3)

3.2.4 Toxicity classification of thermal runaway leakage products (Same as 3.1.4)

3.2.5 Module level test report

Each module can be used to detect the thermal runaway combustion and leakage products in any of the three charging states. That is to say, two groups of identical batteries are provided, and the charging states of the modules are at 30%SOC, 50%SOC and 100%SOC respectively by charging and discharging instrument.

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3 Implementation

3.1 Cell level

3.2 Module level

3.3 System level

3.4 Vehicle level

3.2.1 Samples

3.2.2 Thermal runaway trigger method (Same as 3.1.2)

3.2.3 Detection method of thermal runaway leakage products (Same as 3.1.3)

3.2.4 Toxicity classification of thermal runaway leakage products (Same as 3.1.4)

3.2.5 Module level test report

A) Manufacturer Name and Battery Model in module
B) Rated storage capacity of module (e.g. Ah)
C) OCV and SOC obtained during module adjustment
D) OCV at the beginning of module testing
E) Trigger method of thermal runaway selected by demanders
F) Surface temperature at first emission of gas
G) Surface temperature before thermal runaway (and the position of highest temperature)
H) Formation and composition measurement of toxic products
I) Toxicity classification of battery exhaust.

Detection Method for Toxicity of REESS Vehicle Thermal Runaway Leakage

3 Implementation

3.1 Cell level

3.2 Module level

3.3 System level

3.4 Vehicle level

3.2.1 Samples

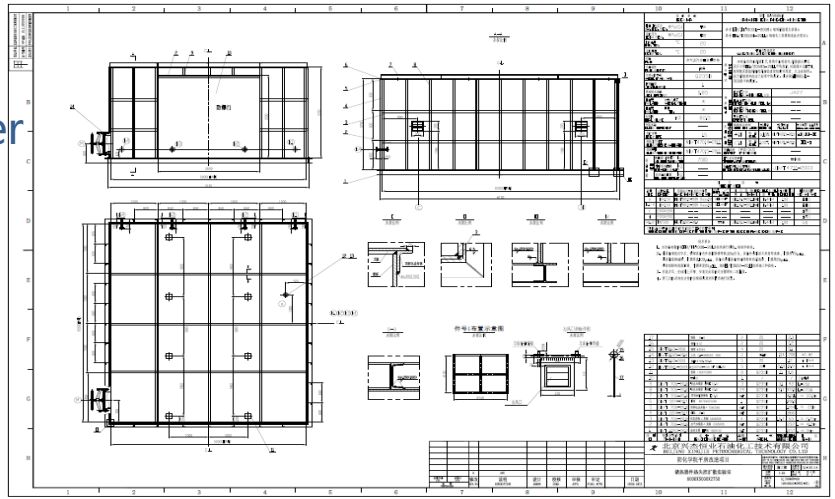
3.2.2 Thermal runaway trigger method (Same as 3.1.2)

3.2.3 Detection method of thermal runaway leakage products (Same as 3.1.3)

3.2.4 Toxicity classification of thermal runaway leakage products (Same as 3.1.4)

3.2.5 System/Vehicle level test report

Under researching and building



The reaction tank design for system and vehicle level thermal runaway toxicity detection

Thanks for listening!