EVS GTR

Li-ion Battery Thermal Runaway Caused Toxics and Analysis

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Contents

Team &Development

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2011-2013

Identification of inorganic small molecule poisons, CO_x, HF, PO_x , Temperature change curves

2013-

Qualification to quantification,
Organic toxics confirm

2014-

Toxics caused by Li-ion battery thermal runaway and emergency treatment

2015-

Safety and protection technology to toxics caused by Li-ion battery thermal runaway

Li-ion Battery Thermal Runaway toxics threat always exists

An improved understanding and control of the Li-ion battery safety, development and induced thermal and chemical threat is actually needed.

Boeing 787

Tesla EV

Samsung Note7

With CO_x, HF, PO_x and toxic VOCs

Database and classification of Li-ion Battery Thermal Runaway toxics

No.	Compound	CAS	Toxity grading	LCB	LMB	NMC	LPB
1	2-Propenal (C_3H_4O)	107-02-8	rank poison	0%, 150%	50%	0%,50%	50%
2	Propanedinitrile ($C_3H_2N_2$)	109-77-3	rank poison			100%	
3	Propanenitrile (C_3H_5N)	107-12-0	rank poison			100%	
4	Naphthalene ($C_{10}H_8$)	91-20-3	high toxic	50%,100%,150%		0%,100%,150%	
5	Carbonyl sulfide (COS)	463-58-1	high toxic		0%		
6	Butane, 1-isocyanato- (C_5H_9NO)	111-36-4	high toxic		50%, 100%	100%	
7	Oxirane, ethyl- (C_4H_8O)	106-88-7	high toxic	50%, 100%	50%,100%		
8	1,3-Pentadiene （C_5H_8）	504-60-9	high toxic	50%, 100%			
9	1-Butanamine ($C_4H_{11}N$)	109-73-9	high toxic				0%
10	1,3-Cyclopentadiene (C_5H_6)	542-92-7	high toxic	100%, 50%	100%	100%,150%	
11	2-methyl-2-Propanamine ($C_4H_{11}N$)	75-64-9	high toxic	0%, 150%	100%		100%
12	Propyleneoxide （C_3H_6O）	75-56-9	high toxic	0%, 150%			
13	Sulfur dioxide (SO_2)	7446/9/5	high toxic				150%
14	2-Butene （C_4H_8）	107-01-7	medium toxic	50%, 100%		50%, 150%	100%
15	1,4-Dioxane ($C_4H_8O_2$)	123-91-1	medium toxic				150%
16	Benzene(C_6H_6)	71-43-2	medium toxic	0%,50%,100%, 150%	0%,50%,100%, 150%	0%,50%,100%, 150%	50%,100%

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Level	GB5044			GBZ230					WHO/IPCS		
	inhalation	via skin	via mouth	Inhalation			via skin	via mouth	via mouth	via skin	Inhalation
	LC50	LD50	LD50	Gas	Vapor	Mog					
	mg/m^3	mg/kg	mg/kg	cm^3/m^3	mg/m^3	mg/m^3	mg/kg	mg/kg	mg/kg	mg/kg	mg/m^3,4h
I/Very Toxic	< 200	< 100	< 25	< 100	< 500	< 50	< 5	< 50	< 25	< 50	< 500
II/Highly Toxic	200 ~ 2000	100 ~ 500	25 ~ 500	100 ~ 500	500 ~ 2000	50 ~ 500	5 ~ 50	50 ~ 200			
III/Toxic	2000 ~ 20000	500 ~ 2500	500 ~ 5000	500 ~ 2500	2000 ~ 10000	500 ~ 1000	50 ~ 300	200 ~ 1000	25 ~ 200	50 ~ 400	500 ~ 2000
IV/Harmful									200 ~ 2 000	400 ~ 2000	2000 ~ 20000
V/Low Toxic	> 20000	> 2500	> 5000	2500 ~ 20000	10000 ~ 20000	1000 ~ 5000	300 ~ 2000	1000 ~ 2000			
VI/Few Toxic				> 20000	> 20000	> 5000	> 2000	> 2000			

Six levels classification including I (very toxic), II (highly toxic), III (toxic), IV (harmful) and V (low toxic) and VI (Few Toxic) level was defined.

According to:

GB5044-1985: Classification of health hazard levels from occupational exposure to toxic substances,

GBZ230-2010: Classification for hazards of occupational exposure to toxicant ,

WHO/IPCS: The User's Manual for the IPCS Health and Safety Guides.

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To test and monitor the rank poison gases is very necessary

- Add examinations of the poison gases leaked form Li-ion battery thermal runaway
- Need new designation or criterion to test the rank poison gases leaked form Li-ion battery thermal runaway
- Need modify existing EVS about battery and vehicle
- We need new test standard desperately !

Occurrence scenes of Li-ion battery Thermal Runaway toxic leakage

Occurrence scenes

Battery tests

- Punch
- Overcharging
- Overheating
- Short circuit
- Vibration
- Disassemble
- Crush
- Immersion

In vehicle

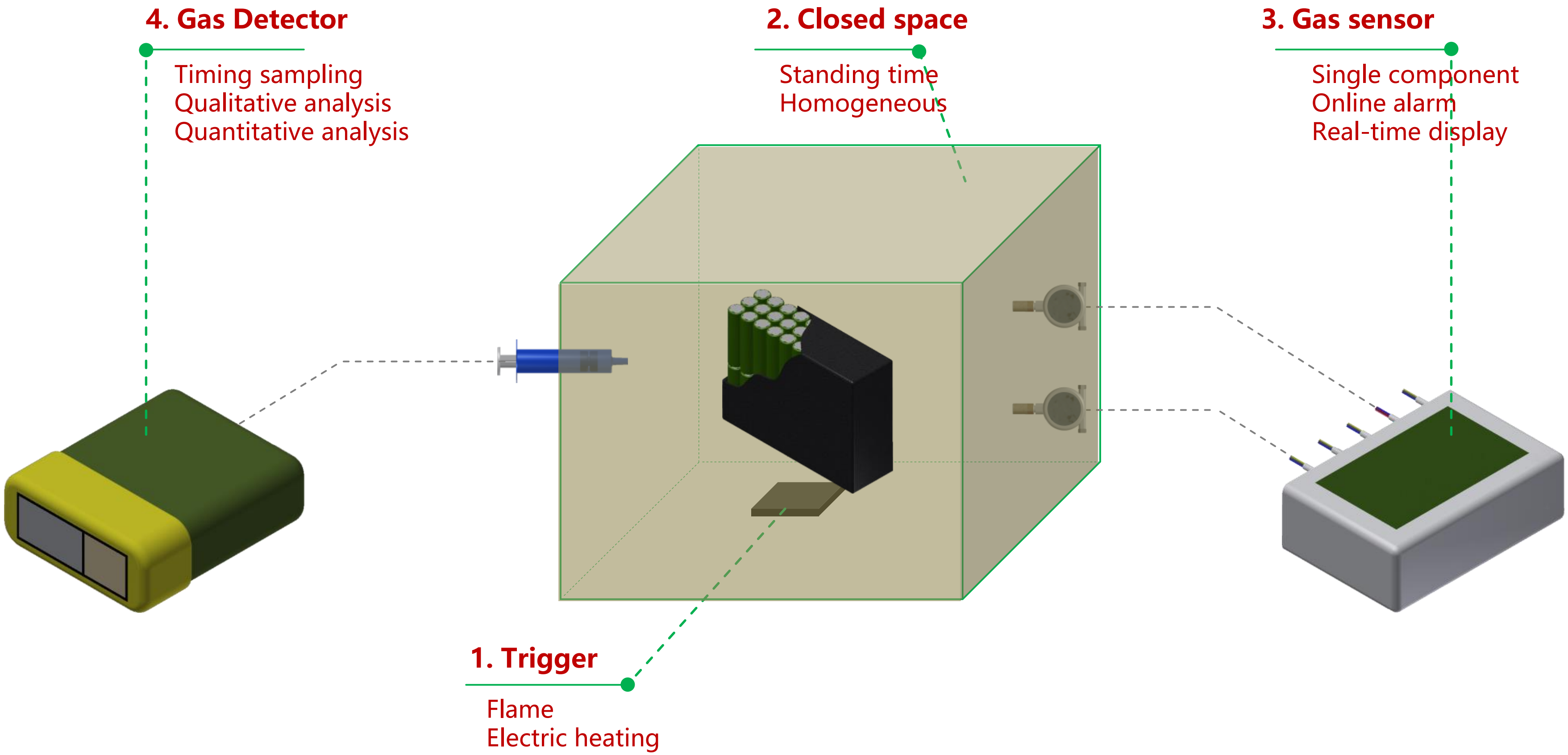
- Leaking
- Firing
- …
- …
- …

Out vehicle

- Vibration
- Collision
- …
- …
- …
- Traffic accident
- Parking

Standard methods to test Li-ion Battery Thermal Runaway toxic gases

Pack Test



We advice to add Li-ion Battery Thermal Runaway toxics inspection items

- Add cell toxics test to all the scenes of the possibility of thermal runaway
- Add pack toxics test to all the scenes of the possibility of thermal runaway
- The rank poison gases need to limit concentration
- The limited concentration should according to GBZ230-2010,WHO/IPCS, and the real test value.
- Database and classification of Li-ion Battery Thermal Runaway toxics need to supplement and unify.