Venting of Gases Test for ElectricVehicles

China
2022.03

Quick Review

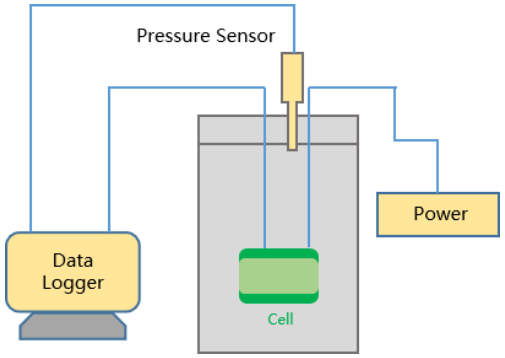
1.Standardization requirements of GTR

- **Phase 1 Several ideas from Japan, JRC and OICA were discussed but no suitable method**
  It was not possible to research and analyse this in Phase 1. Therefore, it will be considered in Phase 2

- **Phase 2 A unified, repeatable, easy to implement method that can evaluate the impact of battery gas production on occupants.**

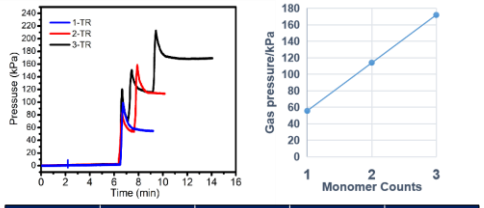
2.Establish a multi-level gas production test method

- **Cell→Module→Pack→Vehicle**
- **Test device & Trigger Method & Collection Method & Analysis**



3.Research progress of China

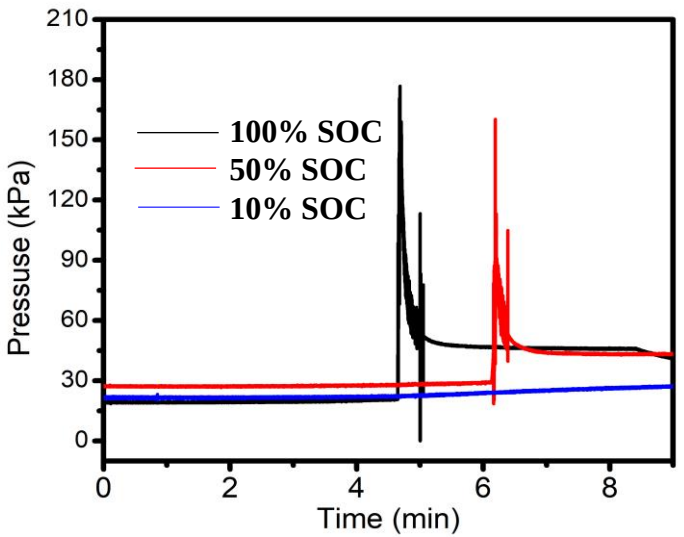
- **Cell Level： The test method on cell level gas production was established， more data required**
- **Module Level: cell result multiplication (CRM) method is preliminarily explored**



ΔP(kPa)	1st	2nd	3rd	Sum
single	55.53	/	/	55.53
double	53.19	60.78	/	113.97
triple	67.71	50.65	53.41	171.77

Progress on Cell Level

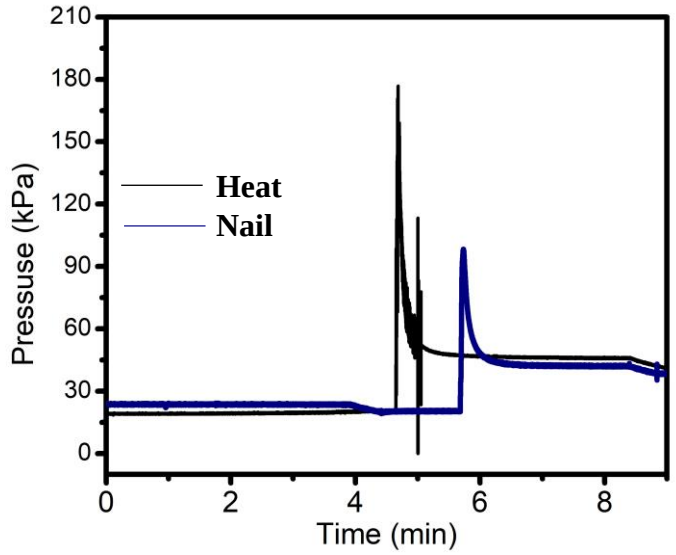
Same Sample with Different SOC



Gas%	100%SOC	50% SOC
CO	19.41	19.43
CO2	11.67	15.27
H2	4.73	3.87
CH4	2.49	6.24
C2H6	0.29	0.10
C2H4	7.21	6.71
C3H8	0.35	trace
Others	53.04	48.27

- SOC has a serious impact on the venting gas process. Considering the actual working conditions, it is recommended to test at 100% SOC from the perspective of severity

Same Sample With Different Trigger Method



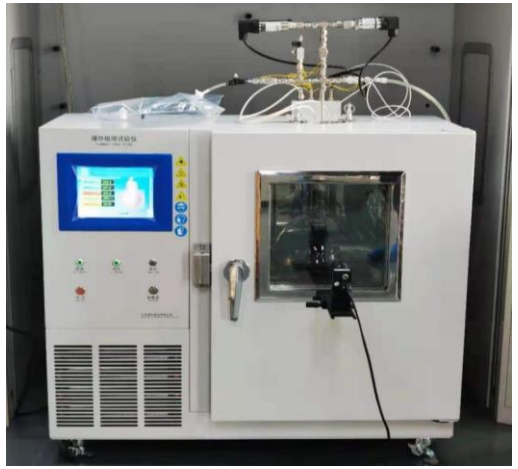
Gas%	Heat	Nail
CO	19.41	29.98
CO2	11.67	trace
H2	4.73	trace
CH4	2.49	5.01
C2H6	0.29	0.75
C2H4	7.21	15.91
C3H8	0.35	1.95
Others	53.04	46.12

- Different triggering methods have a great impact on the venting gas composition. It is suggested that heating and nail should be tested respectively
- The venting gas process of overcharge needs to be further verified

Progress on Cell Level

Explosion hazard of venting gas

- The main component of venting gas is combustible, which may explode in the passenger compartment
- The explosion limit may be one of the evaluating indicator about the hazards of venting gas, while hard to real time test



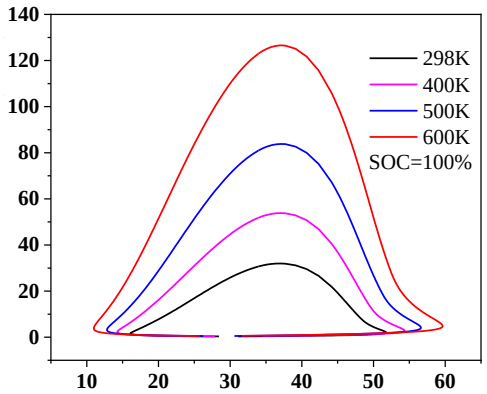
- The explosion limit of gas production can be estimated based on the optimized PREMIX program

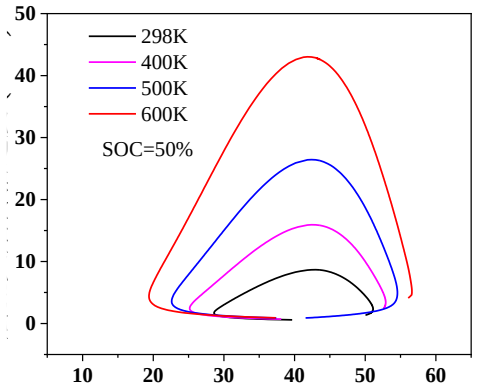
$$\dot{M} = \rho u A$$

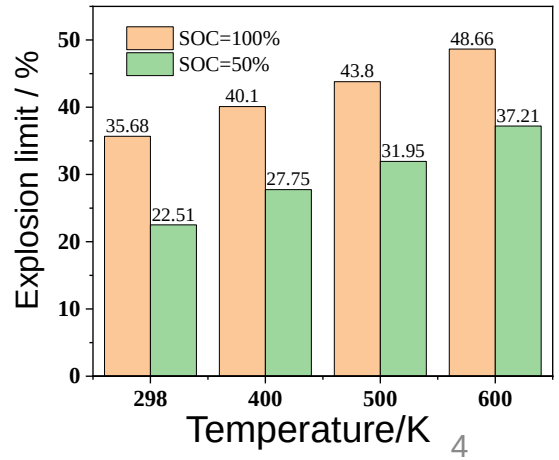
$$\dot{m}\frac{dT}{dx} - \frac{1}{c_p}\frac{d}{dx}\left(\lambda\frac{dT}{dx}\right) + \frac{1}{c_p}\sum_{k=1}^{k}\rho Y_k V_k c_{pk}\frac{dT}{dx} + \frac{1}{c_p}\sum_{k=1}^{k}\dot{\omega}_k h_k w_k = 0$$

$$\dot{M}\frac{dY_k}{dx} + \frac{d}{dx}(\rho A Y_k V_k) - A\omega W_k = 0$$

$$\rho = \frac{p\bar{W}}{RT}$$







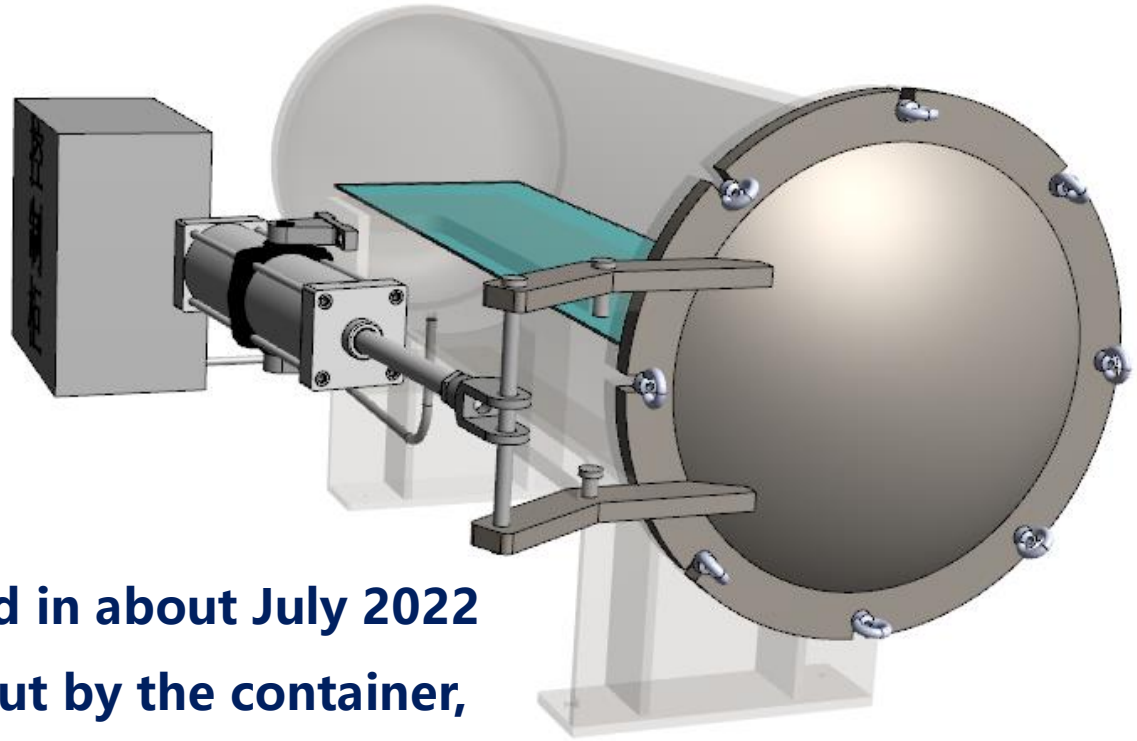
Progress on Module Level

Sealed container method for module

Sealed Container

Module

- Voltage
- Current
- Temperature
- Pressure
- Gas Collection
- CO
- H2
- THC……



- **The sealing container is expected to be completed in about July 2022**
- **Venting gas test on module level can be carried out by the container, multiple parameters can be detected at the same time**
- **Venting gas can be collected for more detailed analysis**

Next plan

——Cell: Further study the impact of gas sampling location, consistency, etc. on test results; Overcharge trigger method will be studied with different type and chemistry.

——Module: Complete 1 or 2 venting gas test results for module in the sealed container.

Conduct more validation of cell result multiplication (CRM) method methods

——Pack & Vehicle: Carry out the vehicle-level thermal runaway test, and place the real-time gas detection device inside the vehicle. This test can best evaluate the impact of gas production on occupants, but the cost of the test is high.