
Mathematical characterization
of internal pressure variation of Ni-MH batteries

Shan Zhongqiang

*School of Chemical Engineering and
Technology, Tianjin University*

■ 电池内压对电池性能的影响

One of the important factors which affects the charge-discharge cycle life and safety of Ni-MH batteries is the battery internal pressure.

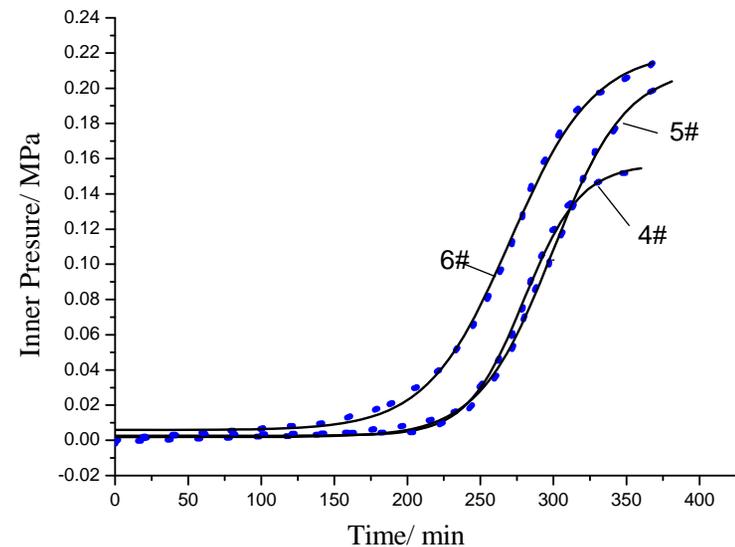
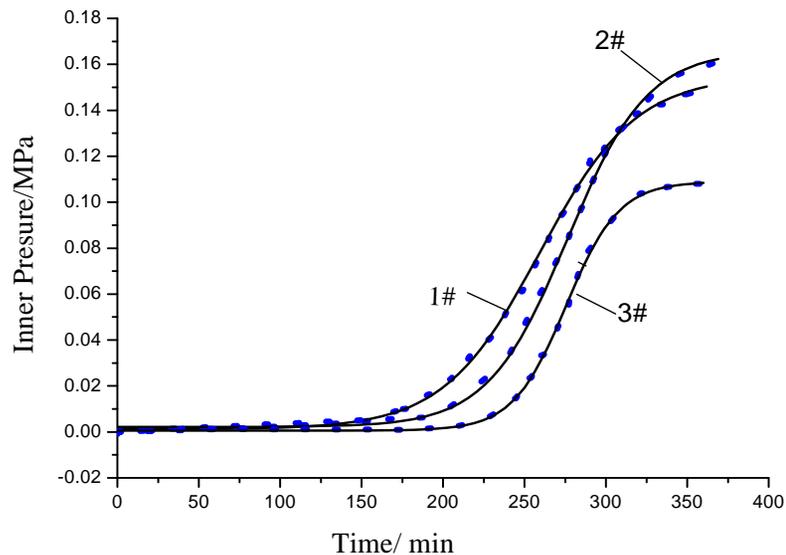


■ 电池内压的测量

Change of internal pressure for different Ni-MH batteries was measured by using a new type of instrument specifically designed to meet the requirement of internal pressure measurements without destruction of the battery.



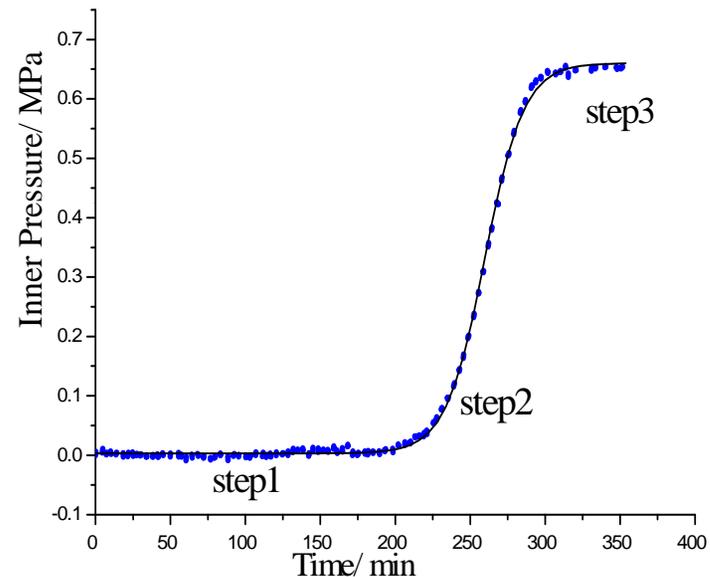
- different amounts of electrolyte
- different mass ratios between the negative and positive electrode materials



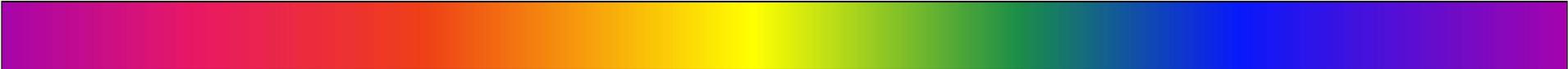
■ 电池内压曲线的数学模拟

The Boltzmann function is a good option for precisely simulating the internal pressure changes during charging at low current density

$$P(t) = P_2 + \frac{(P_1 - P_2)}{1 + \exp\left(\frac{(t - t_0)}{dt}\right)}$$



Typical inner pressure curves of Ni-MH batteries
Scattered data (a), measured curve; Solid line (b), simulated curve

-
- P_1 and P_2 are the initial and terminal values of the internal pressure;
 - T represents the charging time;
 - t_0 is the inflexion of the function, or the value of t when P is at $(P_1 + P_2)/2$;
 - dt is the width where the P value changes acutely, e.g. the width of region of $(t_0 - dt, t_0 + dt)$.
- 

$$k = \frac{P(t_0 + dt) - P(t_0 - dt)}{2dt}$$

- k , indicates the variability of the internal pressure with the charge state or the charge time in the region of $(t_0 - dt, t_0 + dt)$.
- K , which was used to estimate the cycle life of the battery.
- A battery with a lower k displayed a longer cycle life.



■ 今后的工作



一. 动力电池评价测试标准

Battery evaluation and testing standards



目前主要检测项目:

Key items about battery testing

单体cell---20°C放电容量(20°C Discharge Test)、功率测试(Power Test)、-50°C~100°C放电容量(-50°C~100°C Discharge Test)、充放电特性测试(Charge / Discharge Characteristics Test)、常温/高温荷电保持能力(Self-discharge Test)、大电流放电试验(High Current Discharge Test)、常规循环寿命试验(Cycle life Test)、模拟工况循环寿命试验(Condition Cycle life Test)、安全试验Safety Testing -- (包括针刺Acupuncture、挤压Extrusion、短路Short、过充Overcharge、跌落Drop、高温high temperature)等。

- 
- 模块Module : 简单模拟工况Condition Test 、 -50°C~100°C 放电容量试验(-50°C~100°C Discharge Test) 、耐振动试验(Vibration Test)、一致性测试(Conformance Testing)、循环寿命试验(Cycle life Test)等。
 - 安全试验Safety Testing -- (包括针刺Acupuncture 、挤压Extrusion 、短路Short 、过充Overcharge 、跌落Drop 、高温high temperature) 等。
- 

全面的寿命试验

A comprehensive life test

- 1 . 循环寿命Cycle life
- 2 . 55°C搁置寿命High-temperature battery life on hold
- 3 . 55°C加速循环寿命 (High-temperature Fast cycle life)



环境适应性

Environment adaptability

- 1 振动-Vibration
- 2 自由跌落-Free fall
- 3 低气压-Depression
- 4 恒定湿热-Constant hot and humid
- 5 高温下模制壳体应力-Shell stress at high temperatures



安全保护性能

Safety and protection performance

- 1 过充电保护 - Overcharge protection
- 2 过放电保护 - Over-discharge protection
- 3 短路保护 - Short-Circuit Protection



Thanks !

