

Gas Permeability Testing of Battery Diaphragm

Abstract: Abstract: This article briefs on the battery structure, function of battery diaphragm and the influence of diaphragm gas permeability on battery property; and presents the field-testing conditions of Labthink BTY-Den.

Keywords:

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Diaphragm is one of the basic materials of battery. It locates between the opposite electrodes and is used to improve specific capacity and specific energy and to reduce the internal resistance of battery. Excellent battery diaphragm has requirements on the following items: electric insulation, ionic conductivity, thickness and uniformity of material, mechanical strength, alkali resistance, gas permeability and electrochemical stability.

1. Battery Structure

Battery is mainly composed of positive electrode, negative electrode, separator and electrolyte (see fig.1). Diaphragm is a special kind of separator. Before diaphragm appears, paste paper was widely used as separator in paste battery and board battery. When battery industry develops into alkali battery and secondary battery, paste paper can no longer meet the requirement of battery design. With its advantages in many indexes, diaphragm took the position as separators.

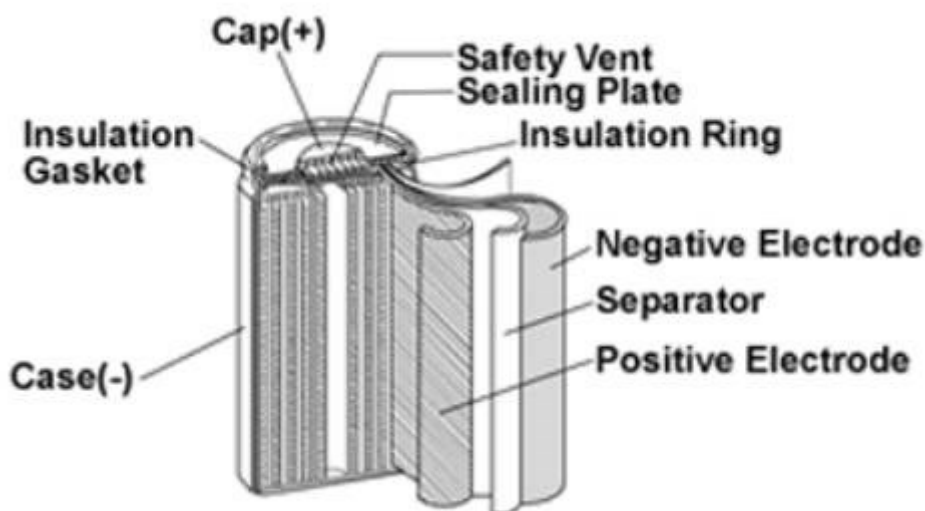


Fig.1 Structure of Nickel-hydrogen Battery

2. Functions of Battery Diaphragm

Diaphragm is the most important part of Battery. As the separator between two opposite electrodes, diaphragm must possess excellent electric insulation. And since it is soaked in electrolyte, diaphragm must have a good alkali resistibility and gas permeability. Therefore, battery manufacturers should choose such thinner diaphragm that

can maintain electric stability, volume stability and chemical stability within a wider temperature range (-55°C~85°C). Such diaphragm should be as thin as possible with high resistance to electrons and low resistance to ions in order to facilitate gas diffusion.

The quality of diaphragm will influence the cycle life and self-discharge of battery to a great extent. The design of diaphragm hole, thickness and resistance have also become important indexes in judging battery quality. As to nickel-hydrogen battery, diaphragm with bad gas permeability will cause an increase of the internal pressure from oxygen produced by positive electrode due to overcharge which cannot be compounded. The increased pressure to certain value will be released from safety vent and cause the loss of electrolyte. Diaphragm with excellent gas permeability is helpful to the compounding of oxygen and can increase the battery capability of over-charge resistance. For lithium Battery, bad gas permeability will influence the transfer of lithium ions between positive electrode and negative electrode, which will in turn influence the charge and discharge of lithium battery.

3. Gas Permeability Testing of Battery Diaphragm

Gas permeability, which is mainly focusing on oxygen, should reach a certain range to meet the operating requirement. Parameters of gas permeability, area density and alkali absorption percentage of the diaphragm are closely related with one another. Bigger gas permeability can cause reduction of area density to some extent, which will have some influences on battery property. If all parameters can reach ideal range while gas permeability is not good, battery property will also be influenced. Therefore, gas permeability testing is very essential to battery diaphragm.

4. BTY-Den Gas Permeability Tester

BTY-Den Gas Permeability Tester is upgraded and manufactured on the basis of Labthink BTY-B1. It adopts the method of positive pressure and can reach a differential pressure of 0.1Mpa between upper and lower chambers, which can fully meet the pressure requirement of diaphragm gas permeability testing. Moreover, the high-resolution sensor offers a reliable insurance for diaphragm's precision testing and at the same time improves testing efficiency.

Use BTY-Den Gas Permeability Tester to test battery diaphragm A and diaphragm B (unknown material provide by customer), differential pressure is 1.22kPa (adjustable). Some testing data are listed in table 1 and table 2.

Table 1. Testing Data of Diaphragm A

Testing time	05/04/27 14:52:33	05/04/28 11:26:38	05/04/29 8:29:59	05/04/30 10:50:59
Testing Temperature (°C)	23.6	23.7	24.0	24.7
O2 Transmission Rate	212.6	214.3	209.2	212.7
O2 Transmission Rate mean	212.2			
S	2.1			
CV%	1.01			

Note : unit of O2 transmission rate : s/100cc · in² · 1.22kPa

Table 2. Testing Data of Diaphragm B

Testing time	05/04/28 10:18:16	05/04/29 11:42:12	05/04/30 8:55:04
Testing Temperature (°C)	23.5	24.0	24.7
O2 Transmission Rate	422.8	429.9	419.1
O2 Transmission Rate mean	423.9		
S	5.5		
CV%	1.29		

Note : unit of O2 transmission rate : s/100cc · in² · 1.22kPa

BTY-Den can perform continuous testing for specimen while maintains a higher precision and data reputability. For example, diaphragm A was tested nine times from 10:26 to 11:26 on April 28th. Testing results are 211.5, 203.6, 205.9, 220.6, 214.4, 214.2, 217.3, 211.4, 214.3 respectively (unit: s/100cc·in²·1.22kPa). Through calculating, the mean value of test results is 212.6s/100cc·in²·1.22kPa. Standard error S is 5.3 and data fluctuation percentage CV% is 2.49%. From such an analysis we can see than data stability and repeatability is relatively better.

5. Conclusion

Auto permeability of battery diaphragm is one of the important indexed in judging diaphragm. It is also an important index in the judging of battery quality. There is no doubt that the appearance of BTY-Den can promote quality testing of diaphragm. On the other hand, the facts also shows that researching of Labthink in permeability testing field is no longer limited to flexible package, Labthink also possesses the ability to manufacture auto gas permeability instrument for other industries.