Oxygen Permeability Test of Film by TOY-C1

Abstract: This paper introduced the principle of equal-pressure method to test oxygen permeability of film, and expand on the oxygen permeability test of film by Labthink TOY-C1, thus realize to use an equipment to test the oxygen permeability of both package and film.

Key words: film, oxygen permeability, TOY-C1

People have already heard about TOY-C1, Labthink's newly introduced permeability instrument this year. Due to its professional function in package oxygen permeability testing, TOY-C1 has become a highlight in domestic permeability testing industry. Its debut on the package exhibition of south China Guangzhou Pazhou in March 2005 has attracted public attention, which not only fills the gap of domestic package permeability testing industry, but also promoted Labthink's status in international permeability testing fields.

But, even if package manufacturers will sometimes need the testing of oxygen transmission rate for certain sheet and film, and such testing demand can be very heavy sometimes. It is indeed necessary for those who have purchased package oxygen permeability instrument independently to buy one film oxygen permeability tester. For such users, it is an optimum choice if the instrument can function as both package oxygen permeability tester and film oxygen permeability tester. Because in this way, not only the expenditure of capital can be reduced, utilization ratio of the instrument is also improved.

1. Test principle

As stated in standard ASTM F 1307, this test method employs a coulometric oxygen sensor and associated equipment in an arrangement similar to that described in Test Method ASTM D3985. Oxygen permeability of sheet and film can be tested according to standard ASTM D3985 when removing the instrument's package testing accessories. It was according to theses two standards that Labthink TOY-C1 was designed and manufactured. Users can perform film oxygen permeability testing in equal pressure method. The testing principle is (see fig 1): the specimen divides testing chamber into chamber A and chamber B with chamber A being 0.1MPa pure oxygen gas at certain flow rated and chamber B being purged by 0.1MPa nitrogen gas at certain flow rate. When oxygen transmits through the specimen from chamber A into chamber B, it will be diverted into the sensor by nitrogen carrier gas in chamber B. Oxygen transmission rate contained in the nitrogen gas is detected by the sensor and then output as corresponding electrical signals.

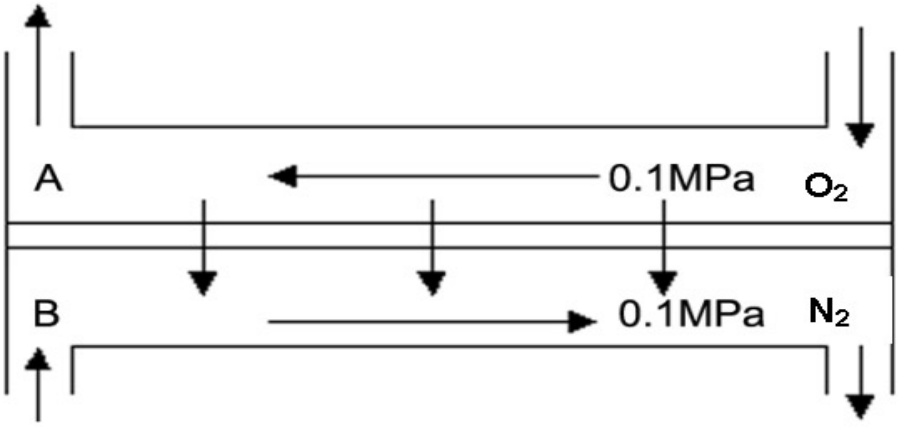

Fig. 1. Test principle of equal pressure method

2. Film testing

Specimen sampling and attachment of film testing, which is simple and convenient, is similar to that of the equal pressure method. To facilitate specimen sampling, TOY-C1 is furnished with special film specimen cutter. Fig. 2 is the specimen that has completed attachment.

TOY-C1 Specimen attachment of film oxygen permeability testing

The dimension of specimen is Φ 140mm. If thickness of specimen exceeds 1mm, corresponding subassembly is needed in the process of attachment. TOY-C1 can perform three-chamber testing, but it should be noted that all specimen for one testing must be prepared for attachment in the same way and of the same material. In the process of attachment, specimen edge should be sealed with vacuum grease. Pay attention not to contaminate testing area by vacuum grease.

Testing process is almost the same with that of the package oxygen permeability testing: purging the system to identify the value of 'system zero point'. Then divert oxygen gas into the upper chamber; output value of the sensor will gradually increase which is an indication that there is oxygen transmitting through the specimen into chamber B. When the oxygen gas transmission rate (O_2GTR) maintained at a constant value, it can be considered as equilibrium of transmission and that O_2GTR is the test result.

Whether the flow rate of nitrogen gas is appropriate during testing will directly influence the test result. Therefore, this instrument has higher demand for controlling device and flowmeter of nitrogen flow rate.

3. Data testing and stability

Measurement range of TOY-C1 is 0 ～ 1000.00ml/m^2 · day(extended to 0 ～ 10000.00ml/m^2 · day with special subassembly). Its testing distinguishability can reach 0.01ml/m^2 · day. The testing curve is shown in fig.3.

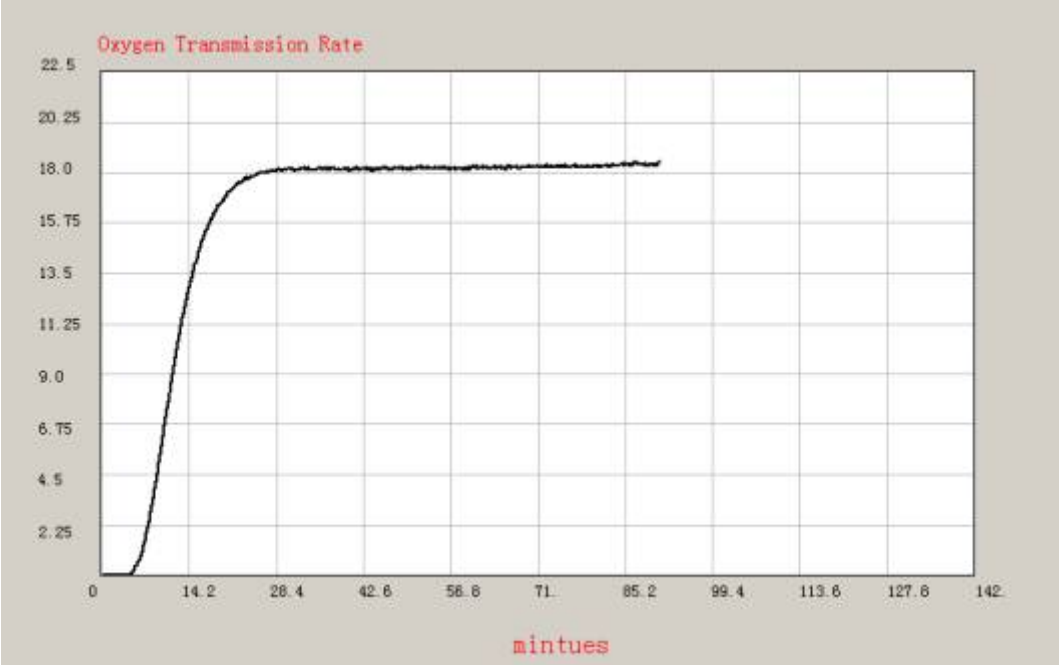

Fig.3 testing curve of film permeability testing

A , B , C , D are the specimens chosen for TOY-C1 oxygen permeability testing . Testing temperature, specimen thickness and testing results are listed in table 1.

Table 1. Data sheet of testing

Specimen	thickness μm	O_2GTR measured data	O_2GTR (mean)	S	CV%	Testing temperature °C
A	20	6.29	6.44	0.14	2.13	23
		6.47				
		6.56				
B	20	10.37	12.17	1.59	13.08	23
		13.38				
		12.77				
C	20	32.66	33.15	0.44	1.33	23
		33.27				
		33.52				
D	25	46.36	49.97	3.98	7.97	23
		49.30				
		54.24				

Note: unit of O_2GTR is ml/m^2 · day.

Generally speaking, TOY-C1 data features a better stability. There are mainly two factors that influence data stability: one is the nonuniformity of specimen thickness. Data stability can be significantly improved if the specimen is uniform in thickness and operators pay some attention in specimen sampling. The other factor is that temperature fluctuation has a great influence on testing. The influence of temperature on equal pressure method is the same with that on differential pressure method. Those

who are interesting can refer to the article named *Influence of Temperature Fluctuation on Material Permeability* updated on January 21st, 2005 in Labthink Lab Forum.

4. Instrument characteristics

Under normal condition, oxygen sensor adopted by TOY-C1 has an expected lifespan of twelve to thirty months, which reduced testing cost effectively. If specimen number is less than three, the instrument can perform normal testing after the instrument self-furnished ‘blank specimen' is prepared for attachment in those testing chambers that does not need specimen attachment and then modify specimen number in system setting. In this way, sensor lifespan is prolonged while measuring range of the instrument is extended.

Testing process will not be affected by power supplying. The only influence of power failure is the inability of testing monitor. Moreover, this instrument has a smaller consumed power, which is less than 30W under normal working conditions.