

## The Application of Permeability Test in Dairy Package

**Abstract:** based on dairy products and the factors influencing quality of dairy products during storage, this article elaborates on the application of permeability test in dairy package. The relationship between barrier property of materials and quality guarantee period of products is also touched on.

**Keywords:** dairy, fresh milk, fermented dairy, milk powder, barrier property, oxygen permeability, and water vapor permeability

In recent years, with the stable development of Chinese economy and the constant improving of people's living standard, dairy industry enters its development of golden age. It becomes one of the industries enjoying the most rapid development and the best growth. At present, milk and dairy products have become one of the symbols of health life. Various kinds of milk food and milk products all have wide sales network of their own. However, as the sale conditions are different, it is difficult to secure dairy food being stored in stable environment (even to fresh milk, preserving it in cold environment all the way is rather difficult). Therefore, the influence of dairy package on product quality is very significant. The package not only influences quality guarantee period of dairy products, but also directly relates with human health.

### 1. Main Factors Influencing Dairy Quality and Corresponding Packing Forms

As a component of dairy products, dairy package has profound influence on the development of dairy industry. This is because milk easily goes bad. Either ultra heat treated (UHT) milk or preserved milk raises strict demand on quality. This article will introduce dairy products according to the classification of fresh milk, fermented milk and milk powder.

#### 1.1 Fresh Milk

Fresh milk can be processed into different kinds of dairy products. Each kind of product has its own packing requirements. The most commonly seen fresh milk are Pasteurized milk and ultra heat-treated milk.

Pasteurization is the most widely used method for milk treatment, in which instant ultra heat sterilization is commonly used, i. e., heat the galactopoiesis to 70°C~72°C for 10~20s. Pasteurization of milk can kill bacteria in galactopoiesis so as to secure the quality and safety of drinking. It can also destroy the microbes and ferment that can result in flavor variation so that quality guarantee period of dairy products can be prolonged. However, Pasteurization can only kill 90%~99% microbes in the milk. Thus the products do not have long quality guarantee period and require cold storage. Light is the main factor resulting in vitamin losing in Pasteurization. Moreover, other nutritional ingredients will also have chemical reaction and decompose when exposed to light. Therefore, dairy packing should be conducted in darkness. Oxygen gas is another important factor to be noted. Excess oxygen gas inside package ceiling or bigger oxygen permeability of package will accelerate the oxidation reaction of inside milk and in turn causes quality deterioration. For fresh milk, the commonly used packing forms are glass bottle, laminated paper box and plastic box.

In UHT sterilization, fresh milk continuously passes the heat procedure and then is sterile packed after a shorter period(1s-2s) of high temperature(at least 135°C) heating. The loss of Nutritional ingredients of UHT milk during storage depends on storage temperature, original oxygen content in milk and properties (oxygen permeability and light transmission) of packing materials. Off-flavor of oxidation reaction and grease deterioration also can enter UHT milk. The extent of these reactions depends on oxygen content in milk and storage temperature. Various kinds of packing forms can be used for UHT milk package and aluminum foil backed

laminated material is the most commonly used material. Aluminum foil is the main permeable layer in this material. It can efficiently prevent oxygen gas from transmitting inside while preserving the flavor of fresh milk.

## 1.2 Fermented Milk

Fermented milk is the product (such as popular yoghurt) of fresh milk or other dairy products first being homogeneity processed, sterilization and etc and then being microbes fermented. Sour milk is a classic kind of fermented milk. It can form different kinds of products when added fruits, fruit flavor or sugar. Sour milk has solidified, stirred and liquid types. Different from fresh milk, the content of carbon dioxide in fermented milk has significant influence on flavor variation and microbe growth. At present, packing forms of fermented milk are also glass bottle, laminated paper box and plastic box (Plastic container, plastic cup).

## 1.3 Milk Powder

Milk powder is a kind of dairy product with big consumption. It is the product of fresh milk or dairy products being spray as well as drying processed. Oxidation reaction is a key factor affecting quality guarantee period of milk powder. To secure or prolong quality guarantee period of milk powder, sealed package is very essential. Special attention should be paid to the differences between milk powder and liquid milk. Damp proof in milk powder package is as important as how barrier property is required. The commonly used packing forms of milk powder are metal can, aluminum foil laminated flexible packing bag, and paper based complex pot.

## 2. Main Test Items of Dairy Package

From the above statement we can conclude that the transmission of light, oxygen gas, water vapor are the main factors influencing quality of dairy products. Light proof of dairy products can be realized without any difficulty since almost all packing materials for dairy products at present are light proof with better effect. However, barrier property is no way so simple. On the one hand, barrier materials are high in cost. Pursuing better barrier property will inevitably increase package cost and consequently result in the increasing of product cost. On the other hand, although multi-layer lamination is a very suitable way to effectively improve barrier property of either laminated paper box, or laminated plastic flexible packing box or laminated plastic cup, the level of domestic self-developing technology is not advance enough for corresponding multi-layer lamination products and lamination equipment as well as raw materials. Laminated equipments and raw materials, especial laminated paper box, mainly rely on importation. That is why although the higher cost of dairy package has already attracted attention, there is still great difficulty replacing this expensive packing material.

In addition, as barrier property of adopted material will gradually become low, oxygen gas and water vapor transmitting inside will also increase, or the rate of filling gases inside packing transmitting out becomes quick. This will eventually results in the increasing of inner oxygen content and humidity, which happens to be the main factor causing milk deterioration. Therefore, to some extent, barrier property of packing materials is the main factor affecting quality guarantee period of dairy product belonging to the same kind (with the same process and treatment). That is why barrier property test of packing materials is of critical importance.

To what extent does barrier property of packing materials affect quality guarantee period of dairy products? Some representative data of barrier property test of dairy packing materials are listed below. The instrument being used are Labthink VAC-V1 gas permeability tester (auto gas permeability test) and TSY-T3 water vapor permeability tester.

Table 1. Barrier property test data of dairy packing materials

Number	Specimen	Oxygen permeability	Water vapor	Usage
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		y	permeability	
1	PP milk film	845.088	1.72	Pasteurization milk
2	PE monochrome film 1 #	958.096	1.82	
3	PE monochrome film 2 #	987.637	2.02	
4	Al laminated plastic flexible packing film 1 #	0.472	0.19	Milk powder package
5	AL laminated plastic flexible packing 2 #	0.404	0.17	Milk powder package
6	Coated PE packing film 1 #	8.454		Dairy packing
7	Coated PE packing film 2 #	13.397		Dairy packing
8	Coated PE packing film 3 #	11.817		Dairy packing
9	PE milk film 1 #	1335.624		Pasteurization milk
10	PE milk film 2 #	1587.467		Pasteurization milk
11	paper moulded laminated material 1 #	0.300	0.28	Pasteurization milk
12	Paper moulded laminated material 2 #	0.418	0.21	Pasteurization milk

note: the unit of oxygen permeability is  $\text{ml/m}^2 \cdot 24\text{h} \cdot 0.1\text{MPa}$ .

the unit of water vapor permeability is  $\text{g/m}^2 \cdot 24\text{h}$ .

Specimens listed in Table one covers almost all kinds of packing materials applied in various forms of dairy packing. For example, laminated paper box such as ridge package, Tetra-Pak package adopts paper molded laminated materials, sterile package uses coated/laminated film, common package usually chooses PE monochrome film, and milk powder package uses AL laminated plastic flexible packing film. According to table 1, the paper moulded aluminum foil laminated materials for laminated paper box and the AL laminated plastic flexible film in milk powder package possess the best barrier property among various dairy packing materials. Moreover, their gas permeability and water vapor permeability are within the range of high barrier property. It is not doubt that the cost must be high. According to relating documents, one Tetra-park package costs at least half a Yuan. Coated /laminated packing film of sterile packing belongs to the range of medium barrier property range and also costs moderately. The most commonly used PE monochrome film and milk film has the smallest barrier property. Its gas permeability is several thousand times higher than that of paper moulded laminated material and AL laminated flexible film, several hundreds of times higher than that of coated/laminated film. Consequently its cost is the lowest, which does not exceed 0.1 Yuan.

The selection of Packing material, material structure and barrier property depends on the expected quality guarantee period of products. For example, when select paper moulded complex material or AL complex plastic flexible packing film with high barrier property as the packing materials, quality guarantee period of dairy products can last several months. Moreover, such dairy products have no strict requirement on storage environment and do not need cold storage. Selecting material of low barrier property may result in product deterioration or bring difficulty to transportation and storage. Quality guarantee period of Dairy products adopting Monochrome film in package is only several days. Such products usually have great consumption and are quick sold after delivery. For example, using packing materials of high barrier property will not obvious prolong quality guarantee period, but results in the increasing of packing cost. That is why packing materials should be selected based on product property and its quality guarantee period. At the same time, barrier property of materials can be 'customer made' for specific product, i.e., designing material structure and select corresponding materials according to the required barrier property. In table one, although both being paper moulded aluminum laminated material, barrier property of 2# specimen to gas is inferior to that of specimen 1#, while its barrier property to water vapor is superior to that of specimen 1#. Both being PE film, some martial possess barrier property of more than 900, while some can be up to more than 1300. Barrier property is improved on the premise of higher cost. Therefore, if the adopted packing material can guarantee product quality within its quality guarantee period, there is no benefit seeking unduly high barrier property of materials.

### 3. Conclusion

At present, domestic dairy packing materials can meet general requirement of quality guarantee already, but advanced dairy packing still relies on importation. As new dairy products are being introduced and new processing technologies are becoming popular, the research and development of new packing forms and the application of new packing materials enter a period of rapid development. However, the requirement on material selection also becomes much higher. Only when various properties of the materials have been comprehensively tested, can the quality of dairy products be secured, can the safety of numerous consumers be insured.