A Study On Food Packaging Materials Testing & Quality Assurance

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ABSTRACT

As food is a natural organic material, Packing is essential to the food production and supply sector since it derives from natural resources and has finite wildlife forms. We could only consume these goods if there were packaging due to their biological existence. Since 2010, hygienic supervision and inspection have been required for all foods, food additives, packaging materials of food containers, instruments and equipment linked to food that are imported or exported. In this paper discuss about type of test to be required for food packing material.

Keywords: *Peel Test, Compression Tests, Drop Test, Dye Penetration Test, Tensile Strength***.**

1. Introduction

Packaging has had a long history. The first "package"—which may have been a cover of leaves, an animal skin, the casing of a seed or gourd, a thin pieces of wood, etc.—came into existence as a result of the necessity for containment and carrying mechanisms among primitive humans. The first forms of packing were produced from fabricated sacks, baskets, and bags made from materials of plant or animal origin, wooden boxes, hollow logs, clay bowls, and mud pots.

The main purpose of packing is to secure and preserve goods from outside contamination [1]. Retarding degradation, increasing shelf life, and preserving the health and safety of processed foods are all part of this role. Food is shielded by packaging from environmental factors such heat, light, moisture levels, oxygen pressure, enzymes, fake odours, bacteria, insects, dirt and airborne particles, emissions into the atmosphere, etc. Traceability, tamper detection, and portion control are other features that are becoming more and more crucial [2].

Early 19th-century cans were produced from iron and steel that had been tin-plated. Early twentieth packaging innovations included transparent cellophane overwraps and panels on cartons, Bakelite caps on bottles, and better food safety. As new materials were created, such as aluminium and various kinds of polymers, they were used to packaging to enhance performance and utility. Used food packaging is put through quality control procedures to make sure it's safe for consumers and the environment.

2. Tear growth test on plastic films

The test mimics how packing foils will behave when the product is opened. The initial tearing strength should be about equal to the remaining tearing strength while opening a plastic bag. There is a risk that the packaging will spontaneously break apart fully and the stuff will pour out if the maximum power during first tearing is too great. Since the tensile strength and rip resistance of stretched foils are both very direction dependent, adjusting the appropriate behavior is difficult. ASTM D1004-13 Tear Resistance (Graves Tear) of Plastic Film or Sheeting is the recommended test method [3].

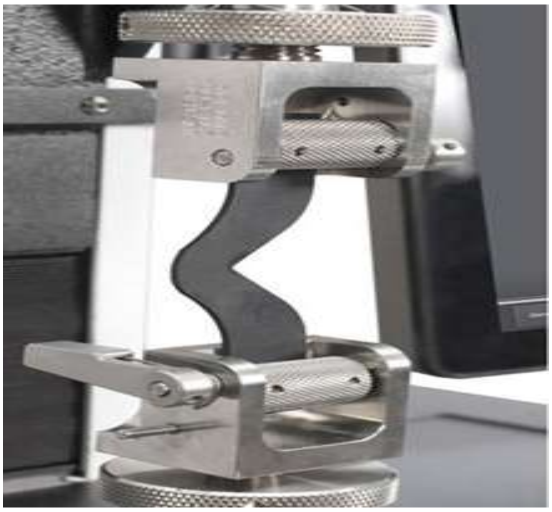

Figure 1: Tear growth test on plastic films

3. Peel testing

Seals are essential to many forms of food packaging; however, their function varies depending on the product. Depending on the kind of packaging, it can need to be easy to open, have hermetic integrity, or be mechanically strong. Therefore, the power needed to remove a lidding material from a pack must strike a balance between the necessity of maintaining seal integrity and the desire of customers to open the packs easily. Food safety and integrity should be given special consideration while developing new pack forms for products. The potential for seal strength to change over time or during or after distribution must also be understood.

3.1. 90°/180° peel tests

Peeling a tape at an angle of 90 degrees or 180 degrees in reference to a substrate is the most common and straightforward technique. The load direction for the 90, 180, and T-peel tests is depicted in the image below. This kind of tests is used to evaluate the adherence and tear strength of adhesives. There are a lot since various substrates and adhesives are utilized for a wide range of applications. The adhesion qualities of various materials are compared using test discs composed of glass or stainless steel with a uniform surface.

The tests establish the force required to repeatedly tear a strip of tape from a test surface or piece of glass, which is known as the bonding or adhesion strength. The force connected to the tape's width is the outcome.

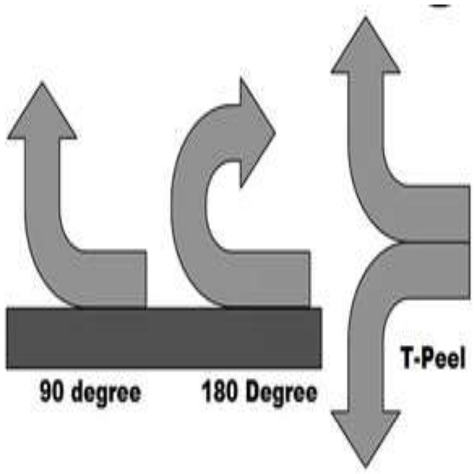

Figure 2: Peel testing

The tack test is frequently crucial to establish a material's capacity for adhesion to a material and to measure the tearing force. In order to produce adhesion to a substrate, contact or minimal contact without exerting force is required.

The same idea is used in numerous peel and tear tests. Examples: EN 1939, EN 1719, DIN 30646, DIN 55475, DIN 55477.

3.2. Peel test on lid or sealing material

For assessing the strength of a flexible, peel able lid that seals packed items, ASTM F2824 provides the specifications. The test procedure is comparable to ASTM F88 for seal strength, except instead of using a tiny 1x1 inch sample specimen, the complete container is used. Similar to a peel test, this test is performed. The manual opening serves as the foundation for the opening angle, which can range from 90° to 155° [4].

The purpose of the test is to ascertain if opening food packaging is challenging or simple. A thermal sealer machine is used to create the majority of these closures. These automated packaging devices frequently experience timing or alignment issues, which results in the seal failing to adhere correctly. The glue that is being utilized can potentially have problems.

Figure 3: Peel test on lid or sealing material

4. Compression tests on plastic beakers, buckets, boxes, containers, barrels and similar dimensionally stable packaging

Due to its affordability, robustness, simplicity of manufacture, and great flexibility, plastic and plastic composites are employed in several applications like Jars, food containers, bags, garments, pipes, computers, and computer accessories. Food containers are made of plastics like polyethylene terephthalate (PES). Containers are made of poly vinylidene chloride (PVC), while PE and HDPE polyethylene are used for a wide range of other food packing purposes. For high-quality product design, it is crucial to ascertain these materials' mechanical characteristics. Plastic materials are frequently subjected to compression testing in order to measure their compressive strength, yield stress, and modulus of elasticity [5].

Figure 4: Stacking crush test on boxes

GGBS obtained from JSW Steel, Andhra Pradesh**.** Physical properties of GGBS are determined as per IS: 12089 and given in Table 2.2

Related Testing Standards

- ISO 604 Compressive Plastics Testing Equipment
- ISO 844 Compressive Strength of Rigid Cellular Plastics
- ISO 14126 Compression Fibre - Reinforced Plastic Composites Test Machine
- ASTM D695 Compression Testing for Rigid Plastics
- ASTM D1621 Compression Testing of Expanded Plastics and Foams
- ASTM D6108 Compressive Properties of Plastic Lumber and Shapes

5. Burst test

A flexible pack's burst strength is measured by inflating it with air at a certain pace until it bursts, which reveals how strong its seal is. Along with the burst pressure value, the failure's place and type (material or seal) are also noted. The test is used to determine how likely it is that a pack would break when subjected to pressure discrepancy, such as those that could occur during retorting or air shipment. Because the forces during pressurisation are distributed more evenly over the perimeter of the pack when it is placed between supporting plates, the weakest location of the seals is more likely to be found [6].

- ASTM F 1140 (Method A & B1 but not B2)
- ASTM F 2095 (Method A & B)
- ASTM F 2054

Figure 5: Burst test

6. Compression strength testing

Individual main packaging samples, such as cartons, bottles, and cans, are tested for compression strength using a 50kN load capacity. The compression strength of larger transportation packing, such as fiberboard boxes, is also frequently tested.

7. Creep testing

The same method is used to demonstrate bursting strength and creep testing. However, a creep test measures seal strength and pack integrity, whereas a burst test measures pack/seal strength. A creep test involves holding the pack at a percentage of its known burst pressure for 30 or 60 seconds to determine whether it passed or failed (in the case of seal leakage). Seal yield, or the narrowing of the seals before and after testing as a sign of internal seal peeling, can also be assessed in the seals.

8. Drop test

The drop tester can be used to ascertain the drop Strength of corrugated boxes while transportation. Carton drop tester provides vertical and an angular drop. This assists in ascertaining the packaging quality and worthiness.

Figure 6: Drop test

9. Dye penetration testing

Most frequently for medical equipment, dye penetration testing is done to visually evaluate any potential flaws in the seal of a sterile barrier system. This test standard uses a simple methodology but has the potential to reveal important information about flaws in the material or packaging process, especially when it comes to certifying the seal integrity for medical devices. Porous materials like paper and non-porous materials like poly or foil are the most frequently analyzed packaging materials tested for dye leaks. During the test, a package is injected with a dye solution to a depth of 5 mm (0.25 in) along the inner seal's longest edge [8]. In general, ASTM has established two dye penetration test standards, which are the ASTM F1929 and ASTM F3039 test standards.

Figure 7: Dye penetration testing

10. Internal pressure resistance testing

Containers intended for carbonated beverages or those that experience other pressure variations during their intended use must undergo internal pressure resistance testing. This mechanical test establishes whether the package complies with relevant requirements and is suitable for its intended application. A ramp internal pressure tester is used for testing. Water is poured into bottles, and the pressure is gradually increased until the bottle or can breaks or deforms. If relevant, the location of the failure origin is recorded together with the burst or deformation pressure value [9].

Figure 8: Internal pressure resistance testing

11. Pendulum impact testing

To make sure that a variety of alternative pack forms are suitable for their intended usage, pendulum impact testing is done to assess the impact resistance, strength, and breaking properties of each one. Glassware, plastic and glass packaging, as well as other products, can all be tested for impact resistance. Usually, impacts are made at the point of contact for that specific item, such as the heel and shoulder of a bottle or the rim of a pint glass, and testing is continued until the sample fails. However, testing can also be done in other specialised impact positions [10].

Figure 9: Pendulum impact testing

12. Tear resistance

Materials for sheets and films can be tested for tear resistance to determine the force necessary to rip single or multiple plies through a predetermined distance after tear initiation [11].

Figure 10: Tear resistance

13. Tensile and T-peel testing

A mechanical test called a tensile strength test is done on packing materials to find out how much force can be applied to it before it breaks or ruptures. It is essentially a "pulling" test that assesses the durability of paper, board, and plastics. The material will behave elastically up to a point before rupturing. The test is adaptable and can be used to gauge a material's tensile strength, elongation, tearing resistance, as well as the amount of force needed to break a seal. Similar to tensile testing, T-peel testing measures the mechanical strength of a material by applying a load to a portion of a packing seal to see how long it can withstand before breaking.

Figure 11: Tensile and T-peel testing

14. Thrust test

Using a thrust pouch pressure tester, thrust testing is performed to assess the seal strength of pouches. The thrust test entails applying a steady pressure for a predetermined amount of time, followed by the observation of seal integrity. When a steady load is applied at a predetermined pressure, this provides an indication of seal strength.

Figure 12: Thrust test

15. Torque testing

The amount of force needed to open a bottle or jar closure is measured by torque testing on the closures, which must weigh the necessity of ease for consumers who want to open the packs against the significance of closure integrity. Application and removal closure torques are measured using a Mecmesin Tornado digital closure torque tester [12].

Figure 13: Torque testing

16. Underwater vacuum / bubble emission testing

Leakages in packs can be found using underwater vacuum / bubble emission testing down to about 250 microns. In the food business, these tests are frequently utilized as rapid off-line checks during production and packaging.

Figure 14: Underwater vacuum / bubble emission testing

17. Push out test on blister packing

The design of the blister pack, especially the opening force and opening mechanism, can significantly affect how easily older persons can use the blister pack [13].

Figure 15: Push out test on blister packing

18. Opening force of ring-pull cans

The cap of a beverages can be opened by pulling a tiny ring. This ring is also known as a zip top or ring pull. On the thin metal plate of the can top, a groove is carved so that a drinking hole of a specific shape opens along the groove. A press instantly engraves the groove, permitting a mass production line that is less expensive. The can might accidentally open if the groove is too deep from the shock of its own weight dropping inside an automatic vending machine. If it is too shallow, it will be difficult for those with delicate fingers to open, threatening the market for female and young people. Determining the depth of their grooves and the amount of power needed to draw the ring pull are therefore two factors that beverage can producers must constantly monitor and assess [14].

Figure 16: Opening force of ring-pull cans

19. Sealed-seam strength

According to DIN 55529 and other standards, the sealed-seam strength of sealing constructed of flexible packaging material is determined. On 15 mm wide strips with a 180° peel angle, a tensile test is run. Depending on the kind of packing material being used, this seal must exhibit a specific rigidity.

Figure 17: Sealed-seam strength

20. Tack loop test for testing the adhesive strength of adhesive tape

The first stage of adhesion is tack. It is measured as the tearing force of a loop material that has come in contact with a test plate's surface. With the sticky side facing out, a strip of pressure-sensitive material is shaped into a loop. The testing device makes contact between the loop and a test plate. The loop is severed when a predetermined contact area is attained.

Figure 18: Tack loop test for testing the adhesive strength of adhesive tape

21. Unscrewing lids/torsion testing

To open a sealing cap, a linear axis and a torsion drive are combined. With the help of this test, the ease of the closure cap may be evaluated while taking the thread pitch into account.

Figure 19: Unscrewing lids/torsion testing

22. Conclusion

In all elements of the contents, the quality of the packaging is critical, but food packaging is especially significant and requires extra care. Numerous quality criteria must be adhered to when packaging food, including chemical compositions, anti-microbial activity, bio tests, dye penetration, and moisture management properties. This papers goal was to provide examples of the many testing techniques used to evaluate the physical characteristics of food packaging materials.

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