

The Technology and Application of Shrink Packaging

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Keywords: Shrink Packaging, Packaging Forms, Application.

Abstract. Shrink packaging is a packaging way which is widely used in the field of modern goods packaging. Its packaging forms, the development of new technology and application field were summarized. Its outstanding features, such as transparent and intuitive, efficient, seal and moistureproof, flexible and convenient operation were analyzed. A broader development prospect of shrink packaging used in various industry products in the form of sales packaging and transport packaging was pointed out.

Introduction

Shrink packaging is a technology of using with heat shrinkable film to wrap goods, then heating, film wrapping tightly goods by shrinking according to certain proportion [1]. Shrink packaging has many characteristics: It can pack special products which are difficult to pack by general method; Its film generally is transparent and can display the appearance of the product after packaging; It can package various kinds of or more pieces of products together easily, and sometimes can save packing box with the help of shallow platter; It can prolong the shelf life of food therefore easy to store; It is good seal, moistureproof, antifouling and antirust so easy to stack in the open air and save storage space; Its packaging technology and equipment are simple and general, easily to realize mechanization, and partially to replace the carton and wooden box; It can be used to pack large volume of product on the scene; Its film have cushioning properties and toughness so it can take effect of cushioning packaging, and therefore reduce the packaging cost [2]. Currently shrink packaging has been widely used in varieties of goods of sales packaging and transport packaging.

The Method of Shrink Packaging

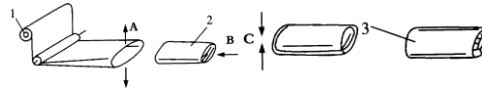
The operation of shrink packaging is to wrap the product with shrinkable film firstly, and to heat sealing and cutting the necessary opening and seam by sealing and cutting packing machine, then the pre-package is heated by heat shrinkable equipment to wrap tightly onto the product with film shrinking. The method of shrink packaging is mainly reflected in the pre-packaging operations. When pre-packaging the size of shrinkable film should be 10%~20% larger than the size of products. If the size is too small, it will cause fill goods inconveniently even lead to excessive shrink tension and result in the film breaks down; if oversize, it will cause insufficient shrink tension therefore lead to the package loosely or unfairness. The shrinkable film can be selected according to product size, quality and required shrink tension. The commonly used shrinkable film is PE, PVC, PP, EVA and so on, and it includes three forms such as flat film, tubular film and folded film, and it could be selected according to different packing method.

The Method of Open at Both Ends

First the product is wrapped inside a sleeve formed by tubular film or flat film, then heating, the completed package has shrink open at both ends. [3].

When using tubular film, first the mouth of tubular film is opened and products are pushed into tubular film with the help of chute, then the film is cut off, as shown in Fig. 1. This way is suitable for wrapping cylindrical items such as batteries, paper rolls, bottles, cans, and so on. Packaging with tubular film can reduce 1~2 sealing process and makes products in beautiful appearance. The

disadvantage of this method is that unable to meet the diverse requirements of products, only apply to a single product packaging in large quantities.



1-Film reel (tubular) 2-Push-in product 3-Package A-Opening B-Push the products into tubular film C-Cut off

Fig. 1 Open at Both Ends Packaging with Tubular Film

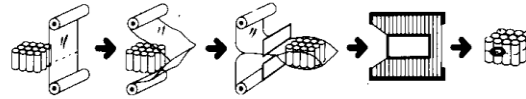


Fig. 2 Open at Both Ends Packaging with Double Flat Film

The method of packaging products with flat film can use single or double flat film which should be wider than products. When wrapping with double flat film, in other words wrapping with upper and lower two rolls of film, the ends of two rolls of film are connected at the same time of the previous pre-package completing sealing cut, then the product is pushed onto the upright connected film by machine or hand. After putting product in place, the sealing and cutting device falls down to seal and cut the other side of the pre-package, then the product wrapped with film undergoes heat to form the package with elliptical shrinking opening at both ends. The operation process is shown in Fig. 2. When using a single flat film, first the flat film is expanded and products are sent to the middle of the flat film to form a horseshoe-shaped pre-package, then the film lap seal is completed. For now, it has been developed a high-speed continuous sealing and cutting packing machine which can wrap products with flat film without sealing, the packaging speed is up to 30~45 pieces/min. Packaging products with flat film are not limited by the change of varieties of products and it is always used for single piece or multiple pieces product, such as one or more boxed products, bottled products.

The Method of Four Sides Sealing

The around the product is wrapped with flat film, tubular film or folded film, and the seams are sealed in the method of lap seal. It is suitable for the requirement of fully sealed product package.

The L-type heat sealing and cutting device apply to folded film, as shown in Fig. 3. A length of folded film is pulled out from the film roll in a horizontal position, and the open end is opened up by mechanical or manual methods, then the product is pushed to crease line of folded film. Before this, a transverse joint is left after the last heat sealing and cutting, so total of two joints by plus the crease line do not have to seal again, therefore the film is sealed and cut with L-type heat sealing and cutting device from the back of the product and the connection of the film. A transverse joint and a longitudinal seam could be sealed and cut each time. The whole pre-packaging process is easy to operate by manual or semi-automatic, and suitable for packaging special-shaped and more size changed product.

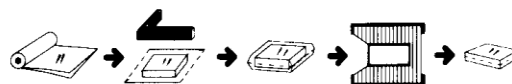


Fig. 3 L-type Heat Sealing and Cutting for Four Sides Sealing Packaging with Folded Film

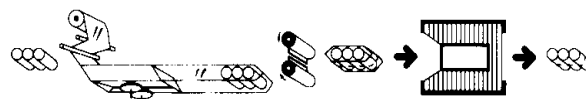


Fig. 4 Four Sides Sealing Pillow-type Packaging with a Single Flat Film

When using a single of flat film the pillow-type package can be made. Firstly, the single flat film

is sealed longitudinally into tubular shape, then products are pushed into it, and then it is sealed and cut horizontally into pillow-type package or is clamped and ligated from both ends into tube package. The whole operation process is shown in Fig. 4.

The progress of four sides sealing packaging with double flat film is similar to the process of open at both ends packaging. It only need to equip with sealing device on both sides of the machine, as shown in Fig. 5.

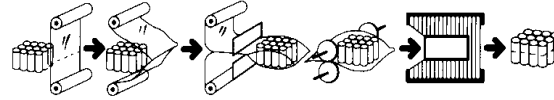


Fig. 5 Four Sides Sealing Packaging with Double Flat Film

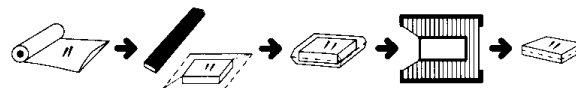


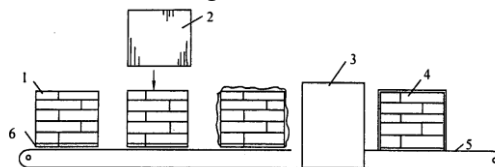
Fig. 6 Four Sides Sealing Packaging with Tubular Film

Wrapping with tubular film only need to seal and cut film at the same time, then make it heat shrinking, as shown in Fig. 6. After the pre-package of four sides sealing package, the residual air inside pre-package in heating process expands to make film shrink difficult, and affect the quality of package. So there is always a puncture needle beside the sealing device, as heat sealing the needle pricked out the vent hole on the film, and the hole often self-closing after heat shrink.

The Method of Open at One End

The cargo tray shrink packaging is a typical example, as shown in Fig. 7. The cargo tray on conveyor belt is covered with a big shrinkable film bag and then sent into heat shrink channel, after passing the heat shrink channel the cargo tray shrink packaging is completed. The main characteristic of this packaging is that it can wrap a number of products firmly, without loose in transit and the package can stack in the open air [1].

The large volume products can be wrapped by the method of shrink packaging on the scene. First a length of tubular film is pulled out from the film roll, then the open end of tubular film is opened up and cover on the outside of the product. After sealing and cutting the open end on the top of tubular film, you can take use of portable hot air gun to heat each part of the film outside of the product in turn to complete heat shrink packaging. This method can complete shrink packaging of large products. The operating process is shown in Fig. 8.



1- Cargo Tray 2- Cover shrinkable film bagging 3-Heat shrink channel 4- Package 5- Conveyor belt 6- Tray

Fig. 7 Cargo Tray Shrink Packaging Process

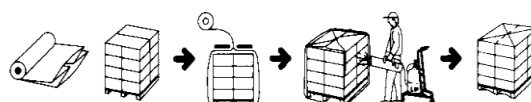


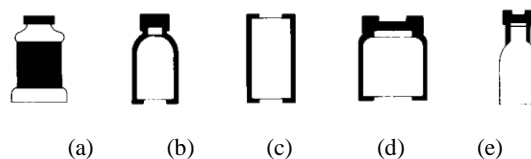
Fig. 8 Large Products Shrink Packaging Process

The Shrinkable Film Label

Shrinkable film is not only widely used in sales packaging and transport packaging, but also widely used to make shrinkable film label. It has unmatched features compared with traditional plate label and roll paper label [4]: (1) Shrinkable film has good features of wear resistance and

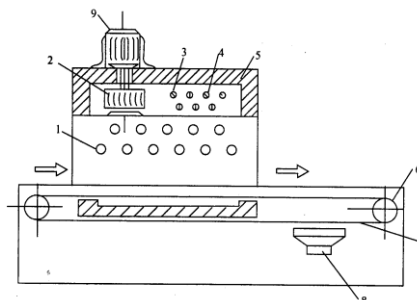
strength, the film printing image is clear and beautiful; (2) For some of the unique shape of packaging container (such as the surface contour have large ups and downs and the label cover area increases, etc) and individual vessel design, shrinkable film label also can fit closely with the surface profile of container; (3) Shrinkable film label have good features of adaptability, whether wood, paper, metal, glass, ceramic containers can be used by shrinkable film for label, and achieve the same transparency with glass container without the use of adhesives.

Shrinkable film label is suitable for round, square, curved, and various of special-shaped bottles, could complete the process of wrapping "head", wrapping "neck", wrapping "waist", wrapping "feet" or wrapping "body" of the container, as shown in Fig. 9. Automatic shrinkable film labeling machine is designed cleverly, the electric control part adopts bar with motor, human machine interface and other automation equipment, so the machine is easy to operate [5]. The speed of sleeve labeling on the side could up to 350 bottles / min and the sleeve labeling on the mouth could up to 400 bottles / min, adapted to the fast-growing demand of shrinkable film label.



(a) Label on the side (b) Label on the whole body (bottle top closed) (c) Label on the whole body (up and down opened) (d) Label on the whole body (bottle mouth opened) (e) Label on the mouth

Fig. 9 Shrink Sleeve Label Bottles



1-Hot air export 2-Hot air circulating fan 3-Heating element 4-Temperature adjusting element 5-Heating channel 6-Driving wheel 7-Conveyor belt 8- Cooling fan 9-Fan motor

Fig.10 Heat shrink channel

Heat Shrinking Process

Heat shrinking process use a device called heat shrink channel. As shown in figure 10, It be composed of conveyor belt, heating and cooling device and so on. When performing heat shrinking operations, put the pre-packaged product on conveyor belt, running at a predetermined speed into the heating channel, heating by the method of let hot air blow to the package, the film outside of products automatically shrink to wrap products tightly, and then send products out of heating channel after the completion of heat shrink, finally remove package from conveyor belt after natural cooling, also can take use of cooling fan speed film cooling according to the product size, types of thin film and film heat shrink temperature.

Heating channel is a box-shaped device equipped heat insulating material in the inner wall, in order to ensure hot air blown evenly onto the package, it could adopt automatic temperature adjusting device to ensure the temperature is constant (temperature difference $\pm 5^{\circ}\text{C}$) and adopt forced circulation system to get on hot air circulation. Hot wind speed, flow rate, the structure of the conveyor, inward and outward shape and material, etc, all affect the process of shrink during heating. The heat shrink channel parameters should be chosen according to the characteristics of the film [6]. Tab.1 is relation of main parameter of shrinkable film and heat shrink tunnel.

Heat shrinking operation can not only adopt heat shrink channel method, but also use the way of heating chamber, flame spraying, portable air spray gun, etc, the advantage is simple and fast, convenient and economical.

Tab.1 Relation of Main Parameter of Shrinkable Film and Heat Shrink Tunnel

The name of the film	Thickness [mm]	Temperature [°C]	Heating time [s]	Wind speed [m/s]	Remark
PE	0.02~0.04	160~200	6~10	15~20	Strong tightness
PVC	0.02~0.06	140~160	5~10	8~10	The shrinkage temperature is low and appropriate for food
PP	0.03~0.10	160~200	8~10	6~10	Long heat shrinkable time
	0.12~0.20	180~200	30~60	12~16	Stop heating when necessary

New Technologies of Shrink Packaging

Shrink packaging is more and more popular with businesses and consumers and rapidly expanding its share of the market occupation, some shrink packaging new technologies are constantly developing and using in a variety of product packaging.

The Cold Shrinkable Film Packaging Technology

Cold shrinkable film packaging technology is developed on the basis of shrink packaging and stretch packaging [7], it absorbs the advantages from shrink packaging and stretch packaging and overcome big investment in equipment, low production efficiency, high energy consumption of traditional shrink packaging and stretch packaging tray, has obvious advantages in packaging effect, packing cost, speed, etc [8].

The thickness of cold shrinkable film is only 0.1mm, the contraction ratio is 17~20%, can stretch or shrink without being heated. Packaging film has good features of transparency, so it is suitable for packaging trays and warehouse management; the cold shrinkable film is 10~15 RMB per kilogram, each tray would use 500~600g film, so that save the packaging cost efficiently; the equipment operation is fully automatic, packing speed up to 60 pallets per hour, firstly, the film was made into the top of closure pockets during packaging operations to wrap the package tray, could have the features of waterproof and moisture proof and suitable for transport packaging, the tray and piled up items are wrapped tightly by cold shrinkable film, can prevent shedding effectively. The whole operation process without heat source could save energy and be security.

The Vacuum Shrink Packaging Technology

The vacuum shrink packaging is a kind of high barrier film packaging technology which is used for beef, pork, lamb, veal, poultry, seafood, dairy products and smoked food and processed meat. Vacuum shrink packaging film have comprehensive performance of low temperature toughness, puncture resistance, abrasion resistance, oxygen barrier properties, heat-sealing shrinkability, contractility, transparency and glossiness, printability, etc.

The vacuum shrink packaging brings green innovation is mainly reflected in: it has high shrinkage rate, maximize the elimination of meat blood oozing caused by bag folds, improve product appearance and extend the meat shelf life, has excellent oxygen barrier properties, minimize the contact of food and oxygen in the range of technology; has good heat sealing performance to prevent food spoilage because of air infiltration in the process of long-term use; has good feature of toughness to prevent packaging to be pierced by the bone fragments on meat during use and transport process, further reduce the loss of raw meat [9].

Shrink Packaging with Cushioning

Shrink packaging with cushioning packages products by double bubble heat shrinkable film, the heat shrinkable film has features of not only heat shrinkable and moisture resistance, but also cushioning property and transparency, it is also similar to the packaging paper in some aspects, it has small mesh structure on one side and has smooth shape on the other side. It's structure is double. One layer is foamed layer, the main ingredient is polypropylene; another layer is non-foamed layer, in other words is heat shrinkable resin layer, composed of low density polyethylene or ionic polymer. The production process is stretching the formed film more than 3 times along portrait and landscape, to make the bubbles in the foamed layer burst to mesh, and then obtain shrink packaging film with cushioning. Using this shrink packaging film for paper box outside packaging, can get

good packaging features of cushioning, shrinkage, transparency, and decoration.

Colored Shrinkable Film Packaging

In recent years, colored shrinkable film expanding market applications rapidly with the advantages of high efficiency, low cost, attractive appearance and environmental protection and so on, businesses use shrinkable film to package products to get the best product display effect and improve product grade to help promoting sales [10]. Such as beer is packaged by shrinkable film which can make the packaging form diversification to promote sales; and other portable package with flexibility is suitable for different specifications.

As the packaging reduction trend, the thickness of colored shrinkable film is gradually thinning, for example, the PE heat colored shrinkable film which is applied to 24×550 ml ice dew water collection of packaging, its thickness is reduced from 80μm to 60μm. Colored shrinkable film packaging has been widely used in the field of beverages, beer, water and other collection of packaging, such as Coca-Cola, Pepsi-Cola, Master Kong, Nestle, Resources Breweries and other famous enterprises have chosen colored shrinkable film packaging as collection of packaging products [11].

Conclusion

In the current situation, people pay more and more attention to green packaging and reduction packaging of goods. The technology, packaging material and equipment of shrink packaging is constantly innovating and developing, shrink packaging will have a broader prospect in the field of food, beverage, cosmetic or pharmaceutical sales packaging and transport packaging with the advantage of intuitive products display, lower packaging costs, flexible and efficient packaging operations, beautiful packaging effect and so on.

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