SHRINK PACKAGING AND STRETCH WRAPPING

Among the specialised plastic packaging systems, shrink packaging or commonly known as shrink wrapping and stretch wrapping are very common and widely used. Though there are some apparent similarities in the two systems, in overall analysis, they are considered to be totally different in terms of material and operation.

In the case of shrink wrapping, shrink film is used as the basic material and heat forms an important part of the operation, whereas, in the case of stretch wrapping, stretch film is used as the basic material and no heat is applied during the operation. Shrink Wrapping is done in 3 or 4 stages, namely:

- wrapping (sleeve wrapping or over-wrapping)
- sealing (necessary only for over-wrapping)
- shrinking (with application of hot air), and
- cooling

Stretch wrapping is done only in two stages, namely, wrapping and sealing (most of the time even without a sealer).

However, in many packaging applications, both the systems are considered as alternative to each other. These systems are mainly used for unitisation, but sometime they are also being used as primary packaging system. Both the systems are used for bulk packaging as well as retail packaging.

Shrink Pack

In fact, both the systems are now being used for some major applications like sleeving for labelling on various containers or sealing, besides wrapping.

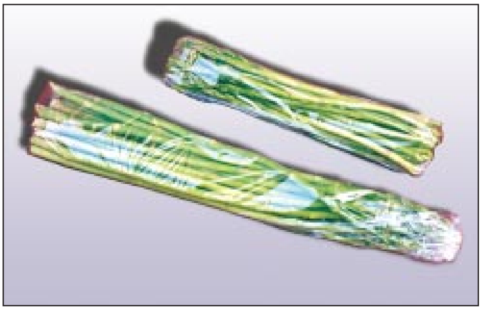
For both the packaging systems, material plays an important role, because without the correct material, proper shrink or stretch wrapping may not be possible. It is therefore, absolutely essential for anyone involved with the subject to either learn about the technical specification of the materials or work very closely with the material supplier, preferably both.

Plastics used for Shrink / Stretch Wrapping

Shrink and stretch wrapping can be quite complex in their structure. Most of the packaging films that are used for shrink and stretch wrapping are from the polyolefin range. These are materials produced from oil based chemicals by what is called a polymerization process, which basically means getting the right molecules and atoms to club together in a way that is required or desirable for a particular application. The most common plastic materials are polyethylene, polypropylene and poly vinyl chloride.

Polypropylene is comparatively less used in shrink and stretch wrapping, because it is slightly harder than the other commonly used materials. It has a higher melting temperature and is less stable when shrinking. However, many over-wrapping machines use polypropylene and some can be put through a shrink tunnel to give a slight tightening effect.

PVC is a dense material. As most polymers are sold by weight and there has been ecological pressure in Europe and America against its use, sometime use of PVC is restricted. However, it is still considered to be a common material in India, when clarity is an important selection criterion, particularly for consumer packaging.



Fresh Asparagus - Stretch Wrapped

Polyethylene is the most commonly used material for shrink and stretch wrapping because it is relatively cheap and can be produced in a range of different densities and modified with additives to perform many functions.

The vast majority of shrink film is LDPE and some of the more sophisticated films have blends of LLDPE as well. Sometimes a little quantity of HDPE material is also added.

For selection of plastic material, besides type of plastics, the yield of the film is also important to be considered from the economy point of view. The yield means the area obtained or number of square meters of film converted from a kilogram of material of a given thickness or gauge.

The gauge may be expressed in micron (0.001 mm), mil (an American terms for thousandths of an inch i.e. 0.001 inch) or simply gauge, which is the old British system where 100 gauge equals one thousandth of an inch. The co-relation of both the systems of measurement of thickness is 25 micron (or 0.025 mm) equals 100 gauge (or 0.001 inch).

For shrink film, the next important factors considered are the shrinkage and the slip of the film. Shrinkage means the percentage shrink in the machine direction, i.e. along the reel of the film, and also in the transverse direction, i.e. across the reel of the film. The slip can be of different types – high, medium or low depending upon how much slippery property in the film is required from the operational point of view. Usually, low slip is desirable.

For shrink wrapping small packs at high speed, particularly for consumer products or display purposes, PVC or specially modified Polyolefin may be used. The "high shrink films" are crystal clear but generally expensive.

For stretch wrapping, majority of films are modified linear low density polyethylene (LLDPE), often three-layer extrusion with "tackifier" added to make them sticky on either one or both sides. Some PVC films are also used.

Plastic Films Used

In short, following plastics films are commonly used for shrink and stretch wrapping:

Polyethylene

- Used almost exclusively or as a combination of LDPE + co-polymers EVA (ethylene vinyl acetate) or EEA (ethylene ethyl acrylate).

  Copolymer Modification: LDPE is sometimes modified by addition of EVA and EEA (up to 8%). EVA is approved by US-FDA for direct contact with food. EEA is approved up to 7% for direct contact with food. However, Vinyl Acetate (VA) or Ethyl Acrylate (EA) content is normally restricted to 3-4%.

- Irradiated polyethylene film containing EVA, shrinks strongly in boiling water and is generally used for wrapping chickens.

- In the form of mono-layer or 3/5 multi-layer, 3 layer wide shrink films of HM-HDPE (rolls/bags), LLDPE (rolls), etc. are available for palletized goods; Diameter > 5m and Lay Flat Width (LFW) > 10m; Film shrinks in area and increases in thickness. This is usually used for protection of industrial products from dust, contamination, rain, etc. Heat required for shrinking PE film: about 200°C for 100g film and 300°C for 500g film.

PVC and PP

- Used for foodstuffs (e.g. meat and vegetables). Both are also used for non-food applications, where increased transparency and gloss justify the increased price in comparison with LDPE.

Manufacturing of Shrink Film

Almost all plastic films shrink to some extent. In most packaging applications, dimensional stability is desirable and shrinkage is considered to be detrimental. However, in some packaging application, controlled shrinkage is deliberately used for certain objectives to be fulfilled. For example, shrink film is used to pack products with a tight pilfer-proof wrap over carton and boxes, so as to utilize number of packs or items on pallet, etc. A variety of shrinkable films have been developed to meet the requirements of many different end-use applications.

Heat-shrinkable film is made by stretching or orienting a conventional film at a temperature close to its softening point (i.e. Tg) and then quenching or freezing the film in the oriented state. The film that undergoes a special stretching and cooling process, causes an orientation in the film and introduces frozen-in shrinkage stresses, which can be given hot air treatment or infra-red radiation.

Figure 1 shows a schematic representation of a single long-chain polymer molecule in the relaxed and considerably curled state that is characterised in an un-oriented film.

Figure 1: Polymer Molecule

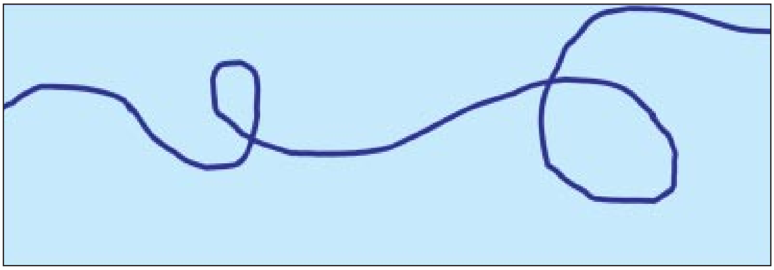
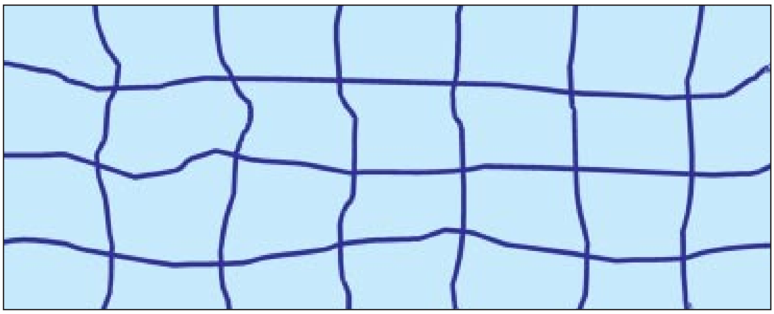


Figure 2: Polymer Molecules in Uni-axially Oriented Film



If the same film is stretched i.e. uni-axially oriented in one direction while it is heated, randomly twisted and intertwined molecules line up as shown in figure 2.

However, if the film is stretched not only in the machine direction, but also in the transverse direction, there will be some orientation of molecules at intermediate angles, but the majority will line up as depicted.

Generally, orientation is imparted by blown-film extrusion process or on tenter frames. When the film is quenched after orientation, the molecules are "frozen" in the oriented position, but they still 'remember' their original shape or regain their memory to return to that shape if the film is reheated or exposed to the orienting temperature. When this does happen, obviously the film shrinks around the product.

Stretch Film

Stretch film is defined as stretchable, elastic, continuous thin plastic film, which is stretched and wrapped around one or more items to protect them from the environment or unitize for handling, storage or shipping. Stretch film is also used to some extent for bundling smaller units and lumber. They are also used for super market tray wraps.

In general, stretch film means a collective name for all types of plastic films, which are wrapped round a package under some form of mechanical stretching. It is a film, which can be cold-stretched in longitudinal and transverse directions without application of heat and which when stretched round a pack maintains a tension for a long period. A strong degree of transverse orientation gives stretch film a good extensibility in longitudinal direction and an increased total strength.

Stretch films entered the market in the early 1970s as a replacement for shrink wrap, used to unitize non-returnable glass bottles, pet jars in a tray, etc. The most common type of stretch film is the 'cling' type which is easy to use since the wrapping is completed by cutting the film between the load and the film roll and merely wiping the loose tail of film against the load. The film to film adhesion i.e. cling, holds the tail in place. Other less common way of attaching the film tail are adhesives, heat sealing, mechanical fasteners and tying.

Shrink Pack of Glass Jars

Advantages and Disadvantages of Stretch Wrap

Advantages

Compared with shrink film and bags, stretch wrapping affords large energy saving and does not require the availability of fuel. Compared with shrink bags in particular, it simplifies inventory. Compared with strapping, stretch wrapping eliminates the need for corner boards and prevents cutting or crushing of the load, since the load-holding force is adjustable and distributed over the film width. Stretch wrapping offers better protection from hostile environments and clear, tinted, or opaque films are available for product identification or pilfer protection. Compared with both shrink films and strapping, stretch films are better suited to withstand shock and vibration owing to their elasticity and memory.

Disadvantages

Stretch wraps generally have less moisture resistance than shrink bags, but a top sheet can be dropped over the top of the load for added protection before stretch wrapping. The cling property that makes stretch wrapping possible, can also promote load-to-load sticking and abrasion. Stretch films cannot be used to compress a pallet load in the vertical direction since it has its primary holding force in the direction of wrap, i.e. horizontal.

Important Material Properties of Shrink / Stretch Film

Low Melt Flow Index (MFI) for PE film (e.g. 0.1 to 0.6) indicates high melt viscosity, which in turn depends upon the fact that the material is composed mainly of long-chain molecules i.e. has a higher molecular weight. Therefore, low MFI of LDPE gives a logical guarantee for high film strength, often a prime requirement for wrapping goods or pallet loads.

As MFI has direct relevance to orientation, stretch properties, strength, etc., shrink / stretch films are divided into 3 MFI classes:

- MFI < 0.6 : For heavy goods and pallet loads
- 0.6 < MFI < 1.0 : For lighter packages where high transparency is valued more than the maximum strength
- MFI > 1.0 : For applications, where strength is of minor importance; used for textiles and such products where a weak shrinkage force is desirable.

Table 1 gives the comparison of performance of various shrink films. The typical properties of the shrink films are given in Table 2.

TABLE 1

Performance Comparison of Shrink Films

Film Type	Advantage	Possible Problems
Polyethylene (low density)	1) Strong heat seals 2) Low temperature shrink 3) Medium shrink force for broad application 4) Lowest cost	1) Narrow shrink temperature range. 2) Low stiffness 3) Poor optical property 4) Sealing wire contamination
Polypropylene	1) Good optical appearance 2) High stiffness 3) High shrink force 4) No heat sealing fumes 5) Good durability	1) High shrink temperature 2) High shrink force, not suitable for delicate or fragile product. 3) Brittle seals 4) High sealing temperature
Co-polymers	1) Strong heat seals 2) Good optical appearance 3) High shrink force 4) No heat sealing vapours	1) High shrink force, not suitable for fragile products 2) Higher shrink temperature 3) Higher heat seal temperature 4) Lower film slip-may give machine problems
Poly Vinyl Chloride	1) Lowest shrink temperature 2) Wide shrink temperature range 3) Excellent optical appearance 4) Controlled stiffness by plasticizer content control 5) Lowest shrink force for wrapping fragile products	1) Weakest heat seals 2) Least durable after plasticizer loss 3) Toxic and corrosive gas emission from heat sealing, therefore good ventilation required 4) Durability problem at low temperature 5) Low shrink force inhibits use as a multiple –unit bundling film 6) Low film slip causes machine wrapping difficulties
Multilayer Co-extrusion	1) Excellent optical appearance 2) Good machineability 3) Low shrink temperature	1) In co-extruded films, one ply compensates for the deficiencies of the other. As a result, they are superior films with no significant performance shortcomings. 2) The wide variability in layer composition and number of layer makes performance analysis difficult.

TABLE 2
Typical Shrink Film Properties

Film Type	Tensile Strength psi (mpa)	Elongation (%)	Tear Strength gf / mil (m N / m)	Maximum shrink (%)	Shrink Tension psi (MPa)	Film shrink temperature range °F(°C)
Polyethylene (low density)	9000 (62)	120	8 (3.1)	80	250 - 400 (1.7-2.8)	150 - 250 (65 -120)
Polyethylene (low density irradiated)	8000-13000 (55-90)	115	5-10 (1.9 - 3.9)	80	400 (2.8)	170 - 250 (75 - 120)
Polyethylene (copolymer)	19000 (131)	130	7 (2.7)	50	450 (3.1)	180 - 260 (85 -125)
Polypropylene	26000 (179)	50-100	5 (1.9)	80	600 (4.1)	250-330 (120-165)
Polyester	30000 (270)	130	10-60 (3.9-23.2)	55	700-1500 (4.8-10.3)	170-300 (75-150)
Poly Vinyl Chloride	9000-14000 (62-97)	140	Variable	60	150-300 (1-2.1)	150-300 (65-150)

Advantages of Polyolefin Film

Strength and Safety of Packs

- Durable and tear-resistant with tough seals
- Neither easily embrittles during packing and delivery nor discolours with ageing
- Strong and flexible packing that ensures tight pack even at refrigerator and freezer temperatures
- Excellent wrap around multipacks and uneven or irregularly shaped product
- Perfects shapes due to high shrinkage
- Ensures consistent and uniform seals

Shrink Wrapped Cartons with Tray

High Shelf Appeal

- High gloss and clarity of added pack value and visual appeal
- Provides tamper evidence and tamper resistance
- Excellent printability for added appeal

Increased Profit and Productivity

- Reduces packaging cost by as much as 50% or more
- Cheaper than other substitutes like carton and packaging (wrapping) paper
- Absence of acids, which corrode machine and sealing wire, thus saving on maintenance costs
- Ease of processing on manual, semi-automatic or automatic shrink-wrapping machine.

Environment Friendly and Safety to User

- Polyolefin films are free from toxic and odour during processing
- Approved for direct food contact by the USDA and FDA in United State of America, Canada and Europe

Comparison of Shrink Wrapping and Stretch Wrapping

Table 3 compares differences of Shrink Wrapping and Stretch Wrapping systems.

TABLE 3

Comparison of Shrink Wrapping and Stretch Wrapping

Shrink Wrapping	Stretch Wrapping
Equipment (heat shrink tunnel) are more expensive	Equipment (relatively simpler and smaller) are generally less expensive.
Sealing required, particularly for overwrapping.	Normally, no sealing is required.
More energy required: Orientation plus heat energy to shrink.	Less total energy - only stretching, but no heat.
May not be suitable for heat sensitive items.	Can even be used under cold conditions (refrigeration).
May distort under transit conditions.	Generally, retains load more tightly.
Wrapped items (two or more) may stick together.	Virtually, no film-to-film sticking.
Stick film takes up uneven contours more readily.	May create areas of higher tension due to irregular products.
Needs different film widths for a range of sizes.	Needs fewer reel widths for a range of sizes.
Can be printed using distortion printing where shrinkage is uniform and well controlled.	Easier to print as stretch is mainly in one direction.
Can provide better weather protection, particularly with a total over-wrap. Adds to general climatic protection.	Less protective, may not be totally waterproof. Lower climatic protection.
Uses generally more film (heavier gauges)	Uses less film

Differences in shrink and stretch wrap for tray packaging are compared in Table 4. Similarly shrink bags and shrink rolls for tray packaging are compared in Table 5.

TABLE 4

Comparison of Stretch Wrap and Shrink Wrap for Tray Packaging

Parameter	Stretch Wrap	Shrink Wrap
Process	Not easy to pack tray by stretch wrapping	It is easy to pack tray by shrink wrapping
Cost	Slight higher than shrink wrap	Less than stretch and CFB box packaging
Machines	No machine for the tray packing	Semi Automatic or Automatic L-sealer with shrink tunnel
Time Required	More time required	Less time required than other process
Manpower	More manpower required	Less manpower required
Production	More production as compared with the other.	Less production as compared with the other.

TABLE 5

Comparison of Shrink Bag (Pouch) and Shrink Roll for Tray Packaging

Parameter	Shrink Bag Pouch	Shrink Roll
Speed of process	Slow speed of operation	Speed of operation is very fast
Steps involved	Steps involved in operation are more	Steps involved in operation are less
Cost of packing	Cost of packing is more	Cost of packing is less
Material required	More material will be used	Less material will be used
Finish of packing	Finish is not uniform	Finish will be uniform and much better
Manpower required	More manpower required	Less manpower required

Cost comparison of various systems of Stretch and Shrink Wrapping with CFB box packaging is given in Table 6.

TABLE 6
Example of Cost Comparison of Three Alternatives for Packaging of Jars

CFB Box Packaging

Item (Lt. Jar)	No. of Jars	Rate of Paper (Rs./kg)	Cost of CFB (Rs.)	Rate of BOPP Tape (Rs./65 mtr.)	Costing of Tape/ CFB (Rs.)	Total Cost (Rs.)	Cost/Jar (Rs.)
1.75	16	13.5	19.27	32	0.52	19.79	1.23
1.5	16	13.5	15.27	32	0.59	15.86	0.99
2.1	16	13.5	23.24	32	0.67	23.91	1.49

Shrink Wrap on Tray Packaging

Item (Lt. Jar)	No. of Jars per Tray	Cost of Tray (Rs.)		Cost of Shrink Film (Rs.)	Total Cost (Rs.)		Cost/Jar (Rs.)	
		With top	Without top		With top	Without top	With top	Without top
1.75	9	2.86	1.68	2.65	5.51	4.33	0.61	0.48
1.5	9	2.82	1.64	2.42	5.24	4.06	0.58	0.45
2.1	9	3.41	1.98	3.12	6.53	5.10	0.72	0.57

Stretch Wrap on Tray Packaging

Item (Lt. Jar)	No. of Jars per Tray	Wt. of Stretch Wrap (gms)	Rate (Rs./kg.)	Cost of Stretch Film (Rs.)	Cost of of tray (Rs.)		Total Cost (Rs.)		Cost/ Jar (Rs.)	
					With top	Without top	With top	Without top	With top	Without top
1.75	9	38.8	100	3.88	2.86	1.19	6.74	5.07	0.75	0.56
1.5	9	40.5	100	4.05	2.82	1.18	6.87	5.23	0.76	0.58
2.1	9	54.6	100	5.46	3.41	1.98	8.87	7.44	0.98	0.83

Comparison of Cost: CFB Box v/s. Stretch/Shrink Wrapping

Item (Lt. Jar)	Cost of CFB Packaging Cost/Jar (Rs.)	Cost of Stretch Wrapping (Rs.)		Cost of Shrink Wrapping (Rs.)	
		Cost/Jar with top	Cost/Jar without top	Cost/Jar with top	Cost/Jar without top
1.75	1.23	0.75	0.56	0.61	0.48
1.5	0.99	0.76	0.58	0.58	0.45
2.1	1.49	0.98	0.83	0.72	0.57

Shrink and Stretch Sleeving

During the past decade, the growth of sleeving has been quite significant. Earlier, sleeving was mostly used for cosmetics, toiletries and personal care product applications. Currently, however it is used for many food packaging applications, including drinking water and other drinks.

Plastic sleeves are basically of two types:

- Stretch sleeves
- Shrink sleeves

Strawberry Punnet - Stretch Wrapped

Stretch sleeve labels are usually manufactured from LDPE, PP and PVC in a tubular form and then flattened and rolled. Depending upon the type of application, machine used, the sleeve manufacturer may need to incorporate perforations between the adjacent sleeves, which helps to separate from one another in order to form the individual sleeves, immediately prior to application to the containers. This separating action takes place as a result of differential speeds within the sleeve transfer station.

The specially designed stretching mandrels open up the sleeves before they are transferred down onto the container. Then the stretch sleeves conform to the contours of the containers.

From the marketing perspective, it is advisable to have cut-off knives as an alternate to perforation, which may result in improper upper and lower edges of the sleeve.

A typical film thickness for stretch sleeves is 55-70μ and application speeds up to 800 containers/ min. are possible, depending upon the type of machine.

As, unlike shrink sleeves, no heat is used, stretch sleeves can be used for applications for a diverse range of plastic containers. This technique is particularly suitable for chilled products like fruit juices where the container is likely to change shape during filling or subsequent storage. Stretch sleeves are generally used on round containers, where the graphics do not require any form of orientation with regard to the geometry of the containers. However, it is possible to orientate the print as is necessary for square or other non-round plastic containers.

Shrink Wrapped Transport Pack for Carbonated Soft Drinks

The method of manufacture, reel feed and application for shrink sleeves are almost similar in many respects to those for stretch sleeves. The main difference is, of course, the fact that heat is necessary in order to create the required degree of shrink to ensure that the sleeve conforms totally to the profile of the containers being labelled, without any evidence or wrinkling or distortion of the graphics. If the plastic film needs to be shrunk by varying degrees in different areas of the container profile, then the original design of the graphics need to take into account the subsequent shrinking operation.

One of the biggest advantage of shrink sleeve labels is their ability to provide 360° graphics around very unusual pack shapes. In addition, shrink-sleeves can serve a dual role, firstly being the products label and secondly providing a seal or tamper evident device. In such cases, the sleeves are designed to encompass all or most of the body area of the containers and in addition, to particularly encapsulate closure area also.

The most common material for shrink sleeves is PVC, but OPP, PET and oriented polystyrene sleeves can also be used.

In conclusion, it can be said that plastics with the application of shrink and stretch technology have not only made the wrapping systems more efficient and cost effective, but also made significant inroads in the arena of consumer packaging, particularly in terms of shrink and stretch sleeving.