Film packaging of paper rolls

Daniel A. Matics and Björn Hellgren

Film-based paper roll packaging is gaining wider industry and customer acceptance as paper manufacturers seek methods to replace conventional kraft roll wrapping systems.

In the early 1980s, several paper mills began seeking new technologies for replacing conventional kraft roll wrapping systems. The search was fueled by objectives that included lower equipment costs, reduced space requirements, and considerably improved roll protection. As a result, film wrapping became an option, especially because it could significantly improve moisture and climatological protection (**Fig. 1**).

Most of the film wrapping systems that were developed fell into two categories: radial wrapping only combined with paper end headers ("combination" wrapping) and radial/axial wrapping ("cocoon" wrapping). Film wrapping systems initially were successful, but the mid-1980s brought insurance industry concerns regarding fire protection. Extensive fire testing was completed, resulting in the finding that film wrapping provided fire protection equivalent to conventional kraft wrapping.

Increasingly, paper mills are giving attention to the potential of film-based roll packaging. A number of film-wrapping systems are now in operation and the technology is gaining acceptance among the industry's customers.

Today's major trend and primary emphasis in film wrapping is toward using film packaging as a major new marketing tool, particularly in export markets.

History

In today's quality-conscious market, the paper industry faces stricter demands for improved product protection during handling and transport. Traditionally, the industry has protected its product by wrapping rolls in paper. Most rolls produced today are packaged in several layers of kraft paper or kraft/polyethylene laminate using conventional wrapping machines that incorporate varying levels of automation. Some board grades are still merely banded and shipped unwrapped, although customer requirements—particularly in the export markets—probably will soon eliminate this practice.

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1. Distinctive roll packages at MoDo Papers' Silverdalen ("Silver Valley") mill

Over the past decade or so, customer pressures for superior packaging protection have instigated the search for alternative methods of wrapping paper rolls. Although paper has always been considered an excellent packaging medium, it is sometimes regarded as not necessarily the most effective medium for protecting paper rolls, especially from moisture (from sources not related to weather) and climatological (weather-related) damage. Further, certain paper manufacturers have sought more cost-effective methods in the interest of reducing the capital costs, manpower requirements, and space utilization of conventional wrapping systems (**Fig. 2 and 3**).

To meet the demand for improved packaging protection and lower equipment costs, a number of mills have considered plastic stretch film to be an obvious alternative. However, only for six or seven years has high-speed, high-capacity equipment suitable for stretch film wrapping of paper rolls existed. Film wrapping has also met with philosophical resistance from some paper industry purists, even though polyethylene-laminated kraft paper has been used as a wrapping material for some time. Stretch film roll wrapping has also faced obstacles from certain North American insurance carriers in regard to fire protection. Since many of the fire insurance restrictions initially placed upon film-wrapped rolls were not based upon actual testing, they often appeared as speculative if not altogether contrived. However, after several fire tests were completed in conjunction with a major carrier, results indicated that film-wrapped rolls posed no greater risk than conventionally wrapped rolls.

Experimentation in methods of using plastic film to wrap full mill paper roll production began in earnest in the early 1980s. Since several types of plastic film and equipment were already being used for pallet wrapping throughout the industry, the natural transition was to attempt to apply the same wrapping process to paper rolls.

Swedish developments

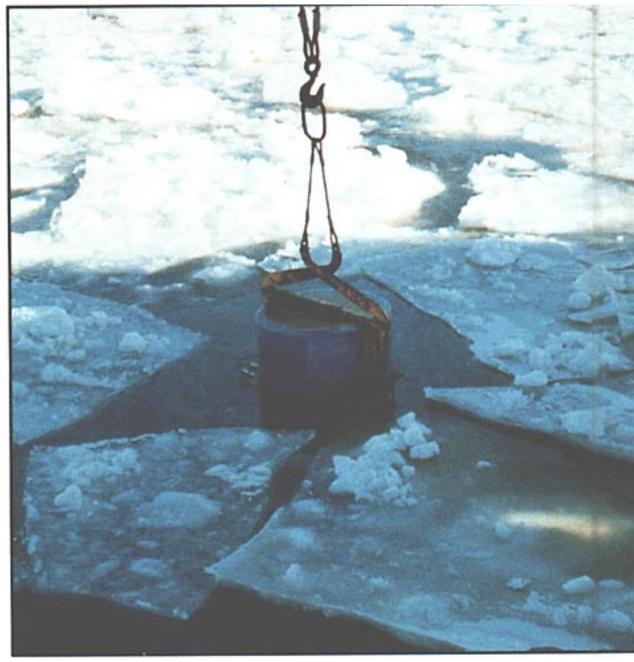
Some significant early developments took place in Swedish mills. The Iggesunds Kartongfabrik AB board mill in Iggesunds and the Holmens Bruk fine papers mill in Wargön began extensive testing of film wrapping early in the decade.

The Iggesunds board mill initially tested equipment that wrapped rolls in an axial direction similar to typical "cocoon" type wrappers. However, this method was found to be unsatisfactory and, in conjunction with the supplier company Stretch Emballering AB, equipment was developed that wrapped the rolls in both axial and radial directions. This wrapping system counter-wraps two rolls in two different directions at right angles to each other. The equipment uses 70 μm ($\cong$ 3 mil) thick linear low-density polyethylene film applied in a number of layers both radially and axially. At least three of these machines are in operation in the world today, primarily in Scandinavia.

A second type of film wrapping was developed for the Holmens Bruk fine papers mill, which initially tested cocoon-type wrapping but found that the end and edge protection was not sufficient to meet its requirements. Unlike the Iggesunds Bruk mill, which supplies board that is often trimmed on each edge by the customer, the Holmens Bruk mill supplies lightweight coated (LWC) paper used in high-speed printing presses. Consequently, the mill wanted to reduce the edge damage as much as possible. The Holmens Bruk mill was also concerned that cocoon-wrapped rolls would result in condensation formation on the roll ends because the roll could not "breathe"; water vapor could not escape from a roll fully enclosed in plastic film. In concert with the supplier Uddevalla Mekaniska Verkstad, a system was devised that used a combination of two materials: linear low-density polyethylene film (as was also used at Iggesunds Bruk) and specially treated corrugated board roll end headers. This is known as "combination" type wrapping.

The double-wall corrugated board headers used at Holmens Bruk are cut, two at a time, by an automatic roll head cutting machine developed by Solbergs, a Swedish company. The pair of headers are cut to match the exact diameter of each roll in order to provide end protection all the way out to the edges of the roll. The low-density polyethylene used at the Holmens Bruk mill has a thickness of 80 μm (3 mils).

2. The direct approach to moisture protection testing: lowering the combination wrapped roll into the ice-clogged Baltic Sea



The wrapping system designed at the Holmens Bruk mill came to be known as the "Roll-a-Pack" system. Seven are in operation in the industry today, including one system in Alabama.

North American systems

While the Swedish mills were busy developing film wrapping systems, a Canadian manufacturer was also pursuing the possibility of film wrapping its paper rolls with the primary aim of reducing roll wrapping costs. The E. B. Eddy Co. of Ottawa, Ont., contracted with Lamb-Grays Harbor Co. to build a prototype wrapping machine that could apply film to the paper roll in a radial direction. This unit ultimately evolved into a semi-automatic film applicator that requires manual placement of the film's edge onto the roll. Bulk-cut headers are held against the roll with core plugs. The unit went into production in 1984, and several exist today.

A significant difference between the Canadian and Swedish wrapping systems is that E. B. Eddy decided to use polyvinylchloride (PVC) to wrap the rolls instead of polyethylene. The PVC used at the Canadian mill is approximately 30 μm (1.2 mils) thick. In most installations, however, PVC has not been considered practicable because of the potential environmental hazards of burning it. Polyvinylchloride emits toxic fumes when burned; polyethylene is environmentally safe to burn.

Adoption of film wrapping systems in the United States got under way in the mid-1980s. A radial wrapping system of the "Roll-a-Pack" design was installed at MacMillan Bloedel's Pine Hill, Ala., mill in 1986. The system uses low-density polyethylene film for wrapping corrugating medium and linerboard around the roll body, but does not

3. Moisture protection test results showed very little damage to the combination wrapped roll.

use headers for roll end protection.

Of greater significance was Appleton Papers Inc.'s corporate-wide effort in the middle part of the decade to adopt plastic film wrapping systems. Appleton, a leading manufacturer of carbonless papers, sought a method for protecting its product against mechanical stress while also significantly reducing its roll packaging costs. Appleton Papers began testing materials and methods for wrapping the carbonless rolls using an inner cushioning layer of polyethylene foam and an outer layer of polyethylene film. Ultimately, a system was developed wherein three wraps of interleaved foam and film were applied to the roll body, followed by two final wraps of film only. Chipboard headers were tested in combination with the foam/film wrapping, but became too wavy when the film was applied. Bulk-cut, double-walled corrugated board delivered in 2-in. increments was later used and produced superior results. The equipment for applying the foam and film was developed through the combined efforts of Appleton Papers Inc. and Automatic Handling, Inc. Approximately 25 of these specialized machines are in operation today at Appleton facilities.

The fire insurance issue

While by 1986 there was concentrated activity toward industry adoption of film wrapping in North America, there was also a strong movement by a major insurance carrier to require greater sprinkler capacities for warehouses containing film-wrapped rolls. This requirement was apparently based on the carrier's assumption that film-wrapped rolls constituted a greater risk of fire hazard than unwrapped or conventionally wrapped rolls. The assumption, however, was not based on any actual physical testing. The carrier's requirement for greater sprinkler capacity effectively halted film wrapping's continued growth in North America. Fire testing of film-wrapped rolls had to be undertaken by interested parties, including several paper companies and equipment manufacturers in conjunction with the insurance carrier, in order to determine whether film-wrapped rolls required higher sprinkler capacities than unwrapped or conventionally-wrapped rolls.

Appleton Papers Inc. took the lead by conducting its own fire tests at the insurance carrier's research facility. Initially, results for the Appleton Papers-sponsored fire test showed that the foam/film wrapping used by the company offered fire protection equivalent to kraft wrap. However, the insurance carrier raised the issue that film wrapping alone (film wrapping without the foam below it) could require higher sprinkler capacity than the foam/film wrap.

To overcome this assertion, another large-scale fire test sponsored by E. B. Eddy, MacMillan Bloedel, Uddevalla Mekaniska Verkstad (manufacturer of the "Roll-a-Pack" system) and several other American and European companies, was undertaken in the spring of 1987. The fire test was conducted on film-wrapped heavyweight kraft paper. The 45-in. diameter rolls were encased in polyethylene stretch film that was wrapped radially around the rolls in several layers, overlapping the ends by about 3 in. (This is the normal "combination" wrapping method that incorporates corrugated board end headers.) The main test array consisted of 20 stacks of rolls, each of which was 20 ft high. The test array conformed with the American Paper Institute's standard configuration.

Protection was provided by standard, 17/32-in. orifice automatic sprinklers approved by the insurance carrier, temperature rated at 280°F and installed at a 10-ft × 10-ft spacing with deflectors located approximately 7 in. beneath the ceiling. Water pressure at the sprinklers was automatically controlled to provide a constant 0.30-gal/ft^2/min density.

According to the insurance carrier, the test's purpose was to determine if the level of sprinkler capacity required for unwrapped on-end storage of rolled kraft paper was adequate for rolled paper wrapped in plastic. Therefore, the test compared the sprinkler demand of film-wrapped paper with that of unwrapped kraft paper rolls. Because most paper rolls are packaged in kraft paper, some similarity with the sprinkler capacity demand of conventionally-wrapped rolls might be assumed.

The conclusions were that plastic-wrapped rolled paper would not cause more sprinklers to operate than would unwrapped kraft paper, and that the overall extent of fire damage in plastic-wrapped rolled paper would not exceed the overall extent of fire damage in unwrapped rolled paper. It was also shown that plastic-wrapped rolled paper can sustain high temperatures at the ceiling for longer periods of time than unwrapped rolled paper, because a lower moisture content may be maintained in the plastic wrapped paper. However, this was also an advantage in one respect because the higher heat of the film-wrapped rolls caused the sprinklers to function much more quickly than with the kraft-wrapped rolls. The test also determined that the rate of flame spread in plastic-wrapped rolls would not exceed the rate of flame spread in unwrapped rolled paper.

Finally, the test indicated that when exposed to flames, the plastic wrap would burn away quickly but would not contribute significant amounts of fuel to the fire. Overall, it was shown that the fire damage in the unwrapped paper was somewhat greater than with the plastic-wrapped paper, but the difference was not considered significant. This is contrary to some European fire tests, which have shown that considerably less damage occurs to film-wrapped rolls because they can be doused with water without sustaining damage. Future tests will be conducted to determine the fire hazard created by plastic film in comparison with conventionally-wrapped lightweight paper rolls.

Environmental considerations

Another significant issue raised by using plastic film to wrap paper rolls has been disposal of the film after the customer removes it from the roll. Generally, incineration or recycling are the best means of disposal.

Thomas B. Brighton, market development manager-industrial products, Mobil Chemical Co., points out that incineration is the most common disposal method. Pure polyethylene film, when properly incinerated, produces the same energy value as natural gas; burning emits carbon dioxide and water. Tests have indicated that polyethylene film yields a heating value of 19,687 Btu/lb. This means that proper incineration of plastic films can actually generate more Btu/ton than coal. Some ash can also be created, depending upon the amount of adhesive additive put into the film.

Programs to recycle plastic film used in stretch wrapping are still in the early stages, but efforts are being made to organize more extensive collection programs (**Fig. 4**). According to Brighton, "At this point in time there is still no significant market for stretch film scrap. However, a number of ideas are being considered for possible re-uses of plastic films. One of the obstacles to recycling plastic film is that the adhesive additive—normally, the cling enhancer polyisobutylene (PIB)—make recycling difficult."

"Since stretch wrapping applications require an aggressive cling characteristic, there is presently no way to avoid the use of PIB. More research needs to be done in this area," he said.

However there is some demand for used polyethylene film, and film manufacturers have set up programs for repurchasing used stretch films. For instance, Presto Products, the film supplier to Appleton Papers Inc., repurchases and recycles both the polyethylene film and polyethylene foam used by Appleton Papers into a block material used in construction, such as underlaying of building sites.

Film manufacturers emphasize that photo- or biodegradation are not the answers to eliminating used stretch films. Incineration is probably the best course for now, but recycling will become more important.

Film characteristics and considerations

At present, there are two methods for manufacturing stretch films. The "cast" process involves melting the film polymer, forcing it through a slot die, and casting it onto chilled rolls. In the "blown" film process, a large bubble is created and then collapsed upon itself, resulting in two separate layers. Brighton points out that both methods have advantages and disadvantages. According to Brighton, the cast method produces a very smooth film surface structure. The gauge variation of blown film can be very wide—perhaps as much as ±20%. The roll of cast film does not look as good as the blown film, but the gauge variation is much less. Cast film offers thickness uniformity, with variations as low as 3-5%. Therefore, the advantage of cast film is that it requires much less cling enhancer than blown-type film.

4. Pallets of used film wrap for recycling. Unlike conventional wrap, polyethylene is quickly removed from the roll and can be compacted and handled easily.

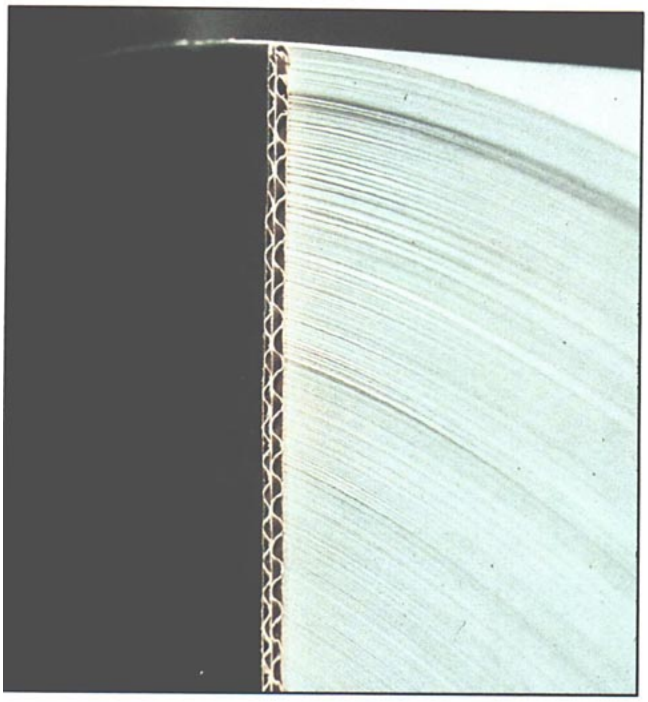
"The requirement for less cling enhancer (PIB)," states Brighton, "is significant because PIB generally tends to migrate. It can also be temperature-, time-, and winding-sensitive. Thus, PIB can cause telescoping of the film roll and result in considerable waste."

According to Brighton, Mobil Chemical is overcoming the problem of telescoping with specially designed packaging, wherein the film roll is suspended by the core and actually hangs in the packaging. A shaft holds the film rolls in suspension during transport. Another method of reducing the possibility of telescoping is to increase the core size of the film roll.

"For some of our customers, we have increased the core size to six inches from the normal three-inch diameter core," he said.

A particular limitation for papermakers in the United States and Canada is the fact that few film extruders are able to produce a film roll of sufficient diameter to meet the design requirements for modern stretch-wrapping equipment. On at least two of the combination-type wrapping systems available today, for instance, film roll diameters of 32 in. are optimal, although not required. The larger diameter rolls allow for longer operating times, without the necessity of downtime for changing the film roll.

5. Maximized edge protection is achieved by cutting the board header to the precise diameter of the roll



European film makers have made significant advances toward developing types of stretch films specifically for the paper-roll-wrapping market. The Swedish firm Trioplast AB was the world's first film manufacturer to introduce a specially designed polyethylene film for use with full mill-scale paper roll wrapping equipment. The fundamental difference between stretch film developed for use with paper rolls and normal stretch film is the film's thickness.

At the outset, stretch film used with machines such as those at Iggesunds Bruk and Holmens Bruk was a very thick single layer film—100 μm (4 mils). The thickness was gradually reduced to 80 μm (3 mils), and the film was produced by the conventional blown process. Finally, film was produced as a two-layered, 2×40-μm film wherein the blown tube was pressed together instead of split, and cut and separated into two sheets. The polyethylene resin was blended with the cling additive PIB, which migrates through the film and out to both sides.

Optimally, a one-side-only cling effect should be used for paper roll wrapping. The adhesive effect should migrate inwardly and the wrapped roll's outer surface should remain smooth; the resulting friction between the film-wrapped rolls would eliminate the possibility of the rolls sticking together during transport. Several suppliers have introduced cast multilayer film for paper roll wrapping, which makes it possible to add PIB only to the inside layer of the film and thus eliminate potential for telescoping problems with the film rolls. This promising development will probably become the preferred type of film for paper-roll wrapping.

Glenn Garbach, national marketing manager–stretch films, Mobil Chemical Co., summarizes the main considerations in obtaining the proper stretch film material: "What the customer must look for is the proper balance of properties in the stretch film wrapping material. This includes many variables, such as stretchability, puncture resistance, load holding capability, cling, and opacity and/or transparency. Obtaining the right properties for the application depends on several factors: whether the film is cast or blown, what type and quality of the raw materials are used, and whether tackifier agents or natural tackifiers are used."

Garbach emphasizes that "an accurate assessment of the proper balance of properties for the specific application must involve not only a thorough evaluation of the wrapping process, but of the entire roll-handling system as well. Wrapping is only a small part of the process—the whole system and handling cycle must be reviewed to assess the demand on the wrapping material."

Present trends: the emphasis on the header

Based on the number of film wrapping systems operating in the paper industry worldwide, it is clear that the most widely accepted is combination wrapping—the radial wrapping of the roll body in conjunction with the use of corrugated or other types of board headers. It is precisely because of the header that this method of roll packaging has been so successful. Most paper rolls are stacked and transported up-ended, making the potential for damage to the roll end much greater than that to the surface of the roll body. With fine printing paper grades, end and edge protection is especially important. Customers using high-speed printing equipment will very likely immediately reject a roll with obvious end damage in order to minimize the risk of an on-press break.

To date, the best results have been achieved using double-walled corrugated board for the end headers. In Europe particularly, suppliers have developed header materials specifically designed for use with combination wrapping systems.

Usually, the header material is supplied with an extremely high level of flat-crush resistance in order to protect the roll ends during storage and transportation. Since the material's outer layer must resist punctures and tears, high bursting strength is essential. One supplier's tests of header material indicate that a header of approximately 40 in. diameter should provide a stacking strength of about 21 metric tons, assuming an even pressure distribution. Tests performed in the early 1980s by the Swedish Packaging Institute (Packforsk) showed that when applied to a normal roll, the header surface could stand a load of more than 15 tons without being crushed. The tests also pointed out that, under optimum conditions, the end header should be precision cut to fit the roll. A rollheader diameter that was too small or too large would considerably weaken the roll edge protection (**Fig. 5**).

Moisture protection provided by the roll end headers is of increasing concern. In some cases, the header's outer and middle layers are coated with a copolymer/wax dispersion that has good water repellency and moisture resistance. The design also allows sufficient water vapor permeability to prevent condensation from forming inside the roll package.

In 1988, Packforsk extensively tested moisture protection characteristics provided by combination wrapping to the roll ends. The rolls tested were protected on the ends by a two-ply corrugated board header cut to the exact diameter of each roll, with wax coating on both the middle and top layers of the header. Plastic film was applied radially to the roll body, folded down over the edges 3-4 in., and sealed to the header with hot melt. The test roll of LWC paper was placed in an up-ended position on a platform covered with wet fiberglass insulation material. The platform and the roll were then vibrated for 30 min at frequencies of 3-30 Hz and an acceleration of 0.5 g (4.9 m/sec^2). After the vibration, the roll was left in the wet insulation material for 24 h, then unwrapped and checked for moisture damage. Results showed that no water or moisture damage occurred to the roll end. The wax-coated board header had blocked the moisture from getting into the roll end, and the hot melt sealant blocked the water from getting in between the header surface and the plastic film.

However, specialty header materials are not always necessary. As with plastic film characteristics, header characteristics should be assessed in terms of an individual mill's specific requirements.

Label protection

Although today's customer wants better protection for the paper roll, there is also emphasis on ensuring that the shipping label for each roll is undamaged during transport and storage. Sophisticated tracking systems must be able to read barcode labels clearly. Unlike conventional kraft wrapping and even cocoon wrapping, the combination method of wrapping can place labels under one or more layers of film, through which they can be read by a barcode scanner. The film coloration can be decreased so that the label can be placed under many layers of film, if necessary, and still be readable (**Fig. 6**).

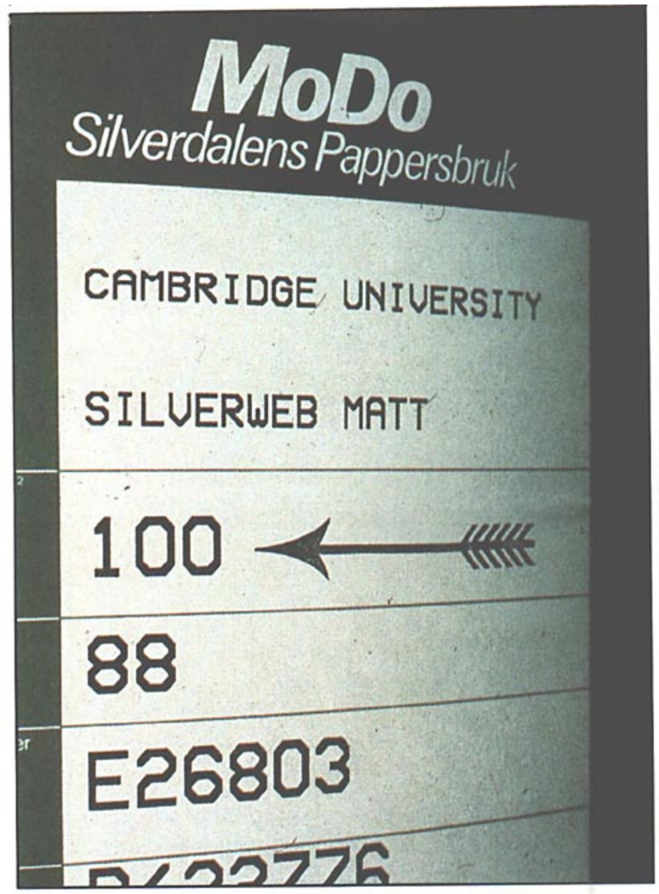
Tests have demonstrated that barcodes can be read through up to three layers of normally tinted film used by combination wrappers, which generally is much less tinted than the film used in cocoon wrapping. Further, the radial-only application of film in combination wrapping results in a wrinkle-free surface, allowing for easier label reading.

The first true possibility for side vacuum handling of paper rolls

Considerable interest has been given to the possibility of side vacuum handling of paper rolls, particularly in newsprint production, although a number of LWC and fine paper manufacturers also have expressed interest. Potentially, side vacuum handling can significantly reduce handling damage and improve space utilization (**Fig. 7**).

In 1984, the four major Swedish pulp and paper manufacturers—Holmens, Hylte, SCA, and Stora—joined in an effort to explore the potential of side vacuum handling and to develop a practical clamp.

Prior to the Swedish effort, side vacuum handling had only been used in some cases in the United States and Canada, primarily because the body wrap normally had to be perforated in order to allow the vacuum to reach the paper roll. This conflicted with many customer requirements for a totally tight or waterproof package for



6. Placed under one or more layers of film, the shipping label is well protected, and readable by today's barcode scanners.

a number of grades and markets. In earlier experiments, side vacuum lifting was cited as a failure due to the fact that paper manufacturers tried to handle rolls with conventional moisture barrier type wrappers (i.e., polylaminated kraft paper), and the result was that the vacuum held and tore the wrapper as the roll was lifted.

However, after extensive testing, the Swedish consortium reached the following conclusions:

- Conventional polyethylene coated kraft paper cannot be used by side vacuum lifting systems. The package is not strong enough to carry the paper roll, and the polyethylene coated kraft paper must be perforated with small holes in order to allow the vacuum to get inside the wrap. This defeats the moisture protection characteristics of the polyethylene coated paper.
- Cocoon wrapped rolls (from Iggesunds Bruk) also could not be lifted by side vacuum clamps. The polyethylene was probably strong enough to carry the roll, but the axially applied film was too loose, and was sucked into the holes in the vacuum clamp and clogged them. This destroyed the vacuum lock, causing the roll to fall from the clamp.
- Only combination wrapping (in this case LWC paper supplied by Holmens Bruk) worked satisfactorily with a side vacuum clamp. The radially applied film was tight enough to stay on the roll throughout the vacuum clamping process. The radially applied polyethylene film was also strong enough to lift the paper roll by

7. Side vacuum handling without perforating the wrapping material is only possible with combination wrapped rolls.

having the vacuum applied only to the outside of the wrap. There was no need to penetrate the wrap and let the vacuum in to the paper roll.

From these results, combination wrapping is clearly the only existing wrapping method that allows successful side vacuum handling without perforating the wrap. Thus, side vacuum handling may become more common in the paper industry and could make a significant contribution to minimization of roll-handling damage. Side vacuum handling also maximizes warehouse space, since no spacing is required between the roll stacks (**Fig. 8**).

Although side vacuum clamping is not used extensively, top vacuum handling of paper rolls is common throughout the world. The primary use is for loading and unloading of ships, many of which are fitted with top vacuum handling equipment.

Top vacuum handling normally requires two procedures. First, a hole, usually in the shape of an "H" (≅ 1 in. by 1 in.), is cut in the inner and outer top headers of conventionally kraft wrapped rolls, or through the single header of a combination wrapped roll. The hole is placed in the center of the header, outside the core. Second, the bottom core end is plugged with an airtight plug.

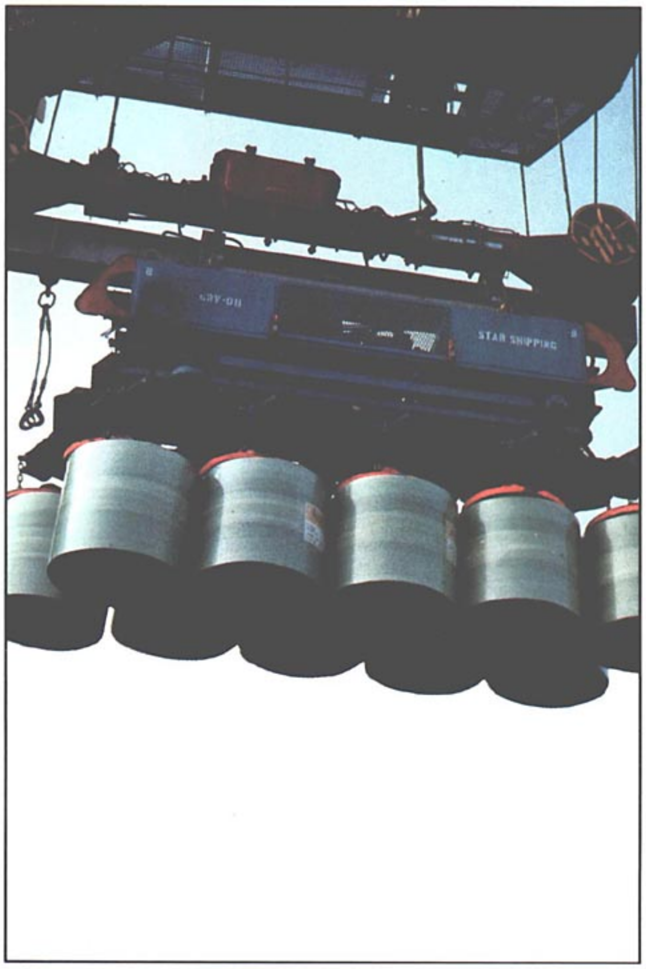
Only conventionally kraft-wrapped and combination-wrapped rolls can be handled by top vacuum. Cocoon-wrapped rolls do not have headers, and the axially applied plastic film does not allow the rolls to be lifted because it comes loose and plugs the vacuum holes. Today, combination-wrapped rolls from the Holmens Bruk mill in Wargön are loaded by top vacuum into ships at the Uddevalla, Sweden, docks.

Latest equipment designs

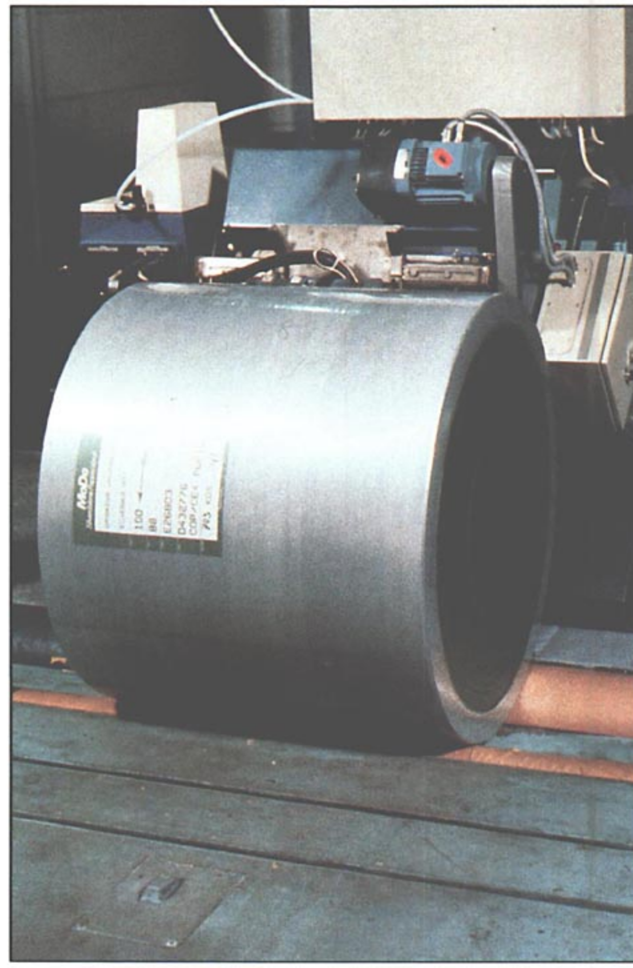
Mills' interest in film wrapping continues to center upon the potential for reduced equipment costs, lower manpower requirements, and minimized space utilization. Thus the trend in machine design would appear to be directed toward low-profile, high-capacity systems that can be delivered and installed at a relatively low cost. Virtually all mills have required that the systems be operated by not more than one person (**Fig. 9**).

The MoDo Papers coated fine papers mill in Silverdalen, Sweden, is one of the first in the world to use a low-profile, high-capacity combination wrapping system for full mill production. The wrapping system, installed in 1988, consists of two main elements: a wrapping unit that automatically applies low-density polyethylene film to the roll body in a radial direction only; and a header cutting system that automatically measures the diameter of each roll and cuts the headers to fit the roll ends within a tolerance of ± 3 mm (1/8 in.). A header holder arrangement keeps the headers in place during the wrapping cycle. The polyethylene film is tensioned over the roll edge and locks the header in place. The polyethylene can be sealed to the header with hot melt, if necessary. Label application is also automatic.

At present, the wrapping system at MoDo Silverdalen



8. Top vacuum loading of ships with Holmens Bruk rolls.



9. Low-profile combination wrapping machines require very little floor space and are capable of wrapping 50 or more rolls/h of any width or diameter.

is not fully automatic. The operator must load and unload the headers from the header cutting machine and place them against the roll ends; the cycle is automatic from this point. Automatic header placement is expected to become available.

The film wrapping system is capable of wrapping 50 rolls/h, with roll sizes averaging a 40-in. width by a 40-in. diameter.

Overall results

Paper manufacturers using film wrapping systems—particularly those combining radial film application with corrugated board end headers—have been highly satisfied with results. Charles E. Lewis, corporate industrial engineering manager, Appleton Papers Inc., and one of the developers of the Appleton Papers film wrapping system, states: "Our system can best be described as an unqualified success. However, as with any new system, a continuous education process is involved. Transition to film wrapping should be undertaken with realistic levels of expectation and adequate support mechanisms in place."

One problem, Lewis notes, was that "both customers and handling personnel often mistakenly perceived our new package as impregnable. In that sense, the packaging itself is somewhat misleading in its ability to withstand harsh contact. Padded clamps and clamp pressure regulators were some of the precautions taken to reduce handling damage."

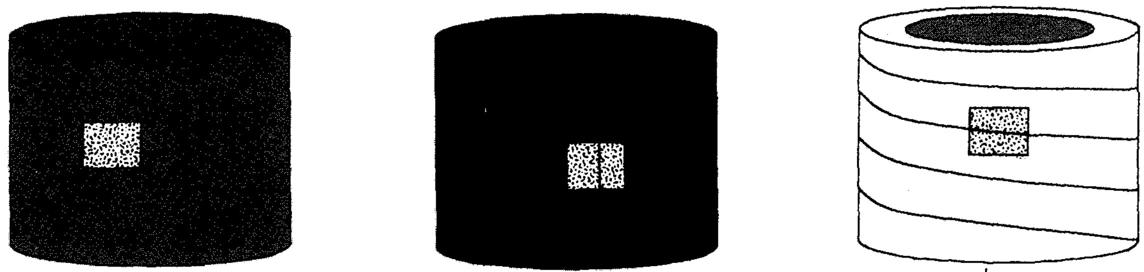
European paper manufacturers using combination wrapping systems initially experienced results similar to those cited by Lewis. Defective clamps and improper handling techniques were often noted as significant causes of damage to the paper rolls.

However, after a learning-curve period during which clamp truck drivers became accustomed to handling the film-wrapped rolls, damage related to clamps and improper handling diminished considerably. Psychologically, clamp truck drivers were usually positive about the new packaging material, expressing the following attitude: "The film packaging made the paper rolls look like very valuable products, so we treated them with much greater care."

According to Lewis, Appleton Papers has experienced a significant drop in damage between the first and second year of film wrapping use. "Between 1987 and 1988, damage complaints dropped considerably," he said.

"Today, transit damage between Appleton and its customers results in significantly fewer customer complaints per month. The number of customer complaints has been reduced substantially."

I. A comparison of roll wrapping systems



	1. CONVENTIONAL KRAFT	2. COCOON	3. COMBINATION
PROTECTION AGAINST			
Moisture/climate	Poor	Good	Good
Mechanical stress	Good	Poor	Good
End damage	Good	Poor	Good
Edge damage	Fair	Poor	Good
Label damage	Poor	Poor	Good
Internal condensation—("roll sweating")	Poor	Poor	Good
ECONOMIC CONSIDERATIONS			
Capital investment	High	Low	Low
Packaging material costs	Low	High	Low
Space requirement	High	Low	Low
Manpower requirement (Operation and maintenance)	High	Low	Low
MARKETING CONSIDERATIONS			
Package appearance	Fair	Poor	Good
Use of printed heads to identify manufacturer	Yes	No	Yes
Use of alternative packaging colors	Difficult	Easy	Easy
HANDLING CONSIDERATIONS			
Roll-to-roll adhesion	Low	High	Low
Vacuum handling:			
from top	Yes	No	Yes
from side	With perforated kraft wrap only	No	Yes

Attractive package: an effective marketing tool

Besides the superior roll protection offered by combination wrapping, the system also improves the appearance of the final product. Unlike conventional kraft wrapping, combination wrapping allows flexibility in the use of packaging colors. Film is available in a wide range of colors, and company logos can be imprinted on the roll headers if desired. With the proper use of film colors and headers, the wrapping process provides a very professional-looking package. As Lewis points out: "Our new dark blue polyethylene package gives us a great deal of recognition and visibility among our customers. The customer reaction has been very positive. In the last two surveys performed by our marketing people, our new packaging rated a 9.5-grade out of a possible 10 from our customers."

Perhaps the greatest potential benefit of combination wrapping is the significant improvement in the product's appearance. At least one paper manufacturer has considered using different film colors to designate paper quality gradations; for instance, red for the basic grade, silver for a medium grade, and gold for superior quality grade. In this respect, combination wrapping offers a previously unavailable range of packaging possibilities for paper rolls and an improved marketing vehicle for eliciting positive customer responses to the product. Regardless of the color of the film material used, combination wrapping ensures that paper rolls appear as the valuable, high-quality products they truly are (**Table I**).□

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