

Film roll wrapping in a U.S. fine paper mill: a case history

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ABSTRACT: *Reduced operating and capital costs, as well as superior protection, make film wrapping of paper rolls an attractive alternative to traditional wrapping methods. This paper discusses in detail the operating experience, packaging material utilization, maintenance, and customer response issues relating to the use of film in the packaging of paper rolls. The type of wrap discussed is the combination method of wrapping wherein low-density polyethylene is used to cover roll circumference, while cut-to-measure corrugated board headers are used to protect roll ends.*

KEYWORDS: *Corrugated boards, fine papers, low density polyethylene, packaging films, packaging materials, plastic films, protection, wound rolls, wrapping, wrapping materials.*

The Ecusta Division of P. H. Glatfelter Co. produces high-quality lightweight printing, cigarette, and specialty papers at its Pisgah Forest, NC, mill. During the late 1980s, the mill began extensive studies of potential alternative methods for improving its roll packaging. The high value of Ecusta paper dictated that the company identify more effective means of protecting roll stock from moisture damage during transport and storage. The substantial material and maintenance costs associated with the mill's existing kraft wrapping system also motivated the company to seek more cost-

effective solutions to its roll packaging problems. Ecusta investigated a number of roll packaging techniques and undertook several customer based studies to determine the response to possible new wrapping methods. Following nearly four years of evaluation, the mill decided to convert to film packaging of its paper rolls in 1993.

Objective: A quality package at a reasonable cost

Since 1968, Ecusta had utilized conventional mechanized kraft wrapping equipment to package its paper

rolls. The kraft wrapping did not provide adequate water and moisture protection from leaking transport containers, nor did it prevent moisture damage in the warehouse. As a result, customer rejections of wet paper became a concern. In some instances, entire truckloads would be rejected when only one or two of the rolls in the shipment were actually affected by moisture.

In the initial effort to upgrade roll packaging, Ecusta considered several methods for simply improving its conventional kraft package. For instance, one approach involved the use of polyethylene coated wrapping paper on both the roll body and the roll ends. The materials proposed for this method were costly, and the package was considered environmentally unsound because it was not recyclable. A new header system using polyethylene coated headers and heated header presses was also incorporated into the existing kraft wrapping line, but moisture problems continued. This was due to the crimping of the body wrap at the roll ends, which created channels for penetration of water and moisture into the roll at the header.

From an economic perspective, the operating costs of the conventional kraft wrapping line were becoming too high. Manpower requirements, maintenance downtime, and material costs were substantial. The kraft wrap required a significant annual budget for sealing tape alone, and Ecusta wished to eliminate this expense.

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When a decision was made to modernize the mill's wrapping system, a completely new kraft wrapping line was at first considered. However, since the mill's roll sizes vary considerably, a new kraft wrapping machine would require multiple backstands with transport mechanisms, which would occupy a great deal of space either overhead or alongside the machine. It was also necessary to install the new wrapping machine in the existing wrap line location since the mill could not effectively re-route the handling of its rolls. The new wrap line had to be commissioned while the existing conventional kraft wrapper was still operating, in order not to interfere with shipment of the rolls.

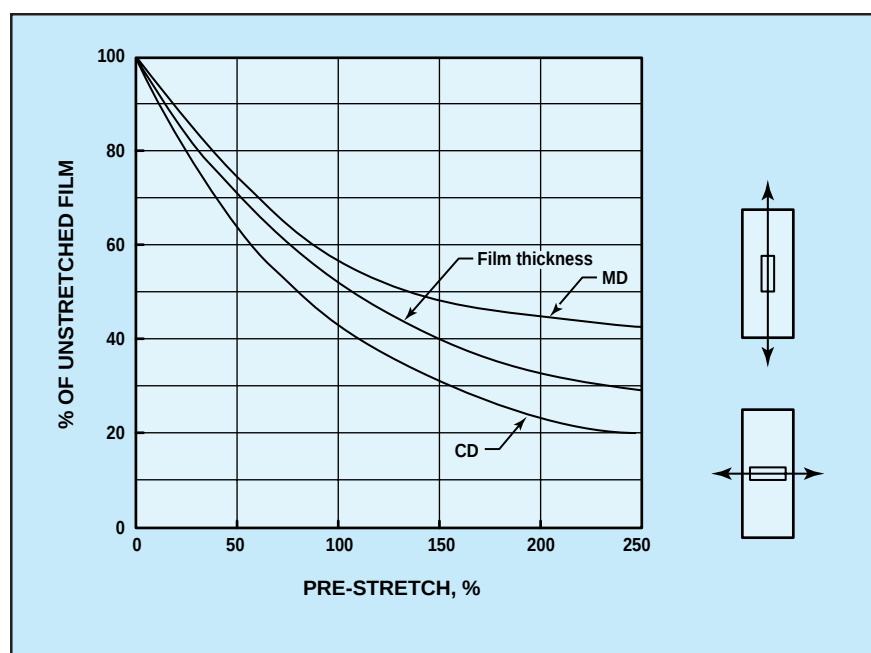
Ultimately, Ecusta decided that polyethylene film wrapping was the most viable roll packaging option due to its ability to protect against water and moisture damage, and considerably lower capital cost and space requirements.

Seeking the best technique available

Several types of film wrapping machines were tested, not only to ensure that the resulting package would be water resistant, but that the final product would be attractive and acceptable to Ecusta's customers. The primary stumbling block to adopting a film wrapping program was the prevailing attitude among paper manufacturing personnel who felt that since the mill makes paper, it should wrap the paper in paper. It took a strong effort to convince some personnel at the mill and customers that film wrapping would offer a superior package.

In its efforts to identify the best available film wrapping technique, Ecusta considered two basic methods of roll packaging: radial wrapping using corrugated board headers (combination wrapping), and axial/radial wrapping (cocoon wrapping). Any new wrapping system adopted by the mill would be required to effi-

1. Polyethylene tensile strength to break



ciently package the mill's peak production. The flexibility to handle a widely varying range of roll widths and diameters would place great demands on the wrapping system.

After careful examination, mill personnel determined that cocoon wrapping would be much more time consuming and result in greater film consumption than combination wrapping. Cocoon wrapping did not offer sufficient end and edge protection, and it was questionable that cocoon wrapping would be capable of adequately sealing smaller diameter rolls against moisture intrusion.

Several radial film wrapping systems using paperboard headers were evaluated. Some of the systems utilized pre-cut headers, but it was decided to adopt a system wherein headers were cut to the exact diameter of each roll, for optimum end and edge protection.

Pre-stretching not recommended

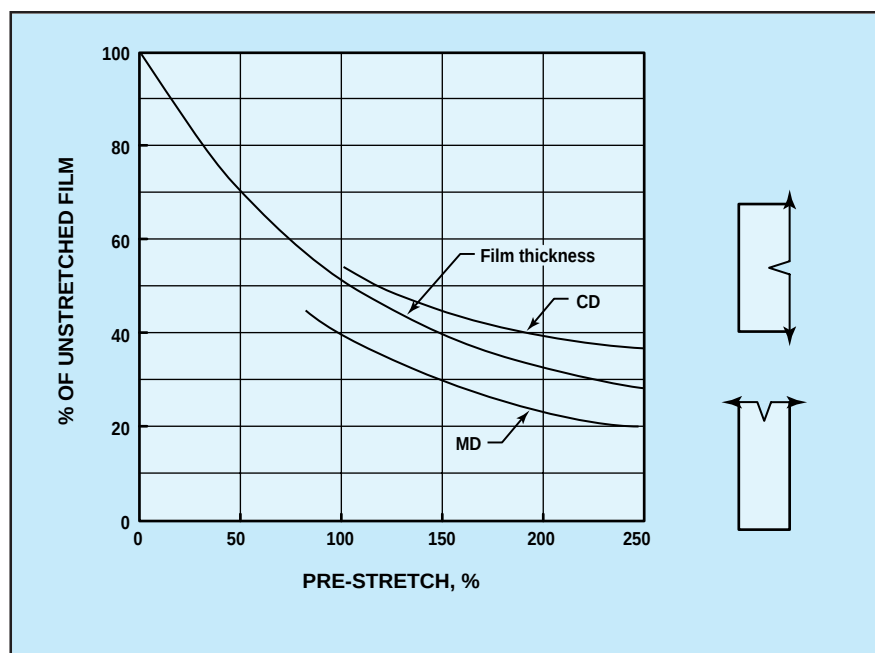
To meet Ecusta's objectives for superior packaging, the plastic film to be used had to be moisture resistant as well as mechanically protective;

one of the many problems pertaining to roll packaging is the likelihood of damage from clamp truck handling. Ecusta was determined to identify film wrapping materials which would not "zipper" when punctured by clamps, or via contact with walls, floors, or other objects. In other words, the wrapping material could not be susceptible to tear migration in the event that the roll package was punctured during handling.

Ecusta evaluated several types of film, including some that required a very high pre-stretch prior to application on the roll. One argument in favor of high pre-stretch film was that the coverage of the paper roll could be accomplished by using fewer pounds of film. However, experiments indicated that a high level of pre-stretch in the film was detrimental because it decreased the cross-directional tensile strength in favor of higher machine directional tensile strength (**Fig. 1**).

When polyethylene film is pre-stretched prior to application, the molecular chains comprising the film become oriented in the machine direction. This increases tensile strength in the machine direction and

2. Tear split resistance of polyethylene film



can decrease tensile strength in the cross-direction. Cross-directional tensile strength is essential to accommodating high stresses imposed on the film. When rolls are lifted by clamps, there must be sufficient cross-directional strength to prevent splitting at the edges, where the film has been tensioned over the roll ends to hold the headers in position.

Pre-stretching also increased the likelihood of tear migration in the machine direction (MD). Subsequent to impact, a puncture in highly pre-stretched film would continue to propagate into a much larger opening than would have occurred if the film were not pre-stretched (**Fig. 2**).

Ecusta ultimately decided to utilize a 3 mil (80 μm) thick film at a relatively low stretch value (approximately 30-40%), which has resulted in a superior package. In fact, the clamp damage to the rolls has been greatly reduced in comparison to the kraft wrap formerly used by the mill. Ecusta experience indicates that the film wrap's puncture resistance is at least equal to if not greater than that of kraft wrap.

A new approach to fire safety issues

Another significant consideration in Ecusta's determination to package rolls in plastic film involved fire propagation rates, and the guidelines of certain industrial insurance carriers regarding sprinkler system protection capacities. Prior to Ecusta's evaluation of film wrapping (in 1985 and 1986), two major fire tests were carried out wherein film-wrapped linerboard and foam and film wrapped carbonless paper were tested for fire propagation rates. These tests indicated no significant difference between kraft wrapping and film wrapping in terms of fire safety.

Coincidentally, during Ecusta's decision making process, a third large-scale fire test of the film wrapped rolls was carried out. Sponsored in 1991 by a consortium of film and resin suppliers and one equipment manufacturer, this test produced a different result than the previous two tests. The insurance carrier that conducted the third fire test determined that, for lightweight and tissue papers, test results indi-

cated that a kraft wrap layer was desirable either over or under the plastic film wrap. By placing one layer of 40 lb (65 g/m^2) kraft wrap or, alternatively, two layers of 20 lb (32.5 g/m^2) wrap on the roll, film wrapped lightweight paper or tissue rolls would not require higher sprinkler capacity requirements than heavyweight (board) paper grades. Film wrapped lightweight paper would be considered as heavyweight paper for fire protection purposes as long as the kraft layer was present. This layer can be applied as necessary by the paper wrapping head incorporated into the system, which is discussed below.

Preparing the customer

Ecusta devoted a substantial effort toward determining customer acceptance of film wrapped roll packages. The company's sales force discussed the new package with many of its customers, discovering that the primary concern was the recyclability of the packaging materials.

Because much wrapping material waste is generated in paper roll wrapping, it is important to the users of roll paper stock that the wrapping medium be recyclable. For many customers in the Northeast particularly, landfill costs can be extreme. The ability to transform the wrap into a reusable secondary product and avoid landfilling was important. Film suppliers were very helpful in developing recycling programs for the company's customer base. When some of Ecusta's customers realized that the new wrap would be fully recyclable, and that many existing wraps were not recyclable due to laminated material content, they became interested in film wrap.

Some customers were also adverse to the use of plastic film because of the fear of the film accidentally re-entering the pulping process. However, the strength of the film which Ecusta uses is such that the film will normally be captured and held by a screening process before re-enter-

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ing the pulp stream. After nearly a year of operations, the fear of film contamination of a pulping process has become a non-issue.

The new wrapping system: how it works

The new wrapping system spirally applies polyethylene film to the roll circumference with cut-to-measure double wall corrugated end headers for roll end and edge protection. The wrapping system incorporates three main elements: a circumferential film applicator, a circumferential kraft wrap applicator (**Fig. 3**), and a header cutting device. Before the rolls enter the system, they are measured with a laser diameter sensor to determine the exact roll diameter. This information is forwarded to a control system, which automatically sets the header cutter loading stops and cutting parameters for the headers to be trimmed. The interactive screen on the operator's desk informs the operator which blank header size to choose. The headers are cut, the trim removed, and the headers are placed manually on the roll ends.

In cases where the rolls are not already protected with a kraft layer applied at the winder, the spiral kraft wrapping head attaches the kraft wrap to the roll with hot melt. It then spirally applies the kraft paper in the same way as the polyethylene film is applied (this process is described below). Since the kraft wrap is applied spirally, only one width of kraft wrapping medium is required.

Subsequently, the polyethylene wrapping mechanism applies hot melt to the leading edge of the film to be applied to the roll circumference. The roller table in the system then rotates and the film wrapping process begins. The wrapping head traverses to spirally wind the roll circumference with a preselected number of layers of polyethylene film over the entire width of the roll. The stretch film is tensioned over both ends of the roll to secure the head-

3. A kraft wrapping head (left) and a film wrapping head (right) spirally apply separate layers of pure kraft paper and polyethylene to the roll circumference, producing a fully recyclable package. The same width of wrapping material is used for all roll widths.



ers in position. The label is inserted under the final layer of polyethylene film.

Since the film holds the headers in place, it is not necessary to crimp the kraft paper down over the edges of the roll. Therefore the package ends are much smoother than with a conventional kraft wrap package, and the potential for crimping imprints on the roll ends is eliminated. Further, there are no channels through which moisture can pass into the roll itself. Since the headers are cut to the diameter of each roll, edge protection to the outer layer of the roll is assured. The application of the polyethylene film over the edges also reinforces the edge protection to some degree.

Space savings

Ecusta's space for installing a new wrapping line was extremely limited. The existing kraft wrapping line was placed immediately adjacent to one of the truck loading docks in the warehouse area. It was also virtually impossible to modify the mill's roll handling system, and a new finishing building was cost-prohibitive.

Since the new wrapping system applies polyethylene and, in some

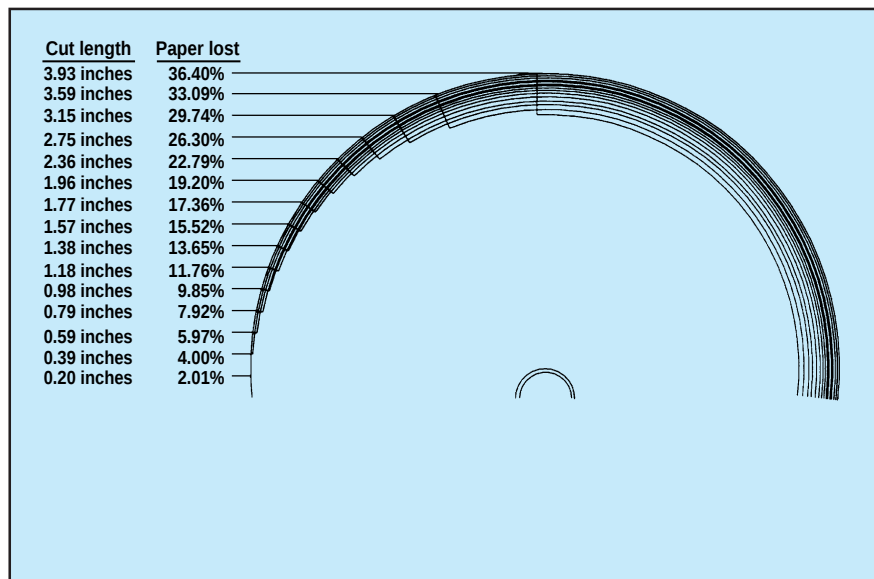
instances, kraft paper spirally with a traversing wrapping head, no backstands for wrapping media were required. The entire system, including the film and kraft wrapping heads and header cutting system, was installed in an area of approximately 250 ft² (23 m²). Less than 10 ft (3 m) of ceiling clearance was required.

Due to the small size of the system, installation in the existing roll ramp was possible, and almost no downtime was required. Civil work was also relatively minor.

Header processing

Since much of the paper produced by Ecusta is a very high-quality lightweight paper, end and edge protection were also critical to the mill's consideration of a new roll packaging method. The headers provide cushioning for the rolls while they are stacked on end. The crush strength of the new headers is sufficient to avoid flattening, or allowing protrusions from the floor to damage the ends or corners of the rolls. Since the headers are cut to the diameter of each roll, there is full protection given to the outside edges. This is important, since damage near

4. For a roll with a diameter of 40 in. (approximately 1 m), the diagram illustrates the percentage of paper lost due to a cut in the radial direction on the "end-part of the edge."



the edge can result in substantial loss of paper (**Fig. 4**). Overall, end and edge damage has been reduced considerably.

Label protection

Under a single layer of film, the labels are secure and well protected. They can be read easily with bar code scanning equipment. At the customer's facilities, labels are easily removed and are in excellent condition.

Some of Ecusta's customers expressed an interest in being able to remove the label and keep it for inventory control purposes. If a label is attached with adhesive to kraft wrap, that label cannot be easily removed for further use. With the film wrapping system, the outer layer of film is simply cut open and the label pulled out. Normally, it is in exactly the same condition as when it was printed at the mill.

Clamp handling

In the early stages of the mill's investigations, there was concern about the ability of the mill's clamps to grasp and pick up rolls wrapped

in plastic film. A number of experiments were undertaken wherein rolls wrapped in plastic film were picked up and moved up and down rapidly in order to determine if the wrapping could actually be shaken loose. It was not possible.

At Ecusta, the clamps do not have variable clamp pressure control. Clamping is accomplished through the initial settings of the hydraulic system. The operator does not have any alternative settings. The rolls are clamped at a single standard pressure, then picked up and transported. Therefore, it was essential to ensure that there would be no problems with package strength in terms of roll handling.

Installation and startup

A critical element of the installation of the new film wrapping system was continuity. The existing wrapping system had to continue functioning while the new system was being installed. It was actually very easy to install the new wrapping system immediately following the existing kraft wrapping system due to the small size of the equipment. Today, the rolls pass directly through the

old wrapping station and scale and into the new roll wrapper which is installed mid-way in the delivery ramp. The mill's ability to package rolls was never interrupted by the installation of the new system.

In terms of operator training, understanding the new system was relatively easy. The control panel commands were very straightforward, and most of the operators quickly grasped how to operate the machine. The switch from using the old kraft wrapper to using the new film wrapper took place in a matter of hours. Within two days, the complete transition was made from kraft to film wrapping. Since the operators of the existing wrap system remained in the finishing area during the installation period, they were able to discuss with the installation technician exactly how the new machinery would operate.

Maintenance

Another positive element of the adoption of the film wrapping system was that the amount of maintenance required was considerably lower. With a film wrapping system, there are fewer moving parts and those parts are much simpler than in a conventional kraft wrapper. The existing kraft wrapper required quite a lot of maintenance, primarily due to its age. The kraft wrapper had many parts which required continual replacement, and the amount of maintenance resulted in substantial downtime.

Comparatively, the film wrapper is relatively simple and the maintenance effort required mainly involves ensuring that the attachment bolts are kept tight. Because Ecusta runs a relatively large number of rolls per day, there is constant stress on the machine. The amount of shock loading to the system requires frequent review of the condition of the fasteners incorporated into the system.

In terms of changing the wrapping media itself on a regular basis,

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this is a very simple process. The operator can remove the expended roll of film or kraft paper in a matter of minutes, and can roll the new media into position at the wrapper. The wrapping unit itself includes an elevating device to move the new roll of either plastic or kraft paper into the dispensing position. There is no strenuous work required from the operator to change the wrapping material itself.

Customer response

After more than one year of operation, Ecusta has eliminated virtually all complaints from customers regarding water and moisture damage. Mechanical damage to the roll has not been a problem to date, and the mill's customers seem to be pleased with the package in terms of appearance, protection, and overall

integrity. The rolls today simply appear more valuable; therefore, they are treated with more care.

An additional advantage of the film wrapping system is that it offers great flexibility to customers who require different types of wrap. Normally, Ecusta offers a basic standard wrapping for all of the rolls that are stored or further processed in the mill for shipment to customers. However, when customers have a specific request for specific types of wrapping, it is a simple matter of setting the control program for varying numbers of layers of film or paper to be applied to the roll. Since some customers may require a certain number of layers of film on the roll and, because the mill's delivery system is totally random, it is essential that the operator be able to quickly choose one wrapping type or another. This flexibility was not

available in the previous conventional wrapping system.

Final evaluation

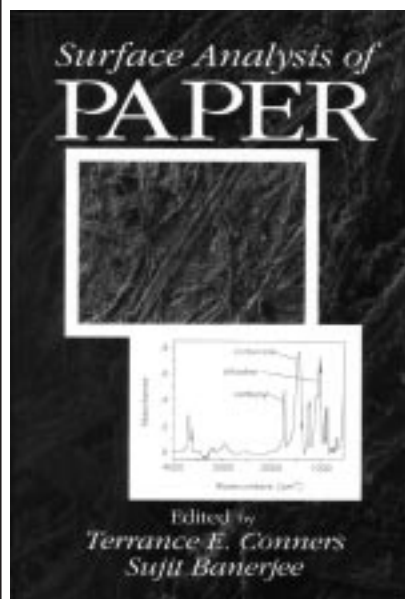
In conclusion, results have overall been very positive. Losses due to customer rejections of wet paper rolls have been virtually eliminated. Ecusta has achieved improved protection for its roll packages, and has reduced packaging, maintenance, and manpower costs.

Although some customers were initially hesitant in accepting the polyethylene wrap, the vast majority now view the new package as a significant improvement. Overall, customer response has been highly favorable. ■

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