Selecting proper winding tension for various web substrates

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ABSTRACT: This paper gives guidelines for determining tension ranges for various substrates run on today's complex converting lines. The relationship between web thickness and tension requirements is discussed. Nonlinear tension increases are covered, and charts are included to assist converters and machinery builders in selecting unwind, process, and winding tension for various substrates.

KEYWORDS: Converting machines, film, paper, paperboards, processes, tension, thickness, substrates, unwinding, web tension, winding.

The object of tension in a web is to provide control of the web during unwinding, to convey it through a converting process such as coating, printing or laminating, and to rewind the product. Without sufficient tension, the web would not track correctly, might not wrap coater rolls properly, and could cause wrinkles and poorly wound rolls. In the case of automatic transfer at a turret unwind or winder, there must be suitable tension for the knife to cut the web.

This article does not discuss how tension is generated or the types of tension control systems available. I intend, instead, to provide guidelines that aid in selecting tension requirements for various substrates.

The web can be coated or uncoated, stiff or flexible. It also may be a composite material. The tensions given later in this article may be adjusted up or down, based on previous experience with particular webs or conditions.

Tension based on web thickness

In the past, tension in the web usually has been directly related to web thickness: for example, a 150-g/m^2 paper substrate requires three times the tension of a 50-g/m^2 paper. By investigating equipment operating in converting plants and initiating discussions with some converters, we have found that the relationship between web thickness and tension requirement is not linear. For further proof, we tested various substrates in laboratory conditions where tension control and tension indication is available.

Today's converting lines are often required to handle a wide range of substrates. Typical is a flexible packaging extrusion-coating line where primary substrate ranges from film to paper to light paperboard. By reducing the tension on the thicker webs, we improve the operation of the machine in the following ways:

- The electrical drive horsepower required to drive a machine can be reduced.
- Wear and tear on the associated equipment, bearing life, etc. is improved.
- Overall tension range is reduced, resulting in a tension that is easier to control. A range of 10:1 is about the maximum for good transducer operation.

Unwind tension for paper and paperboard

Figure 1 shows the tension requirement for paper and paperboard at an unwind that is followed by driven pull rolls. This tension is normally less than the process tension because minimal tension will prevent cinching or telescoping of poorly structured rolls. The lower tension requirement allows the use of smaller brakes (either friction or regenerative-motor type). The pull roll can be a nip type or "S" wrap. In either case, the pull-roll units must be able to hold back the tension differential between the unwind and the process. *If pull rolls are not used, the* unwind braking system must handle the process tension.

Process tension for paper and paperboard

Figure 2 represents process tension for paper and paperboard. This is the tension required to convey a web from the unwind pull rolls through coaters, around and over expander rolls, edge guides, etc., including the winder. Generally, coating added to the web does

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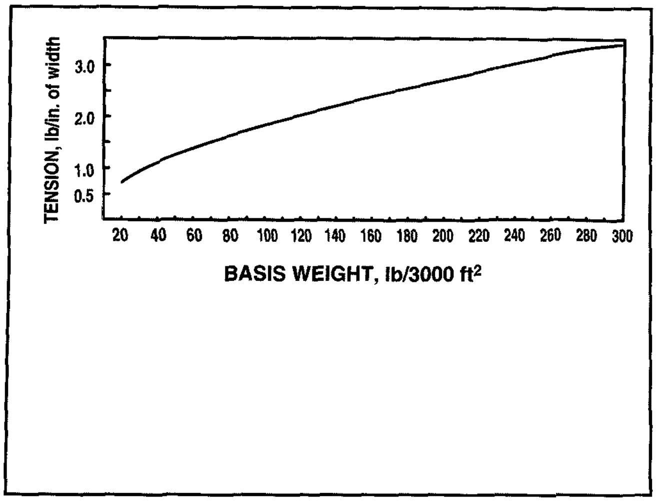
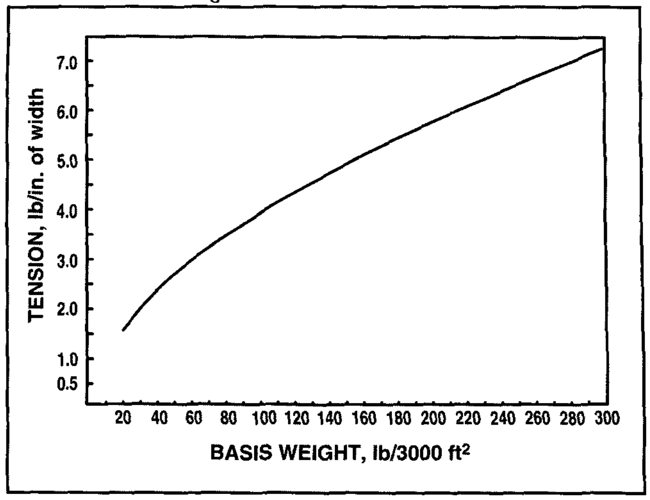
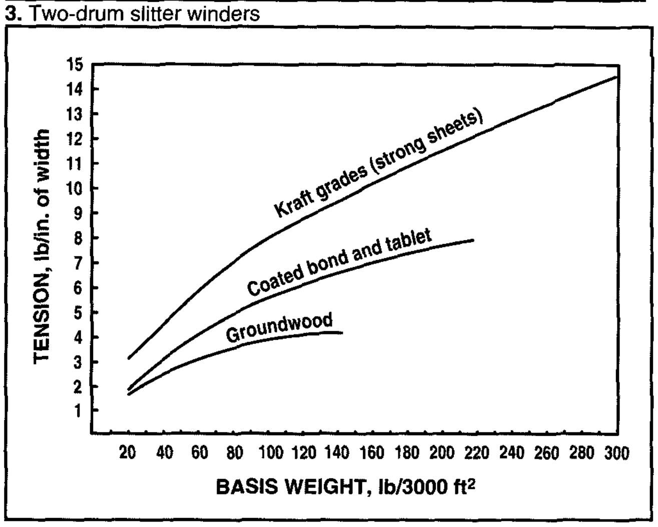
1. Unwind tension



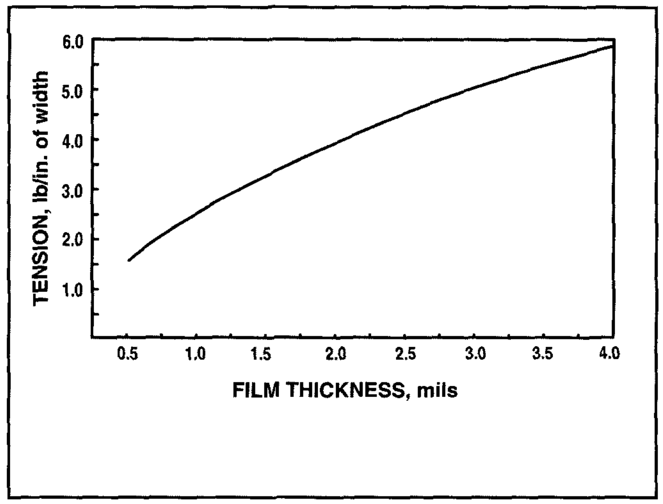
2. Process and winding tension



3. Two-drum slitter winders



4. Extensible films



not require additional tension and can be ignored. Obviously, if two or more webs are laminated, the tension must be increased. This is determined by adding the basis weights of the substrates that were laminated and using the tension listed in Fig. 2. For example, if a 200-g/m² and a 100-g/m² paper web are laminated, use the tension for a 300-g/m² web.

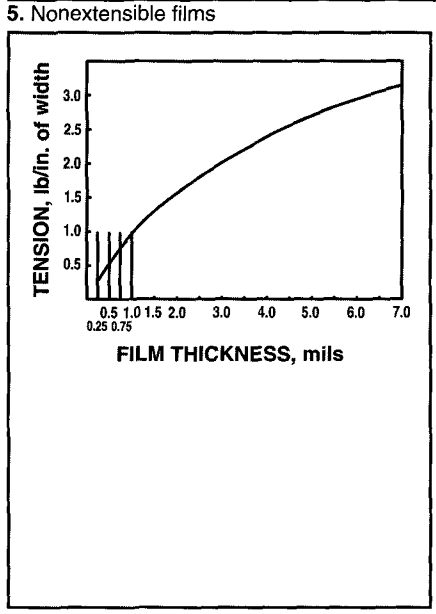
Tension requirements of two-drum winders

Figure 3 lists the tension required for paper and paperboard being slit and wound on a two-drum winder. This is basically the same as the winder power tension chart shown in TAPPI Technical Information Sheet 403-11. These tensions are greater than those for a converting line due to the requirements of a tight, hard roll able to withstand rough treatment in handling. There are three curves, each giving tension figures for types of paper. The short-fiber groundwood requires less tension than kraft paper. Also, the tension versus thickness is not linear.

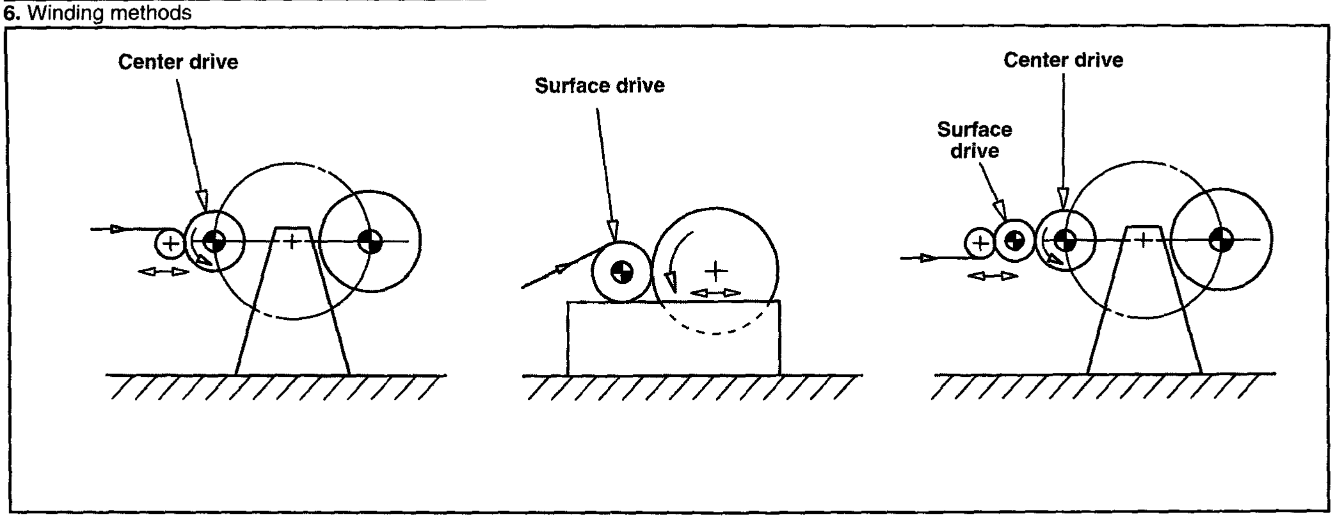
Tension requirements of extensible films

Figure 4 gives the tension criteria for extensible films such as polyethylene, polypropylene, and nylon.

5. Nonextensible films



6. Winding methods



Tension requirements of nonextensible films

Figure 5 lists the tension required for nonextensible films such as polyester, oriented polypropylene, and cellophane. The heavier polyester webs are tough materials and may require special attention if automatic transfer is used at the winder. Our research determined that polyester webs over 7 mils thick needed increased tension at the winder during roll changes to ensure good knife action.

Winder techniques that influence tension

Except for coating, printing, or laminating, the most important winding operation is usually the windup. A roll must be built that is reasonably straight, is able to withstand handling, and can be unwound in a later process.

Although the tensions shown in Fig. 2 are used for winders, the method of winding also affects the formation of the roll. Converting machine winders normally fall into one of three categories (**Fig. 6**): center drive, surface drive, or a combination center–surface drive.

The center winder can be single-positioned or turret type. Torque put into the center of the winding roll provides the tension that is the primary factor in controlling density. A rider roll (lay-on roll) is sometimes incorporated into the winder system, which will have an effect on roll density by ironing out air. Increased loading against the winding roll produces a more tightly wound roll.

The surface winder also is known as a single-drum winder or reel. In addition to web tension, the loading between the winding product roll and the drum has a definite effect on the density of the roll. By using more nip loading, a tighter roll will be wound without increasing the web tension. Under laboratory conditions, I was able to wind rock-hard rolls of 12-point (195 g/m^2) paperboard at 3-pli (0.53 kN/m) tension using high nip loading. I found that if less tension was used the web would not track or wrap the idler and expander rolls properly.

The combination center–surface winding system can be used with a single-position or turret winder. This system employs a center drive and also has a driven lay-on roll that provides a surface drive. This drive is normally found where a wide range of substrates is used. The lighter substrates are wound by center wind only. The heavier substrates use the surface winding in addition to the center wind. Most paper and film webs wound by the center method require taper tension. The process shown in Fig. 2 can be used at the core. For winding systems, having a lay-on roll, whether driven or not, is often desirable to reduce nip loading as the roll builds. In cases where taper tension is used, a pull roll is located immediately upstream from the winder to prevent the reduction in tension from affecting the converting process.

Summary

Figures 1–5 can be used as guidelines for tension requirements when determining equipment size and drive horsepower. These tensions are considered the maximum required to convey the web through a converting process and winder. If the paper or film being handled is of even caliper and without baggy edges or center, less tension can be used, resulting in less power consumed and reduced wear on machinery. TJ

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Conversion factors

lb/3000 ft^2 x 1. 627 = g/m^2
lb/in. of width x 0.175 = kNm
Thickness in mils x 0.0245 = mm