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Web Tension Tech Tip

By R. Duane Smith

Product Manager – Specialty Winding
Black Clawson Converting Machinery / Davis-Standard LLC
Fulton, NY 13069

Web Handling can be a real Challenge! We need to convey a web flat and straight through the process without generating defects such as wrinkles. To do this, we need to convey this web under a certain amount of web tension. The question then becomes –How much web tension do I need to use to insure success in producing a web product without defects that will run on our Customer's process without problems and meet the expectations of our Customer's Customer for the web material that we produce.

The answer to the web conveyance question – How Much Web Tension should I use? is AS LITTLE AS POSSIBLE!
In a perfect world, we would not need to use Web Tension. We would simply float the sheet straight through the process without wrinkling or bagginess defects. Unfortunately, webs are not perfect and rollers are not perfect. Therefore, we do need to use web tension to successfully convey webs through a production line. This Tech Tip will address the suggested maximum web tension. Just remember, in almost all cases, when it comes to Web Tension – MORE is usually NOT BETTER!

Since no web is perfectly flat, we need to convey imperfect webs. The suggested amount of web tension is typically between 10% and 25% of the web material's elastic limit (tensile strength). That means that if it takes 10 # (4.5 kg) of tension to stretch a 1" (2.54 cm) web to the point it will break or permanently deform, then you should run about 1 pli (pounds per linear inch) or .18 kg/cm of tension (10%) with a maximum tension of 2.5 pli or .45 kg/cm (25% of the elastic limit).

Plastic and Paper Technical organizations such as SPE and TAPPI have done studies and gathered a lot of empirical data on the suggested amount of tension. They suggest that the MAXIMUM web tension for plastic films is below the level that the film is stressed to 1.5% of the modulus of elasticity of the film material.

Examples in both the English and Metric units as well as typical modulus of films are given in the TAPPI Film Extrusion Manual – 2nd Edition, TAPPI Press, 2005 pages 315-317. They have also published charts for suggested tension ranges for various materials which are shown in Figure #1 for common materials within the flexible packaging industries.

TYPICAL TENSION VALUES-
Films & Foil

FILMS	TENSION LEVELS
Polyester	0.5 to 1.5 lbs./inch/mil
Polypropylene	0.25 to 0.5 lbs./inch/mil
Polyethylene	0.10 to 0.25 lbs./inch/mil
Polystyrene	0.25 to 1.0 lbs./inch/mil
Vinyl	0.05 to 0.2 lbs./inch/mil
Aluminum Foils	0.5 to 1.5 lbs./inch/mil
Cellophane	0.5 to 1.0 lbs./inch/mil
Nylon	0.10 to 0.25 lbs./inch/mil

1 lbs./inch/mil = 7.03 kg./cm/mm

FIGURE #1

For the paper and paperboard industry, TAPPI suggests from their empirical studies that the maximum web tension be determined by multiplying the paper's basis weight (#/3000 square feet) by a factor of .035. Therefore a 15# paper x .035 = 0.5 pli tension, a 30# paper x .035 = 1.0 pli and a 60# paper x .035 = 1.5 pli maximum web tension. Figure #2 gives a table of the suggested maximum tensions for Papers and figure #3 gives the suggested maximum tension for paperboard.

TYPICAL TENSION VALUES- Paper

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PAPER, Basis Wgt.	TENSION LEVELS
15 lbs./ream (3000 sq.ft.)	0.5 pli
20 lbs./ream	0.75 pli
30 lbs./ream	1.0 pli
40 lbs./ream	1.5 pli
60 lbs./ream	2.0 pli
80 lbs./ream	2.5 pli

Unwinding Tension (pli) = basis weight x 0.035

Winding Tension (pli) = paper basis weight x 0.055

.035 X 1.5 (50% greater) = Approx .055

Conversion Factors

lbs./3000 ft^2 x 1.63 = grams/sq. meter

pli x 5.6 = *kg/cm* *OR* *pli x .571* = newtons/cm

FIGURE #2

TYPICAL TENSION VALUES- Paperboard

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BOARD THICKNESS	TENSION LEVELS
8 point	3.0 pli
12 point	4.0 pli
15 point	5.0 pli
20 point	7.0 pli
25 point	9.0 pli
30 point	11.0 pli
40 point	14.0 pli
50 point	16.0 pli
60 point	18.0 pli

1 point = .001” = 25.4 microns

FIGURE #3

For the suggested maximum web tensions for laminated structures, simply add the maximum web tensions for each of the materials that have been laminated together (usually disregarding any coatings or adhesives) and apply the sum of these tensions as the web tension for the laminate.

The important tension consideration for laminating flexible film composites is: The individual webs need to be tensioned before they are laminated so that the strain (elongation of the web due to web tension) will be approximately equal for each web.

If one web is strained significantly more than the other web(s), when they are laminated, curl problems or delamination wrinkling known as "tunneling" can occur in the laminated webs. The amount of tension should be a ratio of the modulus and the web thickness to prevent curl and/or tunneling after lamination process.

Winding Web Tension- For a typical center or center/surface winding application, the starting winding tension is considerably higher then the ending web tension. This is known as winding tension taper. When sizing center winding drives and tension control systems, we will use a maximum web tension at the start of the wind (core winding tension) to be 50% greater than the suggested maximum web handling tension. We will then taper the web tension by up to 50% so the max. winding tension equals the max. web handling tension at the full wound roll's diameter. TAPPI suggests that to calculate the maximum winding tension, the paper's basis weight (#/3000 square feet) be multiplied by a factor of .055. Therefore a 15# paper x .055 = 0.8 pli tension, a 30# paper x .055 = 1.6 pli and a 60# paper x 055 = 3.2 pli maximum winding tension at core and taper the winding tension by 25% to 50% at the full roll diameter. See FIGURE #2.

Center/Surface Winding Tension- When using a combination of center and surface winding principles, the surface drive is used to control the web tension and the center drive is used to control the inwound tension (hardness) of the winding roll. The web tension is set at a sufficient level to insure a wrinkle free sheet is presented to the winder and is maintained by transducer feedback control to the surface drive. This web tension is normally held at a constant value during the complete winding process. The winding tension and taper is programmed into the center drive to obtain the roll hardness profile desired. For a slitting and winding application the web tension is set and maintained by the surface drive at the minimum tension setting required to give clean slitting and then sufficient spreading action to insure adequate separation of each of the slit web coming into the winding operation. For more information on the application of center/surface winding, see the Tech Tip on *When to use Center/Surface Winding* available at http://www.bc-egan.com/public_html/Company/publications.html .