Tedlar® SP

polyvinyl fluoride film

Laminating Guide

Introduction

Tedlar® SP polyvinyl fluoride (PVF) film was designed to give exceptional conformability to substrates while maintaining the superb cleanability, durability, color stability, and chemical resistance expected of PVF film. In contrast to traditional *Tedlar*® PVF film that is made by a biaxial orientation process, *Tedlar*® SP PVF film is cast onto a carrier web and dried without orientation. This lack of orientation makes the film much more formable and compliant than oriented film. Because of this combination of high conformability and durability, it is often possible to replace relatively thick films of other materials with much thinner *Tedlar*® SP PVF films. Handling thin, compliant film can present a challenge to those used to handling thicker, stiffer film. In most cases, only a few simple adjustments need be made; however, for certain critical applications, more subtlety is needed. This brochure contains simple "rules of thumb" and a troubleshooting guide that should be sufficient to solve most problems encountered in learning to handle *Tedlar*® SP PVF film.

The web handling characteristics of film depend very strongly on both the design and the condition (e.g., roll alignment and tension control tuning) of the process. Thus, no hard and fast performance limits can be given for handling any film. However, the following suggestions for designing and operating processes for handling *Tedlar*® SP PVF film are based on experience in handling these films in semiworks and production scale equipment.

In order to provide customers with the maximum flexibility in working with *Tedlar*® SP PVF film, these films are available either attached to the carrier web (designated as Type 8 films) or as free-standing PVF films (designated as Type 9 films). In general it is easier to handle the film while it is still on the carrier web, which can serve as a protective coversheet. However, working with Type 8 films requires the customer to remove and dispose of the carrier web (the film releases from the carrier web with minimal effort).

Tedlar® SP PVF film must be adhesive coated before it can be laminated to other materials. In most lamination applications, the adhesive coating is a heat-activated adhesive (e.g., based on DuPont resin 68080). Heat-activated adhesives tend to be brittle at room temperature. This can present some minor complications in room temperature processing; however, this presents no problem at application temperatures. As received from the factory the adherable side of the film will be identified by a label. Partially used rolls should be re-identified by the customer. For adhesive-coated films, the most reliable test is to wipe the film with a swab dipped in acetone, toluene, or MEK; the adhesive will dissolve. Technical information on adhesives for *Tedlar*® SP PVF film can be found in the guide "Flexible Product Adhesives for Use with *Tedlar*® Polyvinyl Fluoride Film."

Safety

Tedlar® SP PVF film is not hazardous as shipped. Laboratory studies by DuPont and experience by DuPont and processors have shown that *Tedlar*® SP PVF film, itself, presents no health hazards. Further safety information can be found in the *Tedlar*® SP guide "Materials and Processing Information Safety Considerations."

Web Tension Settings

Tension must be applied to any web to steer the web and to keep it from wrinkling as it runs through the process. The tension in a web is usually expressed as the total force (e.g., pounds) on the film or as the total force divided by the width of the film to give a tension per unit width (e.g., pounds force per linear inch of width or pli). In simpler processes, the tension may be read as a torque on a brake (or a cantilevered roll) that serves as a relative standard but does not directly convert to the

pounds per linear inch in the web. As far as the performance of the film is concerned, it is actually the pounds of force per square inch of cross section (psi) that matters. A common rule of thumb is that the tension in a plastic film should not exceed one pound per linear inch *per mil* (or 1 kpsi). Usually, *Tedlar*® SP PVF film replaces a thicker film of another material; thus, *Tedlar*® SP PVF film usually requires much less tension to run than the films it replaces. A reasonable starting point for running *Tedlar*® SP PVF film is to scale conditions developed for other films according to the thickness of the film. Even if the process does not have a readout that converts directly to pli or psi, it is advisable to scale whatever tension readout is available to the thickness of the film. Actually, the tension needed to track the film also varies in proportion to the modulus of the film. Since *Tedlar*® SP PVF film is so compliant, the process can usually run at much lower tensions than would be calculated by thickness ratios. It is desirable to run the process at the lowest tension that keeps the web taut. For processes that control tension with a brake pressure, the tension in the web will rise as the roll expires; thus, the brake pressure should be started as low as possible and may need to be reduced as the roll diameter shrinks. More detailed guidelines for controlling tension may be found in the guide "Designing a Process for Handling *Tedlar*® SP PVF Film."

Web Tears and Web Condition

Any tears, nicks, or abrasions in film will cause it to tear more easily than undamaged film. In handling rolls of film, care should be taken to avoid damaging the end of the roll by dropping it or running it into walls. Rolls of film that are received with damaged ends should be returned immediately. Similarly, care should be taken to avoid nicking the film in unwrapping or processing. The web should be steered so that the edge of the film does not rub against stationary objects.

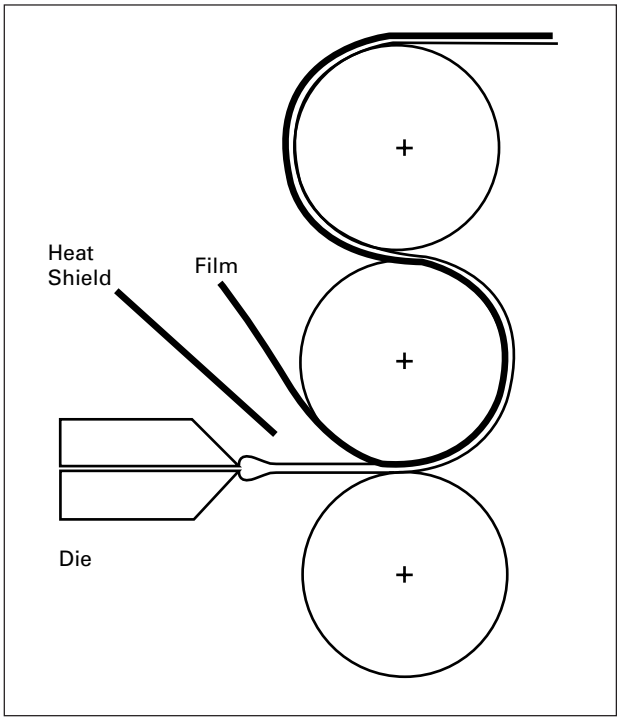
In Process Shrinkage of *Tedlar*® SP PVF Film

There is no advantage to applying excess tension to film. If too much tension is applied to the web, the film will start to stretch. As it stretches, it will also get narrower. If the tension is increased further, the film will break. Depending on the process requirements, some minimal degree of neckdown may be acceptable; however, minimizing neckdown can enable the customer to buy narrower film and thus increase yields. The degree to which film "necks down" is roughly proportional to the degree to which the tension in the web exceeds a critical value (roughly one fifteenth of the yield stress). Since the yield stress drops as the film is heated, there is rarely a problem with neckdown until the film approaches the laminating nip.

There are three ways to minimize the shrinkage—and avoid breakage—of *Tedlar*® SP PVF film in the span prior to lamination. First, film will not stretch as much nor break as easily when it is in contact with a roll as it will in a free span. Thus, if the film can be kept cool and under low tension until it reaches the laminating roll, the process will have more tension latitude. A common cause of excessive heating in the span approaching the laminating nip is radiative heating from the extrusion die. If this is the case, the problem can be eliminated by installing a heat shield to block the infrared radiation from reaching the film. A thin sheet of metal—even aluminum foil—is sufficient, provided it blocks the film from having a direct view of the die. This is illustrated in **Figure 1**.

Second, the onset of neckdown depends on the alignment of the rolls in the process. Twisting the

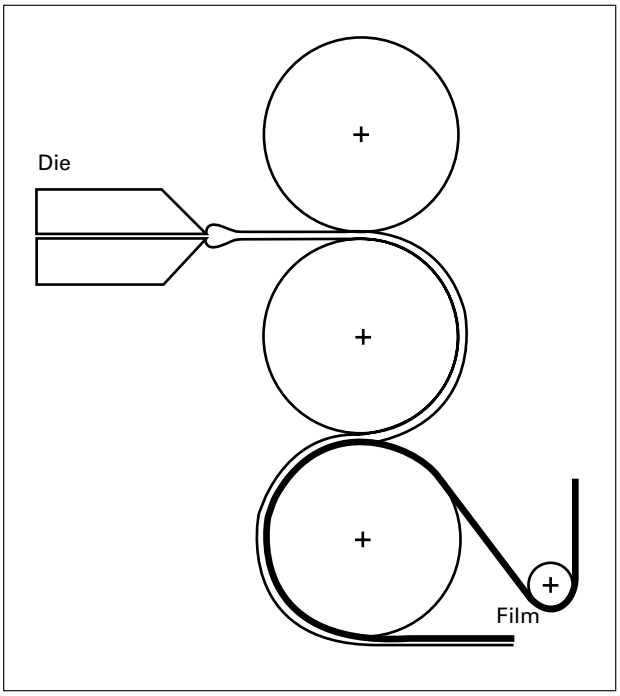
Figure 1. Use of Heat Shield for Upstack Lamination



film is not nearly so much of a problem as stretching one side relative to the other. Thus, the better the rolls approaching the laminating nip are aligned *in the plane of the film*, the less neckdown will be experienced.

Finally—depending on the process—it may be possible to introduce the film into a nip other than the primary nip for the melt. This technique can be used in the rare cases where the film cannot be introduced to the primary nip without the melt overheating the film (provided there is still ample temperature to melt the adhesive in the secondary nip). This is illustrated in **Figure 2** for a down stack laminator.

Figure 2. Alternate Web Path for Downstack Lamination



Troubleshooting Guide—Lamination

Problem	Cause	Solution
Web stretches, necks down	Excessive tension in film	Check tension control (e.g., brake) Be sure all rolls are free turning
	Rolls out of alignment in film plane	Have rolls optically aligned
Film snaps suddenly	Web tear—probably from nicks	Inspect roll for damaged ends, discard damaged film Check process for film rubbing
Film stretches and then breaks	Excessive tension in film	Check tension control (e.g., brake) Be sure all rolls are free turning (particularly rolls that may be hot)
	Film is too hot	Lower roll temperatures Install thermal shield to block radioactive heating
Side to side differences in finished product	Film stretched unevenly	Check alignment of rolls, particularly those approaching the coating nip

For more information, or to place an order, please contact:

(800) 255-8386

FAX: (716) 879-4545

DuPont *Tedlar*®
P.O. Box 88
Sheridan Drive and River Road
Buffalo, NY 14207-0088

Europe

DuPont de Nemours Intl'l SA
2, chemin du Pavillon
P.O. Box 50
CH-1218 Le Grand-Saconnex
Geneva, Switzerland
(022) 7175111

Canada

DuPont Canada, Inc.
P.O. Box 2200, Streetsville
7070 Mississauga Road
Mississauga, Ontario, Canada
L5M 2H3
(905) 821-5180

Japan

DuPont Kabushiki Kaisha
Tedlar® PVF Film
4th Floor Chiyoda Honsha Bldg.
5-18, Sarugaku-cho 1-chome
Chiyoda-Ku, Tokyo 101 Japan
(011) 81-3-5281-3428

Asia Pacific

DuPont Asia Pacific Ltd.
TST P.O. Box 98851
1122 New World Office Bldg.
(East Wing)
Salsibury Road, TST
Kowloon, Hong Kong
(011) 852-3-734-5345

DuPont Singapore PTE Ltd.
1 Maritime Square #07-01
World Trade Center
Singapore 099253
65-273-2244

CAUTION: Do not use in medical applications involving permanent implantation in the human body. For other medical applications, see "DuPont Medical Caution Statement," H-50102.

CAUTION: *Tedlar*® film is not approved for use in ultralight aircraft.

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