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Elvanol® in the Textile Industry

Performance advantages of DuPont™ Elvanol®

Versatility	T-Grade copolymers have essentially the same film strength as a fully hydrolyzed PVOH, the desizeability of a partially hydrolyzed PVOH, and the ease-of-use of a blend
Low Add-On	As much as 50% less than starch
High Weaving Efficiency	Fewer loom stops
Size Bath Stability	No viscosity degradation even after days at elevated temperature
Ease of Desizing	Desizes better than medium-or high-viscosity partially hydrolyzed grades
Environmental	Lower BOD and COD than starch

Elvanol® T-Grades of polyvinyl alcohol are unique copolymers developed especially for use as warp sizes for polyester/cotton blends and other spun yarns. Alone, or in combination with starch and additives, Elvanol® T-Grades are being used successfully on practically every type of spun yarn now on the market; including acetate, acrylic, cotton, rayon, wool, nylon, and polyester spuns and such blends as polyester/cotton, polyester/wool, and polyester/rayon.

Advantages of Elvanol® T-Grades:

Size bath formulas based on Elvanol® T-Grades are simple and easy to prepare, and run without difficulty on the slasher. Important performance advantages of the Elvanol® T-Grades as a warp size include the following:

Low Add-On: The high film strength, abrasion resistance, and excellent adhesion of Elvanol® T-Grades permit their use at about one-third to one-half of the add-on required with starch formulas. Since lower add-on and higher adhesion results in less shedding on the loom, less frequent cleaning of drop wires, heddles, and reeds is required. Reduced add-on also permits greater warp yardage per beam, with consequently fewer doffs at the slasher and fewer tie-ins at the looms. This in turn means increased production at lower labor costs. "Tight" constructions are easier to weave at low size add-on, as there is more air space in the reed. Finally, the lower weight of size present reduces freight costs on shipments of grey cloth to finishing mills.

High Weaving Efficiency: Yarns sized with Elvanol® T-Grades show excellent weaving performance with few loom stops. Good hairiness reduction results in low warp-related filling stops on air jet looms.

Low Weave-Room Humidity: Weaving efficiency remains high over a wide range of humidities as Elvanol® T-Grades remain flexible at low humidity, and is not softened at higher humidities. High humidity is not required for good weaving performance. Consequently, a more comfortable working atmosphere can be maintained without sacrificing efficiency. Lower humidity also prolongs the life of loom parts that are subject to corrosion in moist atmospheres.

Excellent Size Bath Stability: Solutions of Elvanol® T-Grades are non-corrosive and are not subject to spoilage. Unlike starch sizing materials, they can be held at elevated temperatures for days without viscosity degradation. There is no need to heat pipelines to prevent gelling of the size solution.

Ease of Desizing: Elvanol® T-Grades dissolve readily in hot water, without the need for costly enzymes. They are easily removed, even from heat-set polyester/cotton fabrics. Film dissolution studies show

Elvanol® Grades T-66 and T-91 to exhibit better dissolving characteristics than medium or high viscosity partially hydrolyzed grades at 140-160°F (60-71°C), particularly in the presence of mild caustic (often added in cloth preparation).

Environmentally Friendly: Elvanol® T-Grades have low Biological Oxygen Demand (BOD) compared to many other sizes. Combined with the ability to weave efficiently with low add-on, this results in a low BOD and COD (Chemical Oxygen Demand) in the desize stream to a finishing mill's waste water treatment plant or Publicly Owned Treatment Works (POTW). Elvanol® copolymers are degradable in properly designed and operated activated sludge waste water treatment systems. When a size recovery system is installed at the desize stage, virtually all Elvanol® is eliminated from the waste water.

Economically Recoverable and Reusable: The unique molecular structure of the Elvanol® T-grade copolymers is extremely chemically stable, and is not hydrolyzed or otherwise chemically altered in the heat and stresses of a size recovery system. The T-grades are easily recovered and reused in any type of commercially available ultrafiltration system. Reuse is straightforward, as there is no viscosity change during desizing, ultrafiltration, or storage. High concentrations can be achieved, reducing transportation costs and providing maximum flexibility in reuse of the reclaimed solutions.

Favorable Cost/Performance: The foregoing advantages make the overall cost/performance of warp sizes based of Elvanol® attractive, particularly for polyester blend yarns where starch based sizes do not perform well at the low add-on required to achieve fabric quality.

Resin Characteristics

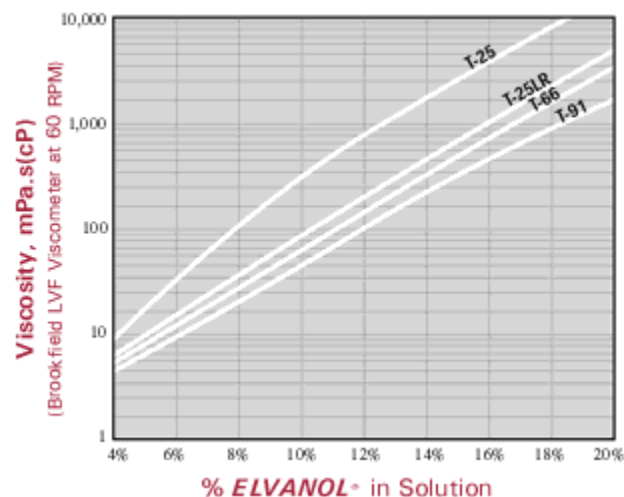
Elvanol® T-Grades are unique copolymer polyvinyl alcohols designed specifically for use as a warp size for spun yarns. Supplied as white, granular solids, they slurry easily in cold water without lumping and dissolve readily on heating.

Shipping and Storage

Elvanol® polyvinyl alcohol is packaged in 50 lb. (22.7 kg) net multiwall paper bags. Bag shipments are available on request in 2,250 lb (1,021 kg) unitized loads on non-returnable pallets. In addition, Supersack shipments of 1,050 lb (500 kg) on non-returnable pallets are also available. For bulk handling, Elvanol® can also be delivered by hopper car or hopper truck (tariff minimum quantities). The bulk density of Elvanol® is somewhat lower than that of starch (24-27 lb/cu ft for Elvanol® vs about 44 lb/cu ft for starch). Bulk storage and handling facilities designed for starch can generally be used with little or no modification for handling Elvanol®. For further information, see product bulletins or call or write your nearest DuPont™ Elvanol® representative.

Elvanol® as supplied can be stored indefinitely without lumping, molding, or deteriorating. Since solutions of Elvanol® T-Grades do not gel or mold, they can be stored over weekends and shutdown periods without impairing their usefulness. Solutions of Elvanol® are stable, noncorrosive, and nontoxic.

Figure 1. Effects of Concentration on Viscosity of Elvanol® at 160°F Size Bath Formulas



Size Bath Formulas

Elvanol® T-Grades of polyvinyl alcohol can be used alone or in combination with starches and additives, depending on the yarn and weave and on individual mill preference. Its applications range from a 100% PVA single component size for polyester, to 50-75% PVA/starch blends for polyester/cotton blends, to 50% PVA/starch blends for cotton to use as a binder in 10-15% PVA/starch blends for denim and towel pile formulations. As a single-component size, polyvinyl alcohol is effective at low add-on for use with the entire spectrum of spun yarns being woven today, including natural, synthetic, and blend yarns such as polyester/cotton spun blends. The low add-on at which Elvanol® can be applied as a single component size is particularly advantageous for tight fabric constructions that are difficult to weave. In combinations with starch, Elvanol® improves the strength of the size film and provides the required adhesion to synthetic yarns. Table I suggests concentration ranges for initial trial in applying Elvanol® alone to typical spun yarns. Wet size pickup will generally be in the range from 100-130% for polyester/cotton blends, but will vary from mill to mill depending on equipment and operating conditions used, e.g., squeeze roll pressure, squeeze roll hardness, and slashing speed.

Because of the wide variation in fiber combinations, yarn count and twist, fabric construction, and slasher conditions, the formulas in Table I are useful only as a general guide. For kettle formulas suitable for your specific yarn and fabric constructions and mill conditions, consult your DuPont™ Elvanol® representative.

Table I - Guide for sizing Spun Yarns with Elvanol® T-Grades

Yarn Size	Solution Solid (%)
Dacron® polyester/cotton Fine Count - 40/1 to 50/1	8-10
Medium count - 20/1 to 30/1	6-8
Dacron® polyester/rayon Medium count - 20/1 to 30/1	6-8
Dacron® polyester/wool	6-8
Cotton Fine count - 40/1 to 50/1	8-10
Medium count - 20/1 to 30/1	6-9
Viscose® rayon	3-5
Acrylic medium count	8-11
Nomex® nylon	9-11
Tencel®	7-9

The addition of 5-8% (on weight of Elvanol®) of a low melting point, emulsifiable wax is generally recommended.

Preparing Size Solutions

Elvanol® polyvinyl alcohol disperses smoothly in cold water and dissolves readily on heating. Size baths based on Elvanol® alone or in combination with starch are easily prepared in all types of equipment now being used for size preparation.

Cleaning of Equipment

Clean the dissolving equipment, pumps, pipelines, and size boxes thoroughly with hot water before dissolving and applying size formulas based on Elvanol®. Inorganic salts, soaps, alkalies, and cleaning powders may increase solution viscosity and precipitate the Elvanol®. Borax, an ingredient of many soaps and cleaning powders, is especially harmful since it causes gelation of polyvinyl alcohol solutions if present even in low concentrations.

Size Preparation

- Add cold water (less than 85°F) to cooking kettle. All of the water should be added before adding solid materials.
- Start the agitator and circulating pump.
- Add the proper amount of Elvanol®.
- Add the proper amount of starch and other dry ingredients.
- Add the proper amount of wax.
- Inject live steam to raise temperature to 180-210°F (80-99°C) and stir at this temperature for 20-30 minutes. If starch is present, temperature should be 190-210°F (85-99°C). Stir for 30 to 45 minutes.
- Add any liquid binders as appropriate.
- Stir for 2-3 minutes.
- Check final solids and viscosity, and add water to adjust as needed.

Slasher Operation

Established slasher practices can be followed in applying sizes based on Elvanol® T-Grades. Size box temperatures of 150-175°F (66-79°C) give best results with size formulations based on Elvanol® alone. This range is high enough to give satisfactory penetration. At the same time, it is low enough to prevent skinning or film formation on the bath surface during "creep" speed operation of the slasher. Spun-yarn sizing formulations containing combinations of Elvanol® T-Grades with modified starches have higher solids contents and higher viscosities. As with other starch formulas, size box temperatures around 180-200°F (80-94°C) are necessary to maintain workable viscosities and obtain satisfactory penetration.

Squeeze Roll Pressure

Normal squeeze roll pressures are usually satisfactory. The amount of size pickup can be varied by changing the squeeze roll pressure.

Drying Cans

For spun yarns, the first drying can should be operated at 220°F (104°C) or perhaps higher to prevent can sticking and film formation. Yarn temperatures above 280°F (138°C) should be avoided. In general, the drying can temperatures should be set at the minimum required to dry the yarns to the final moisture content desired for the particular yarn being sized. Automatic moisture-control instruments work very satisfactorily with warps sized with Elvanol® polyvinyl alcohol. If a double size box is used, it is desirable to dry the sheds separately over at least three or four drying cans. This dries the yarn sufficiently to prevent cementing together when the sheds are joined. Adequate preliminary drying of each shed ensures an easy separation (or break of the yarns at the bust bar and lease rods). It is recommended that the dry cans be coated with Teflon® TFE fluorocarbon resin to prevent can sticking.

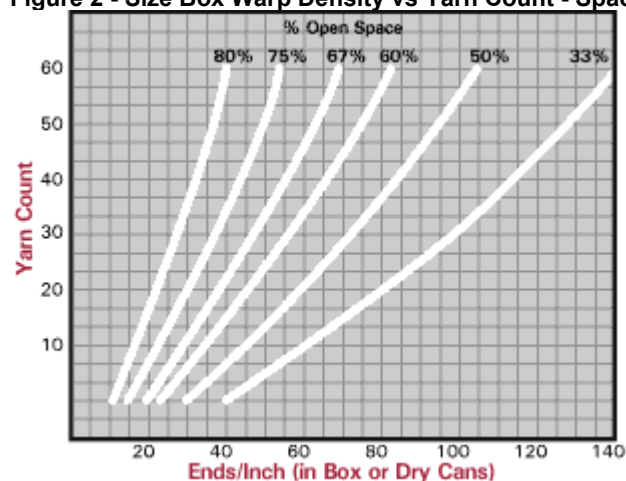
Stretch

Stretch should be controlled for the yarn being sized. Most cotton and polyester/cotton blends will be 0.8-2.0% total stretch. Other yarn types will vary. An even tension should be maintained from section beam to section beam.

Warp Density

Proper spacing between individual warp yarns in the size box is important for optimum pickup of size. Adjacent ends should be separated by a space approximately equal to the yarn diameter. On the dry cans, a minimum of 75% open space is recommended for Air-Jet weaving. It is preferable to use a multiple size box or wet split if available to permit maximum separation (Refer to Fig. 2).

Figure 2 - Size Box Warp Density vs Yarn Count - Space Between Ends



Elvanol® T-Grades adhere without flaking to both polyester and cotton fibers. The fiber bundle is cemented together and encapsulated with size to achieve the abrasion resistance required on the loom. (See sized yarn adhesion photomicrographs, further below.)

Weaving Sized Yarns

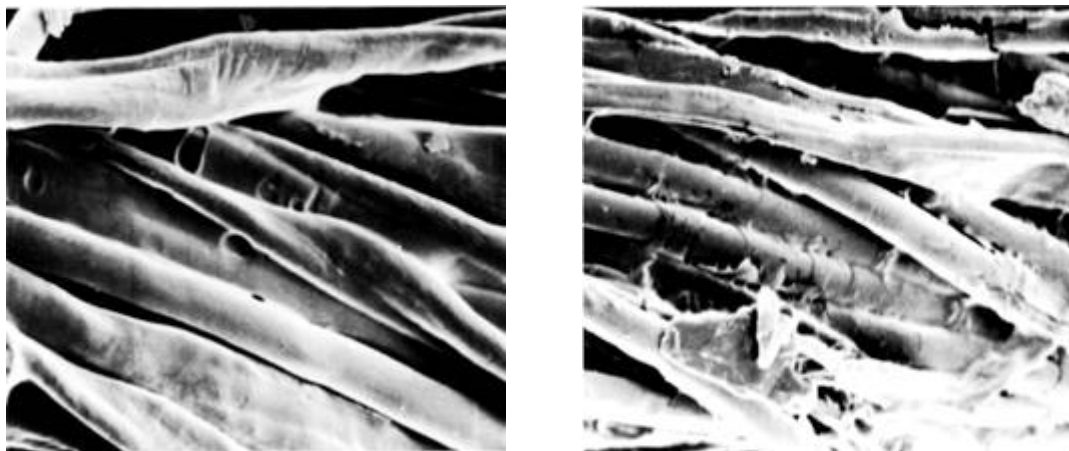
Warps sized with Elvanol® T-Grades of polyvinyl alcohol show excellent weaving performance and are especially advantageous for "tight", difficult-to-weave constructions. Normal loom settings and regular weave room procedures can be followed.

Weave Room Humidity

Warps sized with Elvanol® do not require the high weave room humidities necessary for handling starch sized yarns. Humidity may be reduced to 60-75% relative humidity or even lower if desired, to provide more comfortable working conditions and reduce maintenance costs on loom parts that are sensitive to humidity. Since high humidity does not affect the performance of Elvanol®, customary settings can be maintained during changeover and the humidity reduced after conversion to yarn sized with Elvanol®.

Sized Yarn Properties

Stereo scan electron photomicrographs show the superior film forming and adhesion of Elvanol® (below left) as compared with starch (below right).



The adhesion, toughness, and film strength of Elvanol® are reflected in improved physical properties of the sized yarn. Table II shows the effect of size on a typical polyester/cotton blend yarn to be woven into a 128 sley broadcloth. Elvanol®, at half the total add-on required with starch, produces a stronger yarn with 25% greater elongation and lower stiffness (modulus). The improved toughness of the yarn sized with Elvanol® is indicative of good flex life, abrasion resistance, and shock absorbency on the loom.

Table II. Effect of Size on Yarn Properties (Dacron® Polyester/Cotton, 65/35 Blend)

Property	Sized Yarn		
	Elvanol® T-25	Starch ¹	Unsize Yarn
Size Add-On, %	10	20	0
Yarn Count ^{2,3}	48.0	46.0	48.8
Breaking Strength ^{2,4} , g (mN)	220 (2160)	210 (2060)	190 (1865)
Elongation at Break ^{2,4} , %	10	8	15
Modulus ² , g/denier (g/dtex ⁵)	37 (33.3)	42 (37.8)	25 (22.5)
Modulus ² , g/denier (g/dtex ⁵)	37 (33.3)	42 (37.8)	25 (22.5)
Toughness ² , g-cm/den cm (g-cm/dtex-cm)	0.10 (0.09)	0.08 (0.072)	0.09 (0.081)

¹ Pearl starch plus binders and waxes amounting to 22% on weight of starch.
² Tested at 70°F (21°C), 65% R.H.
³ ASTM D1907-69.
⁴ ASTM D2256-69.

Desizing

Elvanol® T-Grades are readily removed in hot water at flow rates that effectively remove starch. No enzymes are required unless starch is also present. Even after polyester/cotton fabric have been heat-set in the greige, Elvanol® T-Grades of polyvinyl alcohol are readily removed.

Wash Conditions

Cloth sized with Elvanol® T-Grades is readily desized in standard open-width or rope washers. Water

temperature, the number of washes, and the ratio of wash liquor to goods are all important in obtaining complete size removal. The higher the temperature, the more rapidly and completely any polyvinyl alcohol size is removed. Wash box temperatures of 160-210°F (71-100°C) are suitable for removing Elvanol® T-Grades, depending on fabric construction and equipment limitations. The more wash boxes and the higher temperatures used, the more rapidly and completely the size is removed. Generally, a greater number of wash boxes will be required when operating at lower temperatures. Wetting agents and chemical agents such as soda ash or hydrogen peroxide may be added to the wash liquor if desired to increase the rate of solution of polyvinyl alcohol sizes. Liquors containing 8% or more caustic are not recommended for desizing since the polyvinyl alcohol, although dislodged from the fabric, remains suspended as a gelatinous mass which still requires a hot wash for removal. After a fabric has been desized with water, it can be given a conventional caustic scour before bleaching.

Enzymes

The enzymes used in removing starch sizes, and also Elvanol® polyvinyl alcohol/starch combinations, have no effect on polyvinyl alcohol. They neither facilitate nor interfere with removal.

Spot Test

DuPont has developed spot test procedures for polyvinyl alcohol to be used on desized goods. A copy of the procedure and a color chart may be obtained by contacting DuPont.

General

Waste Disposal

Elvanol® polyvinyl alcohol in solution or granular form can be disposed of by incineration or landfill. Any disposal procedure however, must comply with federal, state and local regulations. When exposed to nonacclimated domestic sludge microorganisms, Elvanol® has a low biochemical oxygen demand for periods up to thirty days. Recent work has shown:

- Domestic and textile mill activated sludge microorganisms can acclimate to Elvanol® polyvinyl alcohol under conditions attainable in conventional waste treatment systems.
- Greater than 90% removal of Elvanol® from textile mill wastes can be achieved in activated sludge waste treatment systems that contain acclimated microorganisms.
- Oxygen utilization requirements and sludge production rates are comparable in both domestic and textile waste systems. For more detailed information on the biodegradation of Elvanol®, contact your DuPont representative.

Safe Handling

Elvanol® polyvinyl alcohol can be safely handled in a properly designed bulk silo. Contact your DuPont representative for a copy of the DuPont technical report, "Bulk Storage & Safety Handling Guide." Elvanol® polyvinyl alcohol is a safe material when properly handled. Polyvinyl alcohol is not a primary skin irritant and does not produce skin sensitization. Extensive tests made with Elvanol® indicate a very low order of toxicity when administered orally to laboratory animals. When polyvinyl alcohol is injected under the skin or into the lungs, it is not broken down by the tissues but remains as a foreign body. Under certain conditions of use, dust may be formed from Elvanol® polyvinyl alcohol. DuPont recommends that dust from Elvanol® be treated as a nuisance dust, which is regulated by OSHA under Title 29, Code of Federal Regulations, Section 1910.1000. Under this section, an employee's exposure to nuisance dust shall be limited to 10 milligrams per cubic meter (mg/m³) of total dust and 5 mg/m³ of respirable dust on a time-weighted average in any eight-hour shift of a forty-hour week. If excessive concentrations of dust are encountered, a mask or respirator, complying with Section 1910.134 of the OSHA regulations, should be worn. Goggles should comply with Section 1910.133.

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