A Realistic Comparison of Biaxial Performance of Nylon 6,6 and Nylon 6 Fabrics Used in Passive Restraints—Airbags

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SYNOPSIS

Nylon has been the material of choice for airbag construction because of its specific strength and dimensional stability during deployment. Of the nylons, nylon 6,6 has been widely used in airbag construction. In this article, we attempted to compare the performance of several commercial nylon 6,6 and nylon 6 fabrics offered, for use, to the auto industry. The performance of four traditional nylon 6,6 fabrics are compared with identical fabrics made from nylon 6 fibers. We used a test procedure championed by Chrysler but was developed in our laboratory called the blister-inflation. This test mimics the biaxial deformation of airbag fabric in a manner similar to the deformation of airbag fabric during actual deployment. Several other engineering properties of interest in airbag application are also addressed in this article for comparison purposes. © 1996 John Wiley & Sons, Inc.

INTRODUCTION

Traditionally, nylon 6,6 has been the material of choice for safety airbags. In general, the nylon fiber exhibits high specific strength, abrasion resistance, and toughness or energy-absorption properties. The aging characteristics of nylon are also very good. In addition, comparisons between polyester fabrics and nylon 6,6 fabrics were outlined in an earlier publication.[1] Polyester fibers are known to offer two key advantages over nylons in another passive-restraint application; seat belts. In this application, the nonhygroscopic and nondimensional change of polyester with temperature is highly desirable. However, the normal operating conditions for airbag fabrics present a very different and more taxing environment than does seat belt applications. Under these conditions, nylons have proven to be superior. Nylon's greater biaxial elongation due to lower stiffness offers a unique advantage in airbag application by providing more uniform biaxial stress distribution. Further, their hygroscopic nature assists with additional quenching of the hot gases generated by the airbag's pyrotechnique inflator. Absorption of moisture by nylon also helps in lowering the glass transition temperature of the polymer. The lower T_g can increase fabric permeability at lower temperatures and provide a pneumatic damping action of the airbags, especially in ventless airbag modules.

While differences between polyester and nylon fabrics are clear and better understood, those between different nylons with respect to airbags are not. We need to understand the difference between both types of nylon fabrics before they can be critically compared with respect to their biaxial properties. Even though both nylons are composed of six carbon atoms in their polyamide chain, they exhibit a difference in the orientation of the amide linkage. This difference results in a higher crystallinity in nylon 6,6. Based on airbag restraint requirements, the lower crystallinity of nylon 6 may offer a unique advantage due to the potential for greater flexibility. However, comparisons of the "softness" of the fabric is mute in airbag applications because injuries due to bag slap have been found to be minimized by other restraint reinforcements. Also, the difference in melting points between the two nylons is of little relevance since both have identical glass transition

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regions and fabrics from both exhibit diminishing gas permeabilities above these temperatures. The critical difference in performance between both the nylons is suspected to be due to their basic structural differences. These differences, which are due to the amide linkage, seem to favor nylon 6 for airbag applications. In the published literature, comparison between the three types of fabrics, nylon 6,6, polyester, and nylon 6, were based on toughness, softness, melting temperature range, bag-slap, etc. These comparisons are somewhat meaningless, however, because of various reasons pertaining to unique operating conditions to which the airbag fabrics are exposed. For example, the toughness of both types of nylons are well above the expected performance levels needed for airbags. Also, the difference in the melting point temperature between the two nylons does not represent any unique advantage in an airbag application since the bags never melt. On some occasions, the fabric may be burnt completely due to a projected stream of hot gases in a particular area of the fabric. Burning may also be due to the hot particulate fly ash.

In general, however, the fabrics become soft above 50°C and their permeability decreases dramatically above the glass transition region. The problems due to bag-slap, caused by of the force created due to deploying airbags, can be offset by providing tethers in the airbags. This appears to be the only way for minimizing and maintaining the distance between the airbag and the occupant. Hence, the discussion about the softness advantage becomes irrelevant even at high deployment velocities.

In this article, the performance of both nylons is compared with a more realistic blister-inflation technique developed in our laboratory. This approach mimics the deformation of the fabrics during actual deployment of the airbag after an impact. Specifically, the performance of three different nylon 6 fabrics of commercial interest were compared with three nylon 6,6 fabrics of similar physical characteristics.

THEORY: BLISTER INFLATION TECHNIQUE

In ventless airbag systems, energy dissipation through an airbag is primarily by two mechanisms: (1) through viscose flow of gases through the permeable fabric, and (2) through viscoelastic flow/biaxial stretching of the fabric. Both of these mechanisms, fiber stretching and airflow through the fabric, were quantified using a blister-inflation technique in our earlier investigations.[2-5] With respect to fiber stretching, the approach Tock and Nusholtz[3,4] used for the calculation of the biaxial stress and strain in distended fabrics is based on the relationships derived by Denson and co-workers for solid plastic films.[6-9] In both instances, biaxial tensile stress is calculated by the following equation:

$$\sigma_b = \frac{PD}{d_0}\left[4\left(\frac{h}{D}\right)^3 + 2\left(\frac{h}{D}\right) + \left(\frac{1}{4}\right)\left(\frac{D}{h}\right)\right] \quad (1)$$

The amount of biaxial strain is given by the following equation:

$$\varepsilon_b = \ln\left[\left\{\cos^{-1}\left(\frac{1-4\left(\frac{h}{D}\right)^2}{1+4\left(\frac{h}{D}\right)^2}\right)\right\} \times \left\{\frac{h}{D} + \left(\frac{1}{4}\right)\left(\frac{D}{h}\right)\right\}\right] \quad (2)$$

In these equations, the variables in SI units are σ_b = biaxial tensile stress in the fabric, Pa; P = pressure drop across the fabric, Pa; d_0 = the original fabric thickness, m; h = height of the blister, m; D = blister diameter, m; and ε_b = biaxial strain in the fabric.

Equations (1) and (2) were derived based on the assumption that a constant volume of the polymer sheet deforms from a flat configuration into a spherical segment during the blister-inflation experiments. This same assumption applies to the woven fabric samples used in this study.

EXPERIMENTAL

Fabric Materials

In this article, the performance of three different nylon 6 fabrics were studied and contrasted with traditional nylon 6,6 fabrics. The effect of the gas temperature during inflation and the pressure drop across the fabric on both permeability and biaxial stress–strain behavior were evaluated. However, in addition to the good engineering properties of their constituent fibers, the woven fabrics in airbags must be compatible with the design constraints required in the construction and performance of the airbags.

The nylon 6 fabrics consisted of fibers with two different deniers, i.e., 420D and 630D. Both the 420D and 630D fabrics were of plain weave construction.

Table I Physical Characteristics of Test Fabrics

Polymeric Fabric Type	Fabric Denier	Weave Count	Weave Type/ Process
Nylon 6,6	420	49 × 49	Plain
	630	35 × 35	Plain
	630	41 × 41	Plain
Nylon 6	420	49 × 49	Plain
	630	35 × 35	Plain
	630	41 × 41	Plain

The 420D fabrics were traditionally used on the driver-side application because of the various design constraints on this application. In comparison, a much heavier 840D fabric is typically used for the passenger-side airbag application. The lighter 630D nylons, which were introduced to the airbag market due to size and weight reduction without much sacrifice in the biaxial strength, were also considered in this study. The physical characteristics of these nylon 6 fabrics along with the nylon 6,6 fabrics investigated in this study are given in Table I.

Blister-inflation Technique

The blister-inflation technique is a quasi-steady-state measurement in which a blister is created by a pressure drop across the fabric. The fabric is maintained in this distended shape while data on permeability and biaxial strain are recorded.[2,10] These biaxial characteristics are important since they can be used to estimate the impact energy dissipation characteristics of the fabric used in ventless airbags.[2,5] Moreover, the blister-inflation technique for measuring fabric permeability provides a convenient analog for stretching behavior which is very similar to that which the actual bag must undergo during deployment. When an expansible fabric is stretched biaxially by inflation into a spherical segment or "blister," the fabric's structure can open up and become more permeable, just as the fabric in an airbag does when it is inflated. Both these mechanisms, viscous and viscoelastic energy dissipation, can now be determined a priori from the knowledge of the physical properties of the fabric.[11,12]

Apparatus

In this experiment, a flat sheet of test fabric was deformed into a blister with compressed air. A schematic diagram of the experimental apparatus is shown in Figure 1. The basic component of the apparatus is the sample-jig assembly. The sample jig itself consisted of two metal plates, both with a centered, beveled hole; $D = 0.075$ m. The test fabric of thickness, d_0, was clamped between the plates which were then bolted together to form a tight seal at the edge of the hole. As shown, the compressed air which was used to form the blister passed through a pres-

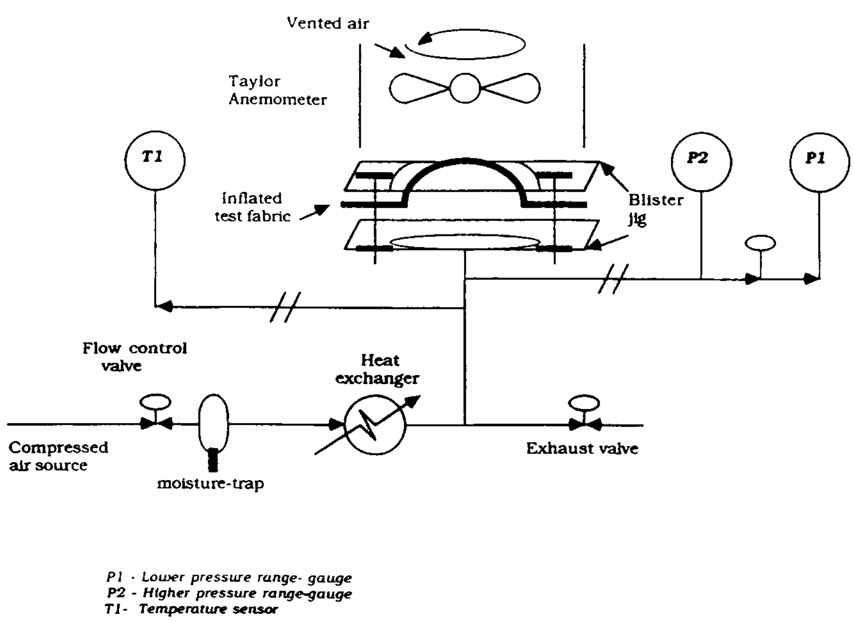

Figure 1 Schematic of blister-inflation apparatus.

sure regulator, a manual valve, a Speedaire® moisture trap, and a heat exchanger prior to entering the blister-jig assembly. A pressure gauge, to determine P, was positioned in the line downstream of the moisture trap to measure the differential pressure across the inflated fabric. The blister height, h, was measured manually. Temperature of the inflating gas was recorded by the temperature sensor across the high-pressure region of the fabric. The volumetric flow rate of air passing through a given test fabric for a given differential pressure drop was measured with a Taylor® anemometer. The volumetric flow was corrected to STP in order to highlight the effects of temperature on permeability.

RESULTS AND DISCUSSION

Permeability—Pressure Drop and Temperature Relationship

Nylon 6 Fabrics

A better insight into a fabric's characteristics is obtained from studies of the variation of permeabilities with inflating gas temperature when the data are displayed as permeability isobars. The pressure-drop range used in this study was 3.4–200 kPa (0–30 psi). The fabrics were tested at five different isothermal temperatures; 8, 25, 50, 75, and 100°C. The experimental volumetric permeability data were corrected to STP for the different pressure drops and temperature for all of the experimental data in order to highlight the temperature effect. The temperature of the compressed air used for inflation was maintained with the use of a heat exchanger. The observed behaviors of the three nylon 6 fabrics are discussed under two separate sections; (1) low-pressure-drop (0–62 kPa) experiments and (2) high-pressure-drop experiments (62–200 kPa). They are then contrasted with nylon 6,6 fabrics of similar construction in the following section.

Low-pressure-drop Experiments

The 420D fabric exhibited a steady decline in permeability with an increase in temperature from 8 to 100°C as shown in Figure 2. No permeability peaks were noticed around the glass transition region of the nylon 6 (50°C) compared to nylon 6,6 fabrics of similar construction from our earlier publications.[11] When the pressure differential was above 34 kPa (5 psi), a decrease in permeability was noticed around 50°C. The region of transition in the nylon

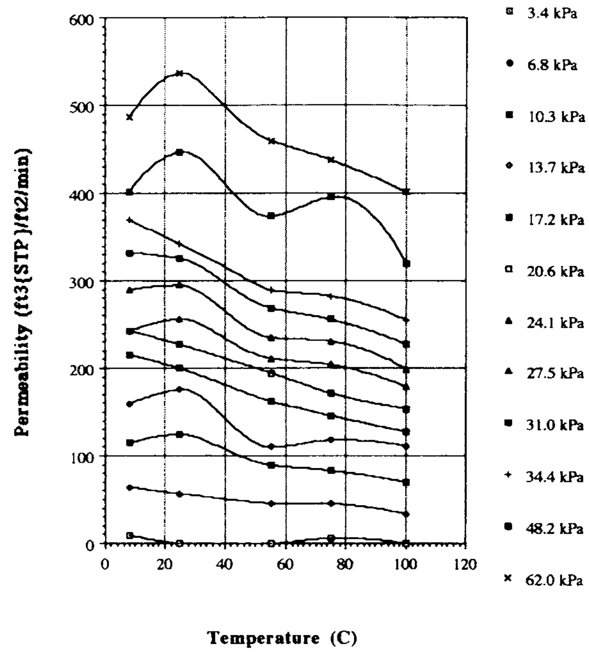

Figure 2 Permeability isobars for the 420D nylon 6 fabric (49 × 49) in the low-pressure-drop experiments.

6,6 fabrics was reported to be in the temperature range of 50 to 75°C.[12] Increases in temperature above this transition region of the nylon 6 fabrics resulted in a steady decline in permeability. This behavior is due to the synergetic effect of temperature and pressure on transforming fiber bundles from a circular to an elliptical configuration and thereby reducing the porosity of the fabric. On the contrary, the same behavior was noticed with temperature levels below room temperature and pressure drops above 34 kPa (5 psi) because of swelling of the fiber bundles that resulted in an increase in the cover factor of the fabric. Further, this behavior is aided by the hygroscopic and the biaxial extension nature of nylon fiber bundles.

The 630D nylon 6 fabric with 35 × 35 weave count behaved in a manner similar to a nylon 6,6 fabric with essentially the same construction.[13] In this fabric, a permeability peak was observed at the upper end of the transition region as shown in Figure 3. With further increases in temperature above the transition region, the permeability decreased as was reported for other fabrics.[14] At temperature below room temperature, the permeability decreased in a manner reported for the earlier 420D fabric.

The second 630D nylon 6 fabric with a 41 × 41 weave count behaved much like the higher denier fabrics used in passenger-side airbag applications, namely, the 840D nylon 6,6 series.[15] This nylon 6

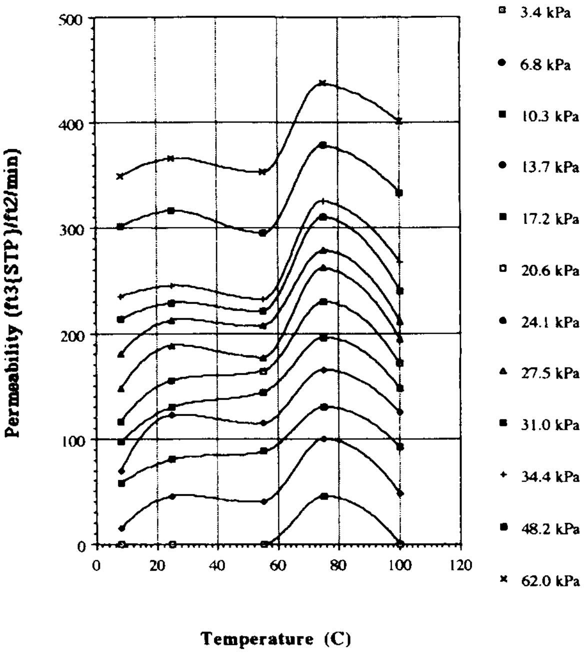

Figure 3 Permeability isobars for the 630D nylon 6 fabric (35 × 35) in the low-pressure-drop experiments.

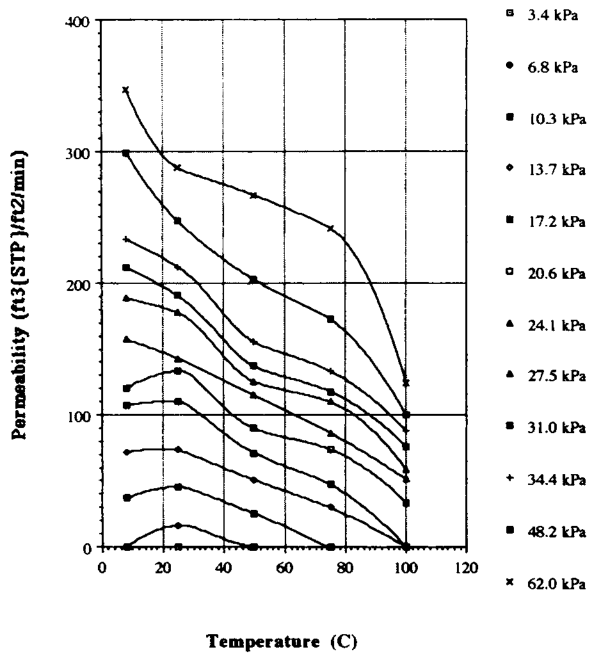

Figure 4 Permeability isobars for the 630D nylon 6 fabric (41 × 41) in the low-pressure-drop experiments.

fabric with a high weave count could be the ideal replacement for the higher weighing 840D fabrics. This fabric did not exhibit any noticeable permeability peak around the glass transition region as shown in Figure 4. Moreover, permeability decreased steadily with increases in temperature. Even though the biaxial extension of the nylon 6 fibers was more than that of the nylon 6,6 fibers, this 630D fabric exhibited an increase in permeability with decreases in temperature below room temperature.

High-pressure-drop Experiments

The 420D fabric, in the lower transition temperature region (50°C), displayed a steady decline in permeability. In the upper transition region, however, the fiber bundles appear to shrink with increases in temperature, and the biaxially stretched fabric exhibits an increase in porosity as shown in Figure 5. At both the extreme temperature levels, permeability decreased with temperature. This nylon 6 fabric exhibited a continuous change in slope of the permeability isobars. A much steeper decrease in permeability isobars was observed for temperatures above glass transition.

The 630D nylon 6 fabric with a 35 × 35 weave count behaved similar to the 420D fabric at high-pressure drops, exhibiting a change in slope from negative to positive at the lower transition temperature level of 50°C (Fig. 6). With a further increase in temperature above the glass transition 50–75°C, permeability increased. But above this transition region, permeability decreased at a steady rate.

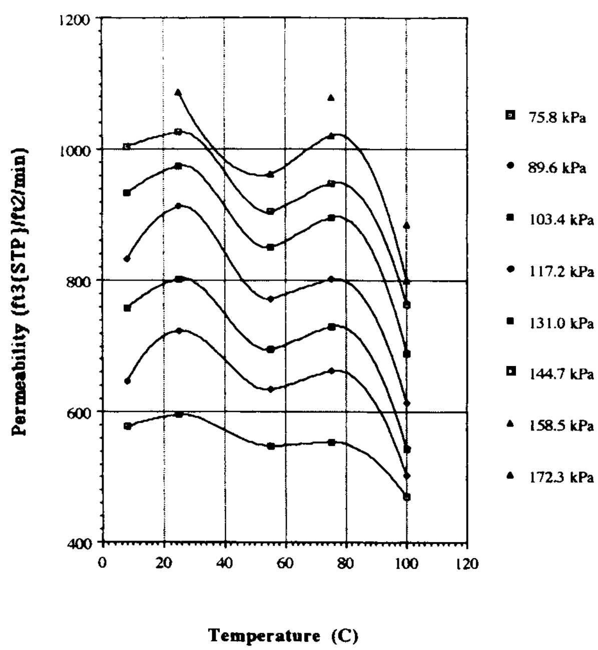

Figure 5 Permeability isobars for the 420D fabric (49 × 49) in the high-pressure-drop experiments.

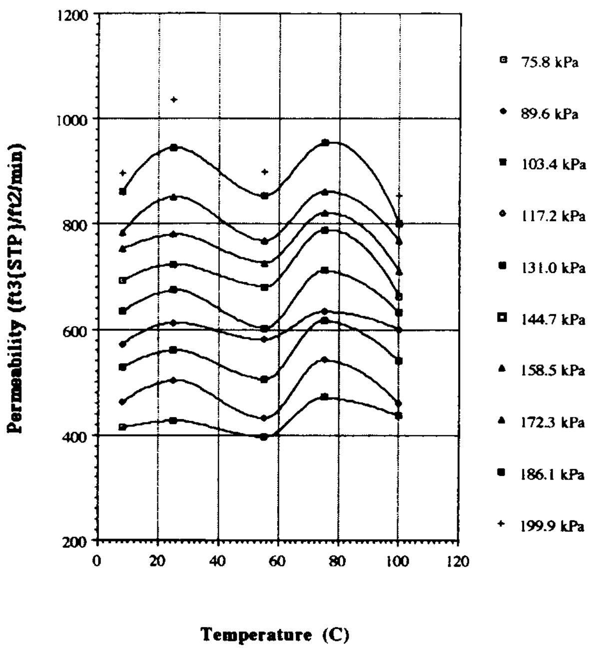

Figure 6 Permeability isobars for the 630D nylon 6 fabric (35 × 35) in the high-pressure-drop experiments.

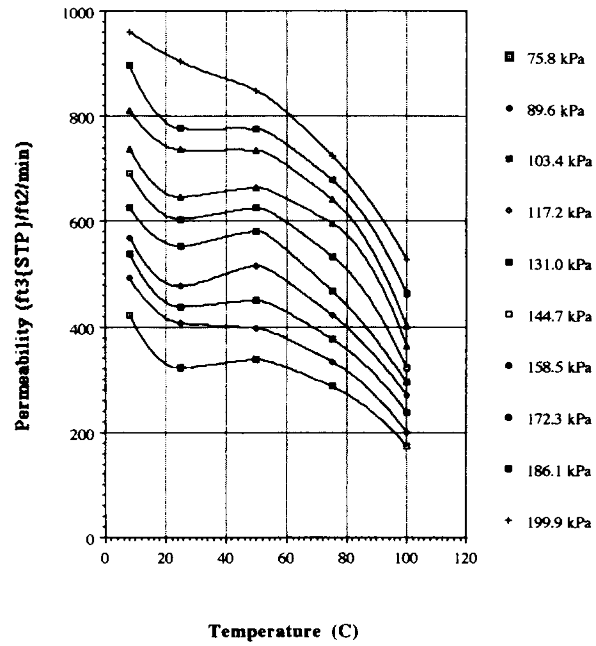

Figure 7 Permeability isobars for the 630D nylon 6 fabric (41 × 41) in the high-pressure drop experiments.

The second 630D nylon 6 fabric with a 41 × 41 weave exhibited a steady decline in permeability with increase in temperature from 8 to 100°C as shown in Figure 7. The overall permeability behavior at high-pressure drops was different from the low-pressure-drop experiments. In general, this fabric was less permeable than was the previous fabric of the same denier.

Comparison of Permeability Behavior of Nylon 6,6 and Nylon 6 Fabrics

The permeability behavior of a 420D nylon 6,6 fabric of similar construction to the earlier nylon 6 fabric is shown in Figure 8. Around the glass transition region, permeability increases with temperature for the nylon 6,6 fabric. But with a further increase in temperature above 75°C, a steady decline in permeability isobars was observed. In general, the nylon 6,6 fabric exhibited lower permeabilities when compared to the nylon 6 fabric. A significant difference in permeability performance at temperature below the ambient level was noticed. In general, the nylon 6,6 fiber is more crystalline than is the nylon 6 fiber. With the lowering of temperature below room temperature, the fiber bundles swell in diameter and the porosity of the fabric increases due to limited biaxial extension.

The 630D nylon 6,6 fabric with a 35 × 35 weave count (Fig. 9) behaved similar in comparison to the nylon 6 fabric of same weave count as shown in Figure 6. The performance of both fabrics around the glass transition region and at both extreme temper-

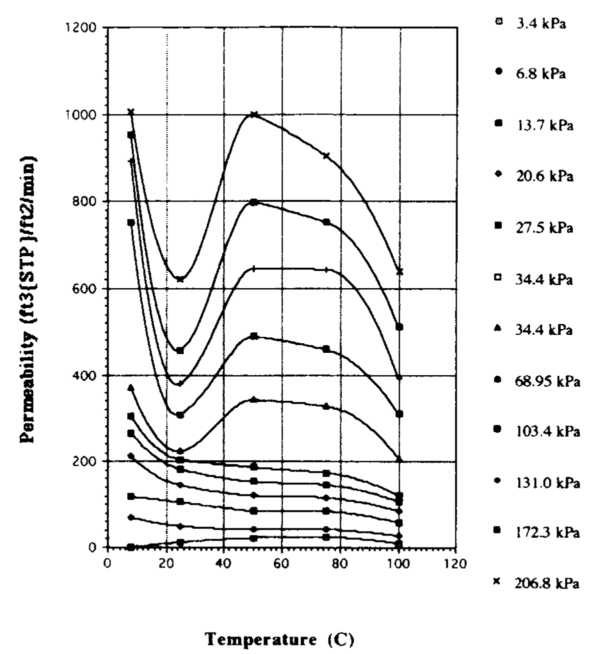

Figure 8 Permeability isobars for the 420D nylon 6,6 fabric (49 × 49).

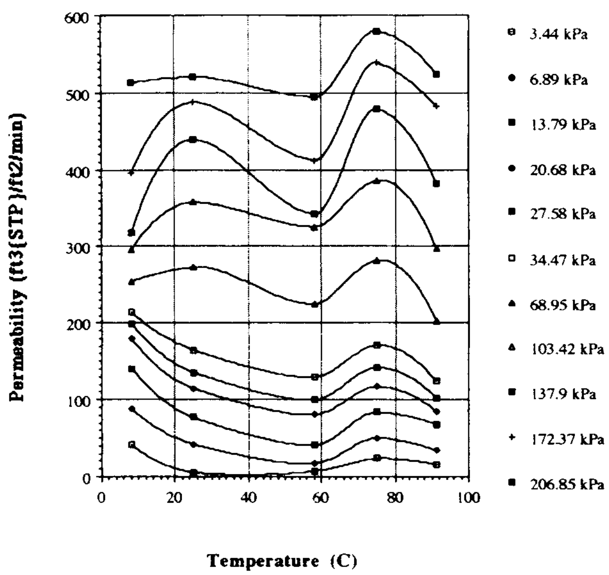

Figure 9 Permeability isobars for the 630D nylon 6,6 fabric (35 × 35).

ature levels are comparable. However, the nylon 6,6 fabric had a much lower permeability in comparison to its nylon 6 counterpart. This must be due to the basic difference in the biaxial extension properties of the nylon 6 fabrics.

The second 630D nylon 6,6 fabric with a 41 × 41 weave count also behaved in a manner similar to the nylon 6 fabric of the same weave count. At the higher-pressure-drop levels, the decrease in permeability with temperature from 8 to 100°C was around 350 ft^3/ft^2 {STP}/min (Fig. 10) compared to 450 ft3/ft2{STP}/min for the similar nylon 6 fabric in Figure 8. But the steep decline in the permeability of the fabric around the glass transition region was similar for both fabrics.

Biaxial Stress–Strain Behavior

Nylon 6 Fabrics

The biaxial stress–strain behavior exhibited by the nylon 6 fabrics during blister-inflation experiments is presented in this section. It is important to remember that in the blister-inflation tests the fabrics are not taken to rupture. As mentioned earlier, the blister approach is a quasi-steady-state measurement wherein a blister is maintained until the necessary experimental parameters are recorded. In this technique, therefore, the fabrics are more sensitive in the lower biaxial strain range, i.e., 2–8%. Biaxial stress–strain behavior at only room temperature should be sufficient from a modeling perspective[16–18]; however, because of the comparison objective in this article, the evaluations were carried out at selected temperature levels in order to correlate the observed permeability behavior.

The observed biaxial stress–strain behavior for the 420D nylon 6 fabric is shown in Figure 11 for selected temperature levels. In general, all the fabrics were observed to undergo some fiber realignment in the lower-pressure-drop range of 0–34 kPa (5 psi). The synergetic effect between the temperature and pressure drop is very complicated and is dependent on various fiber and fabric properties. An understanding of this is necessary in order to correlate the observed permeability behavior with the biaxial deformation process. The 420D nylon 6 fabric exhibited a much stiffer behavior at ambient and lower temperature levels. With an increase in temperature above room temperature, however, this fabric exhibited a much higher biaxial strain development for a given biaxial stress that was observed. This represents a decline in the modulus of the fabric. Such behavior can be correlated to the earlier reported permeability behavior around the glass transition region for this particular fabric.

For the 630D nylon 6 fabric with a 35 × 35 weave count, the biaxial stress–strain behavior was similar for the 8 and 50°C temperature levels for both the low- and high-pressure-drop experiments as depicted in Figure 12. The stiffness of the fabric at 75 and 100°C temperature levels is very similar at low-pressure-drop levels (0–62 kPa). But with an in-

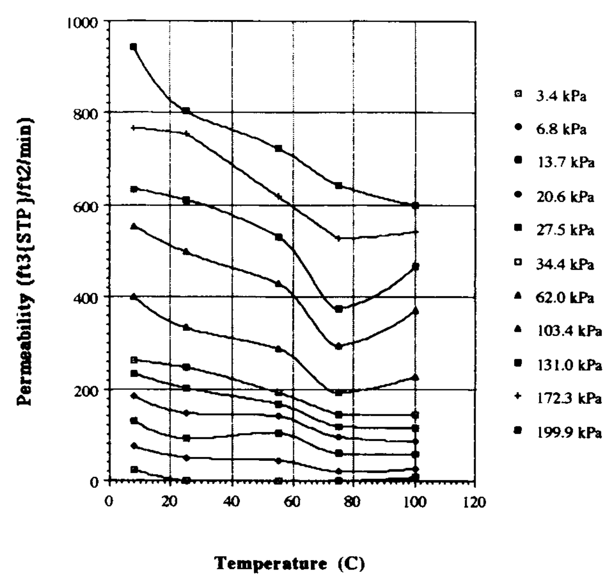

Figure 10 Permeability isobars for the 630D nylon 6,6 fabric (41 × 41).

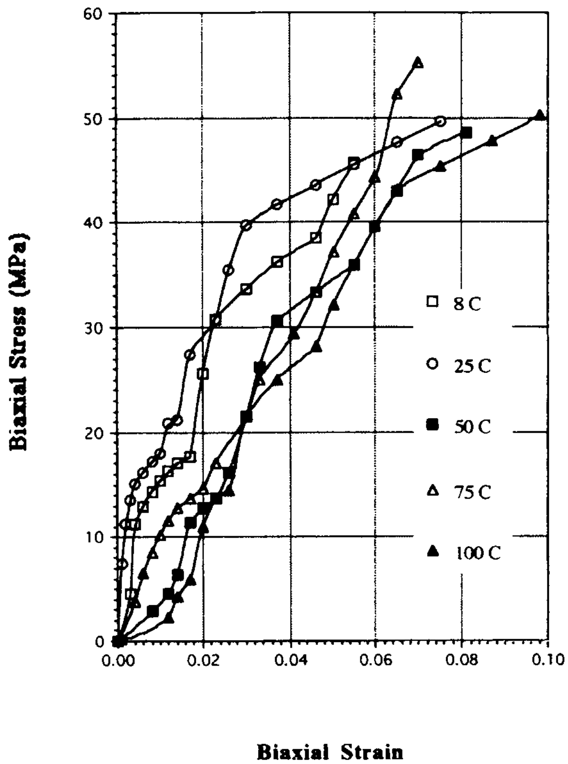

Figure 11 Biaxial stress–strain behavior at different temperature levels for a 420D nylon 6 fabric (49 × 49) in blister-inflation experiments.

crease in temperature to 100°C, the stiffness increases at a steady rate. This behavior for stiffness can be correlated with the earlier reported permeability behavior.

The second 630D nylon 6 fabric with a 41 × 41 weave count exhibited a steady increase in biaxial strain with an increase in temperature. This increase resulted in a considerable reduction in the stiffness (modulus) of the fabric, as shown in Figure 13. This correlates with the observed steady decrease in the experimental permeability isobars.

Comparison of Biaxial Stress–Strain Behavior of Nylon 6 and Nylon 6,6 Fabric

The biaxial performance of all the three nylon 6 fabrics with the nylon 6,6 fabrics are presented only at room temperature levels. A comparison of the 420D series fabrics woven from nylon 6 and from nylon 6,6 fiber are shown in Figure 14. In this figure, the biaxial performance of a 420D polyester fabric with a plain weave is also included to differentiate between the developed biaxial stress–strain fields between these three fibers. The polyester fabric exhibits a much higher modulus than do both nylons.[10] The biaxial stress–strain behavior graphed here is for a pressure-drop range of 0–200 kPa (0–30 psi). Among the nylons, fabrics woven from nylon 6 fibers exhibit a lower flexural modulus, and, hence, exhibit a much higher elongation or biaxial strain development for a given biaxial stress or differential pressure.[10] In fact, the flexural modulus for nylon 6,6 was found to more than twice that of nylon 6 fiber.[10] At a 199 kPa (30 psi) pressure differential, the biaxial extension of nylon 6,6 was 3.8% compared to 7.9% for nylon 6 fabrics of similar construction.

A similar comparison for the 630D nylons with a 35 × 35 weave count is shown in Figure 15. The biaxial modulus of both the nylons 6 and 6,6 fabrics were of similar magnitude until a pressure drop of 34 kPa (5 psi). But with a further increase in differential pressure above 34 kPa, the stiffness of the nylon 6 fabric decreases at a steady rate. In contrast, the nylon 6,6 fabric exhibited a steady increase in fabric stiffness. At 199 kPa (30 psi), the observed biaxial extension of the nylon 6,6 fabric was 7.5% compared to 14% for the nylon 6 fabric. Also, the

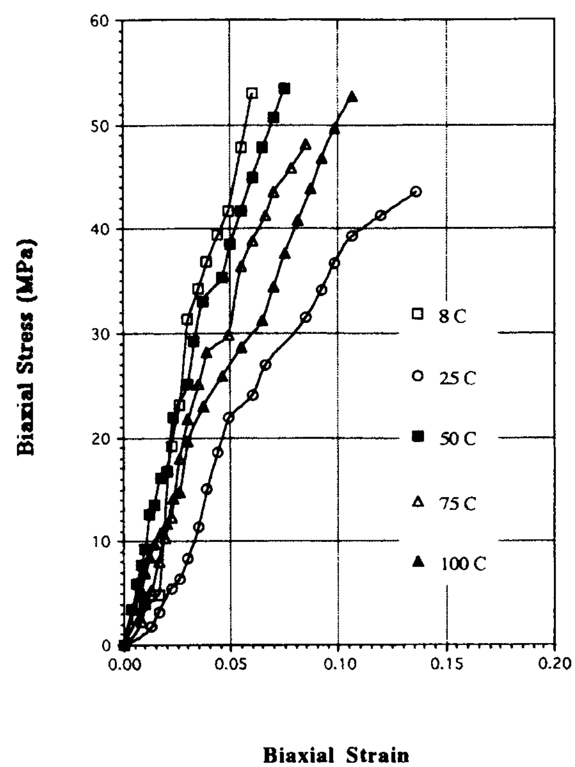

Figure 12 Biaxial stress–strain behavior at different temperature levels for a 630D nylon 6 fabric (35 × 35) in blister-inflation experiments.

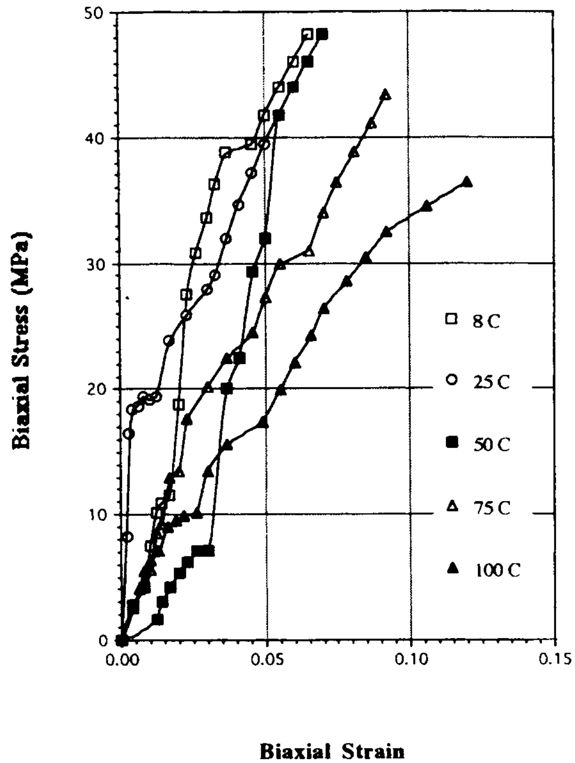

Figure 13 Biaxial stress–strain behavior at different temperature levels for a 630D nylon fabric (41 × 41) in blister-inflation experiments.

biaxial stress fields developed for a given differential pressure drop were approximately twice those of the nylon 6,6 fabric.

The 630D nylons with a 41 × 41 weave count exhibited (Fig. 16) a similar biaxial behavior in the low pressure drop experiments (0–34 kPa) as did the earlier 630D fabric in Figure 15. This initial biaxial phenomenon is probably controlled by fiber realignments in both the fabrics if they are to behave in a similar manner. But with increases in pressure across the fabric, the stiffness of the nylon 6,6 fabric increases at a steady rate for a given incremental pressure drop change, while the nylon 6 fabric does not.

Ball Burst Experiments: A Comparison Between Nylon 6 and Nylon 6,6 Fabrics

A ball-burst rupture is a rapid test compared to the blister-inflation experiments, and also, the fabric is taken to failure in the ball-burst test. In our study, ball-burst experiments were carried out in an Instron tester. Hence, equilibrium conditions are not approached with the ball-burst test. As a result, a comparison of the biaxial data generated by ball-burst and blister-inflation techniques are not necessarily expected to be congruent even over the pressure–temperature range for which they overlap.

The performance of both nylons under ball-burst experiments provided a more realistic view of the strength of the fabric under biaxial conditions. Comparisons of the rupture tensile strength of the fabrics under uniaxial conditions is usually unnecessary in the airbag applications, since the fabric failure does not occur during airbag deployment. Moreover, the performance of both the nylons under uniaxial conditions are similar. A similar comparison of different nylon 6,6 and polyester fabrics was given in our earlier publications.[10] In this study, ball-burst experiments were conducted only at two crosshead rates: 0.5 and 50 in. min. In general, during initial fiber realignment, with an increase in strain rate, the biaxial stress experienced by the fabric decreases with a corresponding increase in the biaxial strain.

The biaxial stress–strain behavior of the 420 nylons with a 49 × 49 construction in a ball-burst experiment is shown in Figure 17. At the high strain rate, there was no detectable difference in perfor-

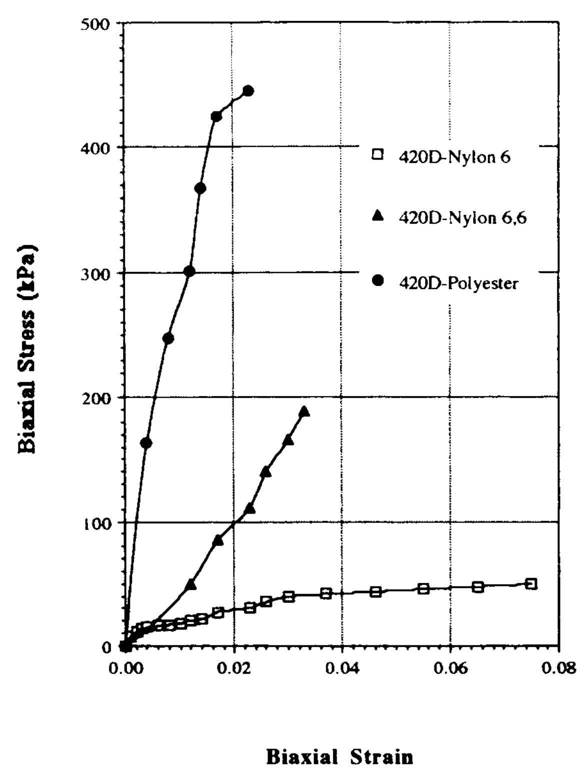

Figure 14 Comparison of biaxial stress–strain behavior at room temperature for 420D nylons and polyesters (49 × 49).

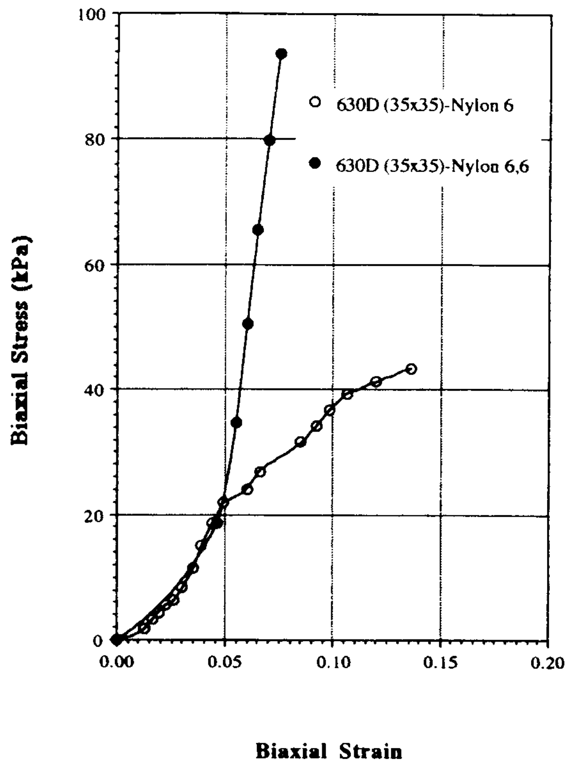

Figure 15 Comparison of biaxial stress–strain behavior at room temperature for 630D nylons (35 × 35).

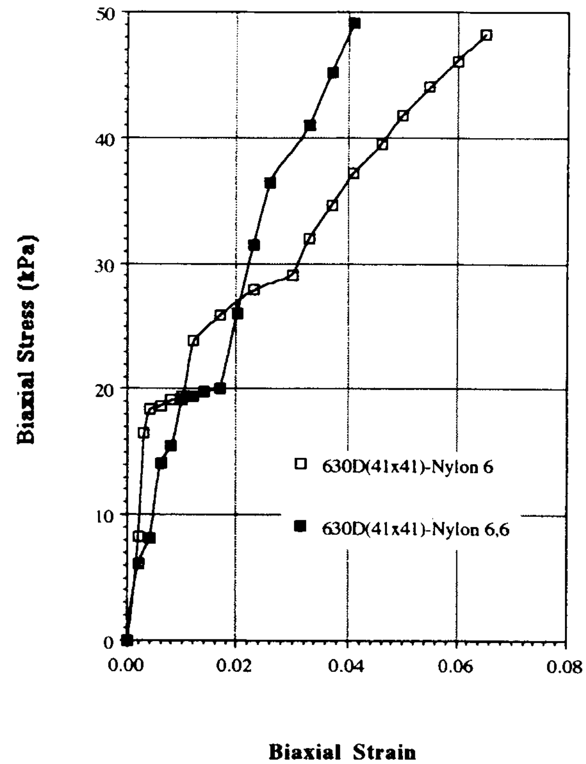

Figure 16 Comparison of biaxial stress–strain behavior at room temperature for 630D nylons (41 × 41).

mance between the two nylons. It is important to note that the rupture or breaking strength is similar for both nylons at this strain rate. However, with decrease in strain rate to 0.5 in. min, the nylon 6,6 fabric exhibits a much higher biaxial stress field (+25%) for a given biaxial strain. This phenomenon also resulted in a higher breaking strength for this nylon 6,6 fabric compared to the nylon 6. In contrast, the nylon 6 fabric exhibits a higher biaxial extension which would appear to offer an advantage in airbag application of the fabric in that it has time to respond. The performance of the 630D fabrics at different strain rates were very similar as shown in Figures 18 and 19. In this series, the nylon 6,6 fabrics exhibited a higher extension at higher strain rates.

Abrasion Resistance: A Comparison Between Nylon 6 and Nylon 6,6 Fabrics

The abrasion resistance of the nylon fabrics were evaluated based on the ASTM-D3886-92 method. A multidirectional abrasion resistance method with a load of 1 lb was used. These tests were performed in a Stoll flat abrasion tester. The results from this tests are shown in Figure 20. The comparison of both nylons are shown in this graph with respect to the number of cycles of failure. As seen in this figure, the abrasion resistance of both the 420D and 630D

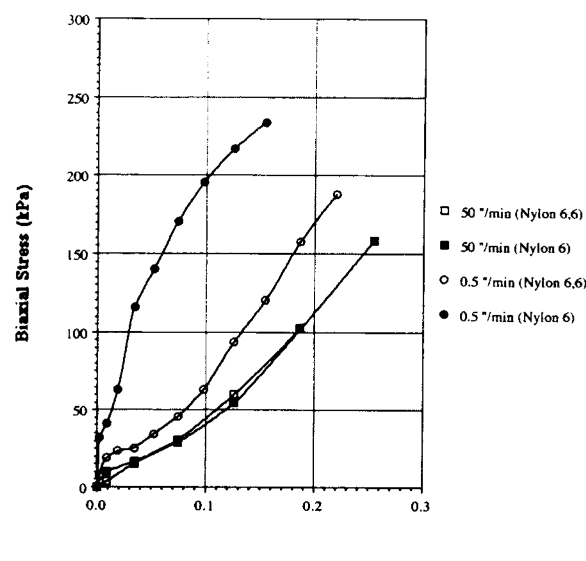

Figure 17 Comparison of biaxial stress–strain behavior of 420D nylons (49 × 49) in ball-burst experiments.

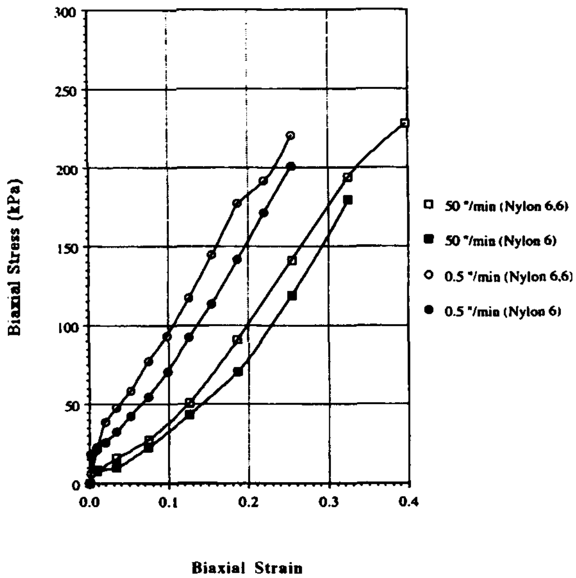

Figure 18 Comparison of biaxial stress–strain behavior of 630D nylons (35 × 35) in ball-burst experiments.

(35 × 35) fabrics woven from nylon 6,6 fiber exhibits a higher abrasion resistance. This indicates that the nylon 6 fabric is much softer than is the nylon 6,6 fabric. However, this conclusion should not be generalized because with a higher construction, i.e., 41 × 41, the 630D fabrics exhibited a similar magnitude of abrasion resistance and a softness difference between the two nylons could not be differentiated.

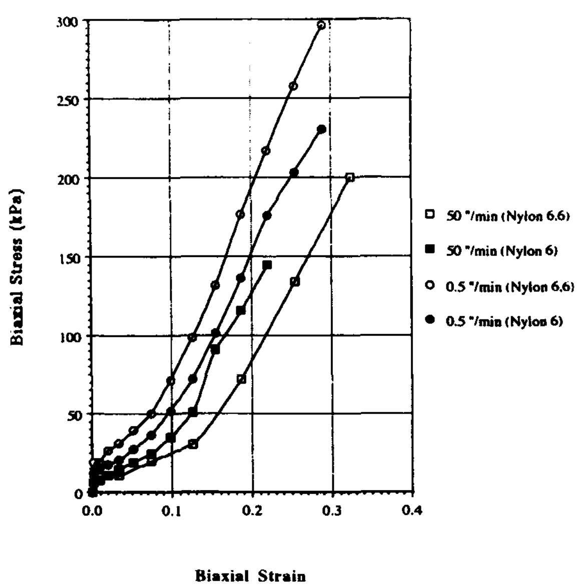

Figure 19 Comparison of biaxial stress–strain behavior of 630D nylons (41 × 41) in ball-burst experiments.

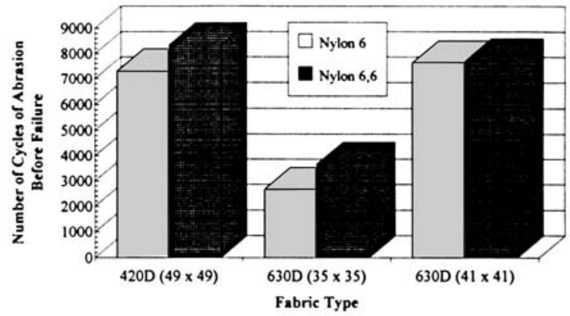

Figure 20 Comparison of abrasion resistance of nylons.

CONCLUSIONS

The performances of nylon 6,6 and nylon 6 fabrics often have been compared within the global bias as it pertains to their use as reinforcement cords in automobile tire applications. In this article, a similar comparison is drawn between those nylons in the airbag applications. In our study, the performance of both types of nylons were evaluated based on their permeability, biaxial stress–strain, breaking strength, abrasion resistance, and softness of the woven fabric. Then, various comparisons between the two nylons were addressed from the point of view of a passive restraint application.

The fabrics woven from nylon 6 fibers, in general, exhibited higher permeabilities and greater biaxial flexibility in comparison to the nylon 6,6 fabrics. These differences could afford an advantage for the nylon 6 in the airbag applications. However, the conclusions drawn in this article should not be extrapolated to the airbag module without considering the complete dynamics of the airbag deployment.

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