

Are There Real Differences Between Type 6 and 6,6 Nylons?

By Carey Mitchell

Nylon can be synthesized in several ways, each beginning with different precursors and ending with different end products, such as nylon 6; nylon 6,6; nylon 11, nylon 6,10; nylon 6-T (Nomex®); with carpet we are concerned only with types 6 and 6.6. The numeral in the type designation indicates the number of carbon atoms in the raw materials. Type 6 begins with caprolactam, which contains 6 carbons, and 6,6 with hexamethylene diamine and adipic acid. There is no technical basis for the belief that more carbon atoms impart better properties as continuous chains are formed. The result is a polymer that can be heat set to retain twist, and contains "dye sites," or amine groups along the polymer chain. These groups are capable of forming strong chemical bonds with dyestuffs, giving excellent colorfastness characteristics. Like other synthetic fibers, abrasion resistance is high. Type 6 has a slightly more open molecular structure, which allows dyestuffs to penetrate more easily.

While some small differences do exist between the two fibers, these must be examined in terms of whether they are practical differences. Tensile strength, for instance, is a very important consideration in rope, but is irrelevant with carpet because high tensile strength is unimportant; in fact, if it is too high, pilling occurs on loop pile carpets because any fuzzing of the pile surface will not break away. On the other hand, a nice marketing story can be woven around small differences in tensile strength.

It is important to understand that differences can be evaluated objectively only

when the samples are produced identically, from yarn processing onward through manufacturing. Otherwise process differences have been shown to exert greater influences on various properties than fiber differences. Several examples of this phenomenon are given below.

SOILING

There is a common misconception that T-6 nylon soils faster than T-6,6 because T-6 has more dye sites. This is based somewhat on the erroneous assumption that dye sites are holes or "pits" in the fiber surface where dye particles lodge themselves, and that soil particles immediately jump in also. Viewing the surface of both types through a microscope shows both to have perfectly smooth surfaces and neither can be distinguished from the other. More importantly, the number of "dye sites," technically known as amine groups, are not peculiar to either type, but are controlled during polymerization to achieve a specific purpose, i.e., some T-6,6 has far more amine groups than T-6! An amine group or "dye site" is simply a chemically active point on the polymer chain where a dye molecule attaches—the important point is that these are inside the fiber, not on the surface, and dye molecules must migrate into the fiber in order to attach.

This myth has been further fueled by a two-decade-old tale about DuPont's square cross section contract carpet fiber, where supposedly the "V" between the lobes of trilobal fibers hold soil more than the square cross section of Antron® fiber. If this were true, DuPont would certainly not market

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square cross section fiber for loop pile carpets and trilobal cross section fiber for cut piles! Conversely, another tale that made the rounds in the marketplace years ago suggested that DuPont's and BASF's contract fibers with holes running lengthwise were produced that way to enable blowing air into the fiber to make it cheaper to produce! The purpose of cross section modification and hollow cores is to impart light diffusion and physical properties.

Carefully controlled tests, where all processes and construction parameters were identical, have demonstrated clearly that fiber type has no impact on soiling rate. The rate at which a carpet soils is determined by many factors, such as residual fiber finish, topical antisoil treatments, on-location treatments, cleaning residues, etc. Today's soil resistant treatments are applied on both types more uniformly and perform better than in previous years.

STAINING

The majority of "stains" involved in complaints turn out to be soiling of some sort. An excellent example is a spill of soft drink or coffee with sugar, where the sugar becomes sticky and turns into a very effective shoe cleaner. The resultant area shows the classic explosion pattern and is often mistaken for a stain, but it can be easily and quickly removed using plain water.

Permanent staining, on the other hand, occurs when a colored material **penetrates into the fiber** and cannot be removed. The best example of this is beverages colored with red food coloring—the food and beverage industry knows this as FD&C Red Dye #40 (Food, Drug and Cosmetic). The carpet industry knows this material as Acid Red 40 because it is used to dye carpet. Not surprising that it is difficult to remove.

Comparative testing of samples processed identically with stain resist shows

no difference in stain resistance between the two nylons. While small differences exist between the fibers not treated with stain resist, the gap is smaller than the differences between the same fiber heat set by different systems, thus another example of process differences exerting greater influence than fiber differences.

APPEARANCE RETENTION

Appearance retention, or "wear," can be assessed in many ways, but the only reliable method is to have real people walk on carpet samples under controlled conditions. When identical samples of each fiber type are constructed, dyed and finished under identical conditions, from yarn formation forward, no difference is detected when tested simultaneously. In many cases where differences have been alleged, the samples were selected from inventory, with no knowledge of processing or controls—it is impossible to make valid determinations under such circumstances.

Various attributes have been cited as being important to carpet appearance retention such as fiber hardness, the complexity of the polymer molecule (number of carbon atoms), resilience, etc. The truth again is that, even if these differences did exist, design and process differences would overshadow them to the point that they would not be discernible.

The hardness issue has been debated for many years; it might be a real issue if the debate were about fiber wearing away through abrasion rather than a change in the carpet appearance. The truth is that all synthetic fibers are sufficiently hard that they simply do not wear away, even under the heaviest traffic. Abrasive wear warranties have made this something of an issue, but since these warranties are obsolete in the marketplace, fiber hardness becomes

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an issue only in comparing synthetic fibers against wool.

Twist has always been the most important factor in appearance retention, followed by pile weight, density, fiber (polyester, nylon, polypropylene), pile height, gauge, stitch count, although the relative order of importance changes depending on construction. It has not been possible within this list to find differences between nylon types, indicating that it is an unimportant issue in the overall picture of carpet performance.

COLORFASTNESS

Colorfastness is not an all-encompassing term, but must be addressed in terms of a specific insult to the fiber dyestuff combination. Carpets are exposed to many indignities, including sunlight, water, detergents, atmospheric gasses, foot traffic, etc., and a carpet's resistance to any of these must be assessed separately; the challenge is to obtain the best balance of these properties.

During the '60s and early '70s, disperse dyes were commonly used in residential and commercial carpet. Type 6 nylon's more open molecular structure allows disperse dyes to move about more than type 6,6; the bottom line is that although there is a difference in colorfastness between the fibers, colorfastness suffers when disperse dyes are used with either fiber. The industry prudently moved away from disperse dyes in the mid- to late-'70s. Colorfastness against sunlight is the most obvious area of concern in that more carpets are exposed to sunlight than to other insults. When carpets produced identically using acid dyes are tested for colorfastness against light, the results are generally identical.

Colorfastness against atmospheric contaminant gasses is of significant concern in areas where humidity is very high year 'round. These gasses are ozone, all of the

oxides of nitrogen (NO_x) and sulfur dioxide. All are oxidizers and are capable of destroying dyestuffs. Ozone has been most often blamed for complaints; it is a very active form of oxygen, but only becomes problematic when humidity exceeds about 95-90% for long periods. Type 6 nylon has been considered more susceptible over the years. The reason for this goes back to the more open molecular structure, where dye molecules are in dynamic equilibrium and are thus capable of migrating to the fiber surface to replace those destroyed by oxidation. The advent of stain resist technology has rendered the difference moot, with comparably treated samples T-6 often outperforming T-6,6. The stain resist prevents this mobility by penetrating the fiber and blocking movement; because it penetrates more easily and deeper into T-6 (stain resist chemicals reside just under the surface of the fiber), it is more effective—this was an unexpected benefit of the treatment.

Colorfastness against water, whether detergent or flooding, is largely determined by dyestuff selection rather than fiber type. Some dyestuffs are capable of producing limited depths of color; when this limit is exceeded in an attempt to make darker shades, bleeding often occurs. This is remedied by switching to a dyestuff that can produce darker shades without overloading the fiber.

All of the above comments apply to dyed carpets; those colored by pigments (solution dyed) are generally immune to these problems.

CONCLUSIONS

Some minor differences exist between the two types of nylon. When examined critically in the perspective of overall carpet performance, it becomes very apparent that these differences are of no conse-

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quence in real world terms. Carpet performance hinges on many factors of varying importance, but nylon type differences are so far overshadowed by the others that they are near the bottom of the list. Carpet purchasers should be keenly aware that marketing stories can be woven to "prove"

anything and that the issues must be considered objectively and in perspective.

(Carey Mitchell is Director of Technical Services at Shaw Industries, Dalton, Georgia.)

(The Digest solicits and appreciates submissions from technical people in the carpet industry.)
