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Technical Article

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Belt Fabrics 101

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Reinforcing Materials for Belting

The structure of belting is basically a composition of elastomers and reinforcing materials. The most common forms of reinforcements are either textiles or metal utilized as wire, cord, yarn, or fabric. The reinforcements fulfill four basic functions:

- Provide dimensional characteristic.
- Determine durability and strength characteristics.
- Act to disperse stress.
- Impart load carrying capacity.

In most cases, vulcanized elastomers by themselves would stretch or elongate to excess without the addition of the reinforcement materials. The belt designer can choose from a host of materials such as nylon, polyester, aramids, carbon, rayon, cotton, steel, and fiberglass; each one contributing different attributes. It is the designer's responsibility to fully understand the working conditions, environment, cost structure, and the parameters to which the belt will be subjected.

Nylon was the first truly synthetic fiber and was announced by the DuPont Company at the 1939 World's Fair. It was not a planned discovery, coming about by uniting small molecules to form giant molecules-polymers. Nylon is chemically a continuous filament aliphatic polyamide. Cyclohexane and ammonia are the basic raw materials. The spinning operation consists of extruding the molten polymer through a stainless steel spinneret to form filaments. The filaments are coated, finish applied, and drawn approximately 500 percent. Drawing orients the molecules and regulates the crystallinity. This amide link provides good adhesion, excellent strength, chemical resistance and high elongation. This high elongation can be reduced through a process known as heat setting. Heat setting is a factory process in which the fabric is baked or steamed under tension and kept that way until it cools. After cooling, the fabric will be stable to any heat lower than that of which it was set. Nylon is also very resistant to both mildew and mold.

Polyester, like nylon, is derived from oil. Unlike nylon, the molecular structure contains aromatic groups that give polyester better dimensional stability, modulus, resistance to sunlight, dry heat, and acid. This structure, however, hurts the adhesion of the polyester to the elastomer and adhesion promoters should be used. Polyester has high strength, resistance to fungus, and is not affected by moisture.

Aramids are the newest reinforcements. Commonly referred to as Kevlar (DuPont) and Nomex (DuPont), they are 43 percent lighter than fiberglass, ten times as strong as aluminum, and approach the strength of high strength carbon on a tensile strength basis. Aramids have excellent stability over a wide range of temperatures for a prolonged period. They show essentially no embrittlement or strength loss at temperatures as low as -320ºF and will not melt or support combustion.

Chemically, aramids are a polymerization product of a terephthalic acid and p-phenylamine (aromatic polyamide). This chemical link results in a fiber with extremely high modulus, dimensional stability, high strength, and excellent resistance to heat and humidity. It does, however, have a vulnerability to shear fatigue, ultraviolet light, and its compressive properties are weak.

Carbon fiber, sometimes called graphite fiber, is one of the strongest and stiffest, reinforcements available. When properly engineered, carbon fiber can achieve the strength and stiffness of metals at significant weight savings. Carbon fibers, in addition, are thermally and electrically conductive, have very low thermal expansion coefficients, and demonstrate excellent fatigue resistance. The impact resistance, however, is less than most other reinforcing material.

Rayon is a by-product of cellulose (wood pulp). Rayon loses its strength when it comes in contact with moisture and it is very susceptible to mildew attack. Rayon has been a belting reinforcement for many years. It has good resistance to most organic, carbonic, citric, and fatty acids; however, due to the availability of synthetics and rayon's low strength, along with environmental production concerns, its usage is diminishing rapidly.

Steel can be utilized as either an interwoven or as a braided wire. Steel cords yield high modulus characteristics and excellent strength. They come in a variety of shapes and weave configurations offering the belt designer more options for how and where it can be utilized. Steel is generally used for high-tension applications that exceed the practical limitations of textiles.

Fiberglass has been available since the 1940s and is still considered the most widely used all-purpose composite reinforcement. Fiberglass is derived from sand (silica) and clay. Other chemicals are added to a molten solution of these two raw materials and the fibers are gravity extruded to form the final yarn. It has excellent strength-to-weight ratio, extremely high modulus, impact resistance, toughness and service temperature. The inorganic glass fibers cannot burn and the high temperature resistance makes fiberglass fabrics outstanding for electrical insulating purposes. Its resistance to flexing, however, is poor!

Cotton is the only natural fiber that is used to any extent in belting. It is highly resistant to organic solvents and heat, but susceptible to mildew attack. Its elongation and strength are low and it has an affinity to water. Cotton fabrics lend themselves to excellent adhesions and produce a thick bulk at reasonable cost.

Look for Part 2 of this article in the June issue: ***Classifying Fabric Yarns and Cord Sizes; Weave Styles***