

Johnson Filaments— making monofilaments for machine clothing

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Although simple nylon and polyester monofilaments once adequately served to form machine clothing, advanced blended filaments now meet the needs of modern papermaking equipment.

History is often said to be the gateway to the future. From its beginning as an offshoot of JWI, Johnson Filaments has focused on improving papermaking by developing innovative products and techniques. On entering the monofilament business in 1972, the division's intent was to replace the stainless steel, brass, and bronze wire then used in the papermaking process. More precisely, JWI saw a need for monofilaments that could satisfy its exacting quality and tolerance requirements.

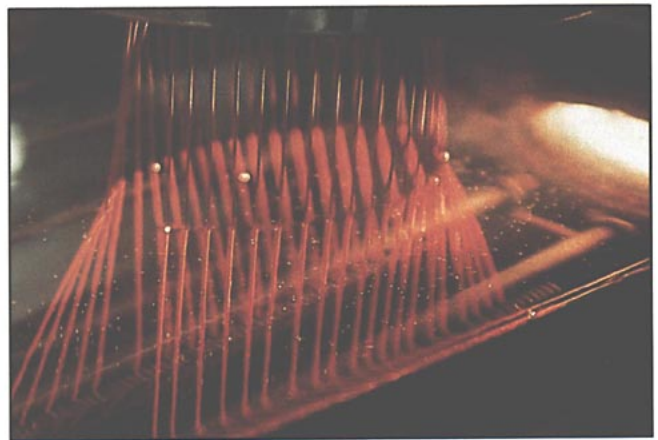
Johnson Filaments' original facility in Montreal, PQ, Canada, still supplies the Canadian market and some specialty items in North America and abroad. Its facility in Williston, VT, opened in 1975 to address the expanding monofilament market. Williston was the first North American monofilaments manufacturer to receive ISO certification. It gained ISO 9002 certification in July 1992. The Montreal facility earned ISO 9002 certification in March 1994. Both are working toward ISO 9001 certification.

Basic monofilaments (also referred to as filaments) can be found in many common items, but they are crude cousins to the advanced filaments Johnson Filaments produces for making paper machine clothing. Johnson's customers, machine clothing manufacturers, weave the various filaments into material for specific applications such as forming fabric, felt press, and dryer fabric for modern paper machines.

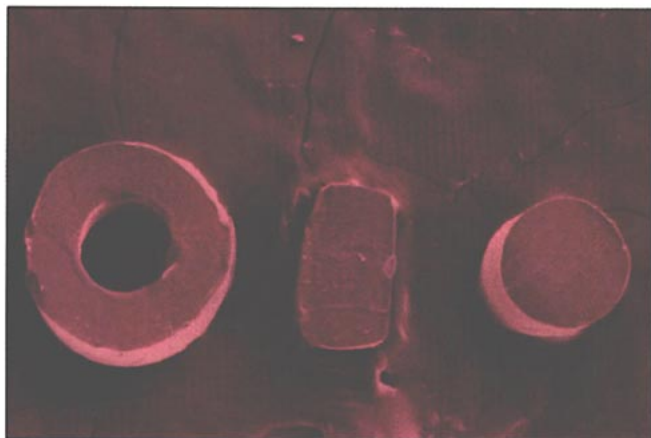
Filaments are formed by melting various resins, or polymers (Fig. 1), in a screw-type extruder. The polymer melt is then squeezed through a spinneret to give it the desired shape (Fig. 2). Depending on the application, the filament may be rectangular, round, or hollow (Fig. 3). A series of draw and relax stages to orient the filament complete the manufacturing process.



1. Polymers start out as pellets.



2. Formed fibers pass through a wash.



3. Monofilament cross-sections



4. Part of Johnson Filaments' production line

Many of Johnson Filaments' monofilament lines feature state-of-the-art technology (Fig. 4). The company expects to extend the technology to its other lines because of its favorable experience and because it fosters product quality and consistency, freeing technicians and operators from certain mundane tasks and giving them more information about the production process.

Much effort goes into engineering the extruder screws; the design is usually completed in-house, while the machining is often done by an outside supplier. Successful screw design is a mixture of experience and cut-and-try evaluations. Because each resin has different thermal properties, each screw must be optimized for a given application.

Machine clothing filaments are generally made from pure polymers such as polyester, nylon, polyphenylene sulfide, and polyether ether ketone. However, as paper machines demanded more fabric performance, it became increasingly difficult to economically use single-resin filaments. As a result, most advanced filaments are now blends, or alloys, of several different polymers. Although a blend is usually more expensive than an equivalent pure polymer, blending can improve fabric performance by increasing abrasion resistance, for example.

A filament designed for paper machine use has specific material characteristics, depending on whether it will be woven into a forming fabric, a press felt, or a dryer fabric. The forming fabric demands a filament material with a wide range of size and crimp characteristics. Crimp defines how well the strand can be formed into the weave pattern, ultimately affecting the stability of the clothing (Fig. 5). The forming fabric is often a "blend of blends." Modern forming fabrics are often woven using alternating strands of polyester and nylon blends to attain the necessary performance of resisting stretch, wear, and stickie accumulation.

Johnson Filaments developed a high-performance polymer alloy that is wear resistant, giving forming fabrics longer life than either nylon or polyester. The monofilament is well-suited to recycling applications. It is resistant to muriatic acid, caustic cleaning solutions used in boil-outs, and bleaching agents such as hydrogen peroxide.

Press felts are normally made from various types of nylon, largely because of its resistance to the high pressures of compaction and wear (Fig. 6). Unfortunately, that unique resistance to compaction is accompanied by a tendency to pick up moisture. There are continuing efforts to develop nylon products which combine the best compaction resistance with the least moisture pickup.

In the dryer section, hydrolysis is a major concern, and dryer fabrics tend to wear more on the edges where there is little sheet moisture. Furthermore, good contact with the paper surface is important for best heat transfer and to minimize energy usage. To best serve this section, filaments are generally flat (actually rectangular with a low height-to-width ratio). While earlier-generation dryer fabrics often suffered from poor dimensional stability, flat-strand-filament fabrics have overcome this deficiency. Johnson also developed an additive which it blends through the monofilament to modify the molecular chain. That modifies the strand surface energy for this application to prevent wetting and stickie formation. Here again it is the polymer alloying that provides the main defense to stickie formation.

Johnson Filaments maintains a precise "recipe book" that clearly specifies the ingredients used in each filament and the equipment and equipment parameters that dictate how the filament is to be manufactured. While this documentation helped them gain ISO 9002 certification, it is also paramount to an orderly manufacturing environment. Despite the high degree of documentation, however, fiber characteristics can be highly machine-dependent. A formula that works on one machine may need to be adjusted to produce filaments with the same prescribed qualities. Fibers are regularly tested to make sure they conform to quality and design specifications (Fig. 7).

In engineering new and improved filaments, company representatives meet with fabric designers and manufacturing and R&D personnel. Because dryer fabrics, for example, can last three years, long-term planning is essential. Johnson Filaments conducts regular meetings with its customers to determine their current needs as well as to discuss "next generation"



5. Crimping or monofilament indentation



6. Batt fibers in a press felt cross-section



7. Checking monofilament strength and characteristics

fabrics, which often take several years to develop and bring to the market.

Johnson Filaments faces several ongoing challenges to remain competitive. Paper machines are running ever faster and becoming wider, drainage zones are faster and shorter than in previous units, and higher dryer temperatures are commonplace. Furthermore, a change from 4- or 5-shed single-layer fabrics to multiple sheds and layers induces stresses that previous pure-polymer filaments cannot withstand. For example, fine paper production now requires very fine fabrics. Whereas a 4-shed 85 x 50 mesh was acceptable 20 years ago, certain fine papers now require multiple-layer fabrics at 180 x 150 mesh. To maintain proper drainage, strand diameter is often reduced, making diameter control more critical. New processes, such as alkaline papermaking, also demand improved filament properties.

When asked about future trends in its products, technical staff in Williston acknowledged that pure-polymer filament grades have been mostly pushed to their performance limits. However, considerable advances are expected by researching new resin blends and additives. As paper grades become lighter, fabrics are becoming lighter and monofilaments are becoming

smaller. Newsprint is now lighter and, in some cases, printing processes have changed. Furthermore, because machine clothing pricing is stable or decreasing due to competition, the company is aware that the more exotic filament blends must also be cost-competitive.

Although Johnson Filaments only uses virgin material to manufacture forming fabrics, the company is very active in recycling its products as well as the filament spools and shipping containers. Johnson makes every attempt to keep scrap out of the waste stream, i.e., landfills. In some cases, scrap product is sold for paint brush or broom bristles, for example. At other times, the scrap is chemically broken down into monomers that are used to make resin. When certain scrap becomes nonrecyclable, it may be incinerated. Another way to recover nonrecyclables is to break them down to obtain synthetic crude oil via pyrolysis; fuel oil is then a byproduct of the crude.

Like many industries, the filament business is somewhat of a closed community. Although trade secrets are closely guarded for as long as possible, it is clear that filament design will continue to advance, meeting the ever-advancing demands of machine clothing manufacturers and ultimately the papermaking industry as a whole. **■**

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