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New Polypropylene Media
for
String-Wound Filter Cartridges

By Hamid Omar

String-wound cartridges are among the most commonly used filtration media for reducing sediments and other suspended impurities in liquids and water. Traditionally these cartridges are made from 'roving' or 'friction-spun' yarn and factors such as media migration and chemical leaching were among the major drawbacks. With a new innovative development in the polypropylene filter media for making string-wound cartridges, problems such as media migration and chemical leaching have been eliminated. Additionally new winding technology combined with the random structure of the new media has further improved the cartridge's effectiveness.

String-wound depth filter cartridges first came on the market in the mid-1930s. These were made from a cotton string media with a metal core. By the early 1980s cartridges made of polypropylene media and core had become popular due to their inertness and wide range of chemical resistance. These cartridges were wound using a polypropylene roving. Roving is a twisted strand of fibers – an intermediate product stage of standard textile yarn forming process. In the later years friction-spun yarns largely replaced roving. Compared to roving, these yarns had relatively higher dirt holding capacity and reduced resistance to flow.

Media Migration – a major problem with cartridges made from roving or friction-spun media

Both roving and friction-spun media comprise short fibers, usually about 2 to 3 inches in length. Loose fiber ends protruding from the surface of such yarns can be seen clearly in Figure 1.

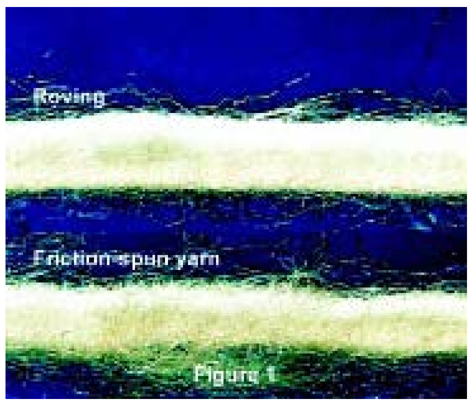


Figure 1

Some of the fibers get broken into even shorter lengths as they pass through the various textile processes of bale opening, carding, drawing and spinning. Many of these short fibers on the yarn's surface are not properly or fully locked into the loosely twisted main body, resulting in media migration problem. Fibers on the surface tend to come loose with the flow of liquid and pressure surges in the system.


Figure 2

Chemical Leaching – another major problem with roving or friction-spun media

In the standard textile manufacturing process, by which polypropylene roving and friction-spun yarn media are made, a spin-finish has to be necessarily applied on the surface of the fibers. Spin-finish contains a number of chemicals like lubricants, surfactants, antioxidants, antistatic agents, emulsifiers, and bactericides, etc. Without the use of these chemicals polypropylene fibers cannot be made nor converted into yarns on the textile machines. The quantity of these chemicals can vary from about 0.5% to as much as 2% by weight of the cartridge media. Unless the media is prewashed, these chemicals start to leach out and can often be observed as foaming in the filtrate. The leaching out of these chemicals can be detrimental for the filtrate as well as the downstream treatments. These chemicals may also pose possible health problems when used for filtration of drinking water.

Unstable Structure and Inconsistent Results – these are the other draw backs of roving and friction-spun media

Filter cartridges made from these yarns, which are smooth and round in cross section, do not form a stable structure. See Figure 2. The yarns typically form a diamond pattern having gaps between adjacent yarns as well as between the layers. Under conditions of flow, rising differential pressure and pressure surges, these unstable round yarns shift, giving rise to particle unloading. In string-wound cartridges, different micron ratings are basically achieved by winding the yarn close together or with some gap. As the gap between the yarns is increased, the round yarns tend to roll or move to one side or the other. The liquid takes the least resistant path between the shifting yarn gaps rather than through the whole media, giving inconsistent results. Figure 3 is a (5 micron rated) closely wound cartridge made from friction-spun media. As shown, a paper clip can be made to easily pass through the media with little pressure and effort. If a paper clip can pass through the filter, any contaminants can, too. Pushing in the paper clip has shifted the yarns to a side, which shows the unstable nature of the media. Most filter housings use a 'knife-edge' sealing principle and unstable edges give a poor sealing and cause by-pass problems.

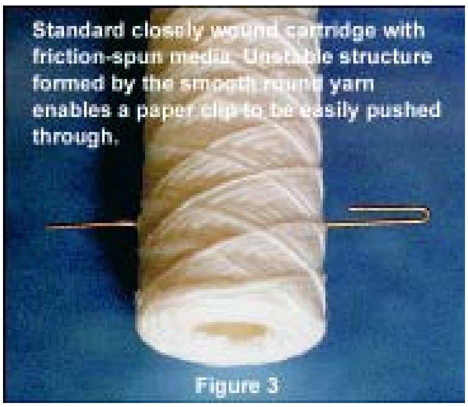


Figure 3

New Polypropylene Filter Media
The new development in the media for string-wound cartridges has overcome all the above shortcomings of roving and friction spun yarns. The new media comprises continuous filaments with a stable, random non-round structure. See Fig. 4.

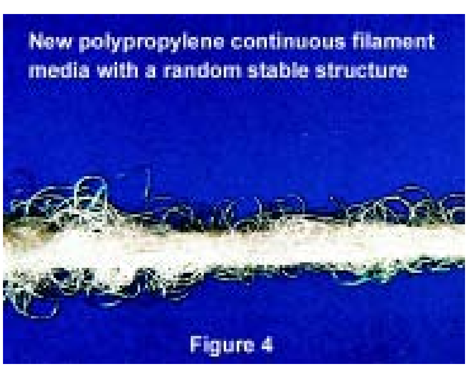


Figure 4

Each of the polypropylene filaments in the new media continues, without a break, throughout the length of the yarn, making the cartridge free from any media migration problems. There are no short fibers. The continuous filaments are melt-spun (extruded) by a newly developed method in which no spin-fish chemicals are used at all. These chemical-free continuous filaments are then, by use of air pressure, randomly oriented to each other, intermixed, looped and entwined into a non-round, highly stable, bulky yarn. Random short loops of the continuous filaments can be seen protruding from the core of the yarn.

As the cartridge is wound from this new yarn media, loops of one yarn trap a part of the loops of adjacent yarn. This results in a highly stable media structure wherein the yarns are prevented from shifting to a side. See Figure 5 for a filter cartridge made from the new improved yarn media. There are no typical diamond shaped open spaces and the yarn covers all the area. A paper clip cannot be made to pass through the depth of the new media. The liquid flows through the entire yarn structure. The stable structure also provides excellent knife-edge sealing.

Figure 5

Density Grading
In the traditional method, density grading is achieved by winding the inner layers tight (higher tension) and the outer layers loose (lower tension). But this makes the cartridge soft and prone to particle unloading. With advancements in winding technology, the pitch, number of crossings and space between each yarn can be continuously varied and controlled from start to finish of the cartridge winding. The inner layers near the core are wound close together and the gap between the yarns is then gradually increased towards the outer layers. This gives density grading without reducing the winding tension. Dirt holding capacity of a true graded density cartridge is increased as the coarser particles are trapped in the outer layers and the finer particles in the inner layers. By maintaining the same winding tension, the structure has the same firmness throughout the depth of the cartridge, giving more consistent performance and improved resistance to particle unloading.

High Solid to Void Ratio of New Media
The continuous filaments in the new media have a tri-lobal cross section which gives numerous small micro void spaces between each individual filament as opposed to the round cross section of standard media. Round cross section results in compact yarn with much reduced space between individual fibres. Tri-lobal cross section of filaments combined with the random structure of the new yarn gives much improved solid to void ratio. This improved porosity provides for higher dirt holding capacity and reduced resistance to flow.

Test Results
Figures 6, 7, 8 and 9 show the test results for a 5 micron nominal rated cartridge made from the new media. The dirt holding capacity, initial efficiency, final efficiency and the pressure drop ver-

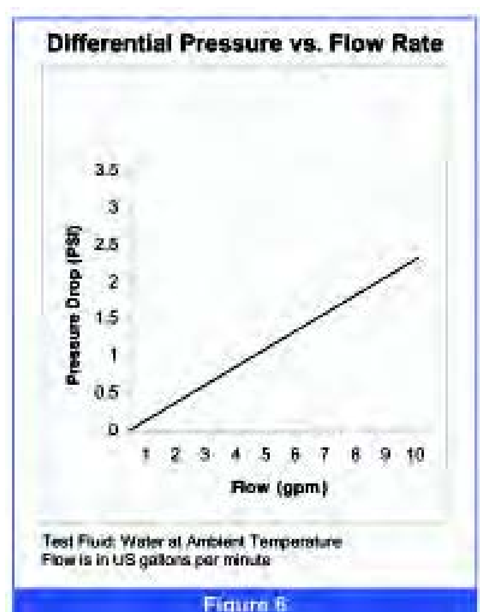


Figure 6

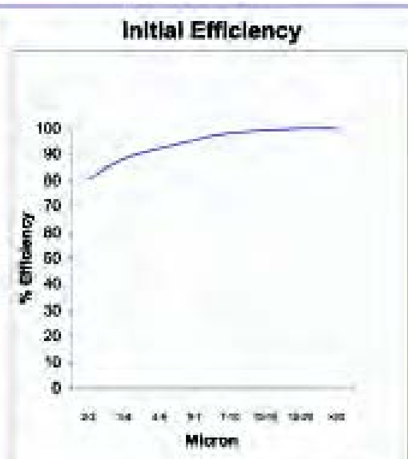
sus flow rate all compare very favorably with standard string wound cartridges. The test cartridge is of 10 inch nominal length and $2^1/_2$ inch diameter.

Dirt Holding Capacity

Differential Pressure PSID	Dust Injected Grams
0.5	0
1	7
1	14
1.5	20
1.5	27
1.5	54
2	68
2	75
3	81
4.5	88
11.5	95
17.5	102
21	108

Test Method: Efficiency and Capacity per ASTM F795-88
Instrumentation: LD 400 SN 95020054
Fluid: Water
Flow Rate: 3 gpm
Temperature: Ambient
Contaminant: ISO Fine Test Dust
Shut Off ΔP: 21 PSI

Figure 7



Test Method: Retention Efficiency and Capacity per ASTM F795
Instrumentation: LD 400 SN 95020054
Fluid: Water
Flow Rate: 3 gpm
Temperature: Ambient
Contaminant: ISO Fine Test Dust

Figure 8

Conclusion

New polypropylene media provides the string wound cartridge with the following advantages:

- Freedom from chemical leaching.
- Freedom from media migration.
- High permeability.
- Low pressure drop.
- High structural stability.
- Resistant to particle unloading.

Test Method: Retention Efficiency and Capacity per ASTM F795
Instrumentation: LD 400 SN 95020054
Fluid: Water
Flow Rate: 3 gpm
Temperature: Ambient
Contaminant: ISO Fine Test Dust
Shut Off ΔP: 21 PSI

Figure 9

- Excellent knife edge sealing.
- High dirt holding capacity.

Hamid Omar is the technical director of Syntech Fibres (Pvt) Ltd., of Karachi, Pakistan. The company has developed the new PP filter media for string wound cartridges and produces Sedifilt and Aqua Clear brand filter cartridges. Omar can be contacted at fax: +92 21 5060407 email: syntech@fascom.com or website: www.syntechfibres.com/cartridge