New Fouling Resistant Filter Media used in 3M™ High Flow and 740 Series Products

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Introduction

Filtration is a critical unit process of numerous industrial processes. Therefore, it is vital to ensure that filtration is optimized and performs as intended. Filters are used to remove solid contaminants from fluids. Size exclusion is a major particle removal mechanism for retaining particles larger than one micron. The particle size distribution in the effluent is controlled by the design of the filter media. Fibrous structures are very common, which create a labyrinth of pores that the fluid must pass through. The pore size distribution and tortuosity along with the particle size distribution have a great bearing if and where the particles are removed. The microstructure of a nonwoven filter media is shown in Figure 1.

Figure 1. - A typical non-woven filter micro-structure

There are numerous applications in which the contaminants are not just solid particles. There also exist organic deformable contaminants in the fluid that could have detrimental effects on the filtration process. These contaminants could be organisms, proteins, or cell debris generated by bacterial activities that are usually observed in aqueous systems. This is a well known and persistent problem with Reverse Osmosis (RO) membranes. The pre-filters that are used to protect the RO membranes are also vulnerable to bio-fouling that may lead to frequent change-outs.

There are also industrial processes that contain hydrocarbon contaminants with high molecular weight behaving similar to a viscous wax. These contaminants are captured by the adjacent fibers forming a film that causes the differential pressure to quickly increase across the filter media and result in frequent change-outs.

The growth of bacteria in aqueous systems and bio film formation is one of the major concerns of the process engineers. Study of fouled filters showed a thin and dense film layer that bridges across and over the fibers (Figure 2).

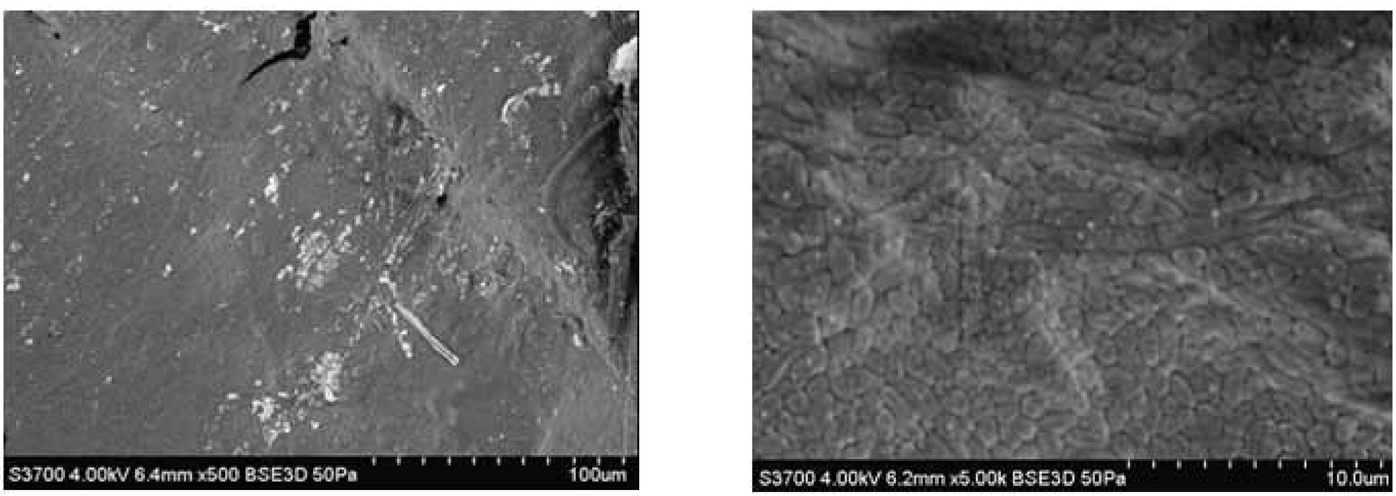
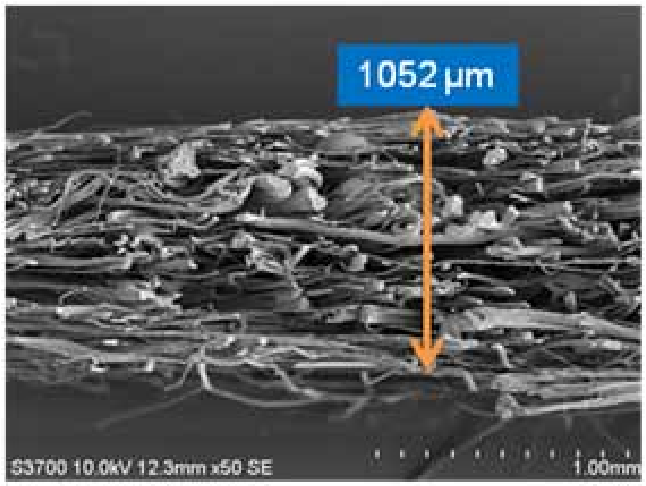


Figure 2. - Scanning electron micrographs of fouled filters.

There are several filter design parameters that have influence over the filter's tendency to organic fouling. These are; filter material, fiber diameter, pore size, distribution, filter depth, and fiber surface characteristics.

The compound effects of the above were studied and led to the design of a depth non-woven structure that optimizes the solid particle capture while significantly delaying the organic fouling of the filter. The microstructure of this filter media is shown in Figure 3 where it is compared side by side with the qualifying filter layer of a typical non-woven filter.



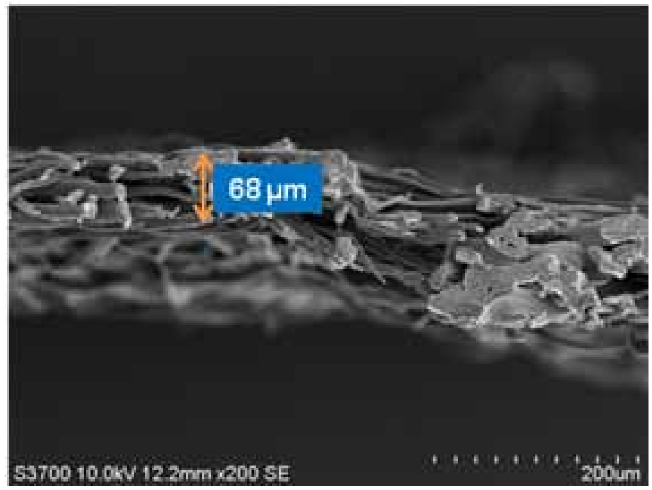


Figure 3. - Scanning electron micrographs of (a) depth non-woven filter media and (b) typical qualifying layer in a filter

The filter depth is increased fifteen times versus typical non-woven media. This high depth challenges the deformables contaminants in the fluid to pass through a much more tortuous path leading to increased filter contaminant capacity and longer life compared to standard depth filter media. The actual increase in filter life depends on the characteristics of the contaminants in terms of size and distribution, and elastic modulus.

Case Study, amine application

An on-site side-by-side filtration study of similarly micron rated high and standard depth High Flow media was performed on a Sulfinol amine solution. The high depth media processed three times higher volume than the standard depth media, as shown in Figure 4. By analyzing the behavior of these two filter media in Figure 4, it can be seen that significant pressure drop increase for the high depth media occurs much later than with the standard depth media. The higher depth for the new media is a major reason for this performance.

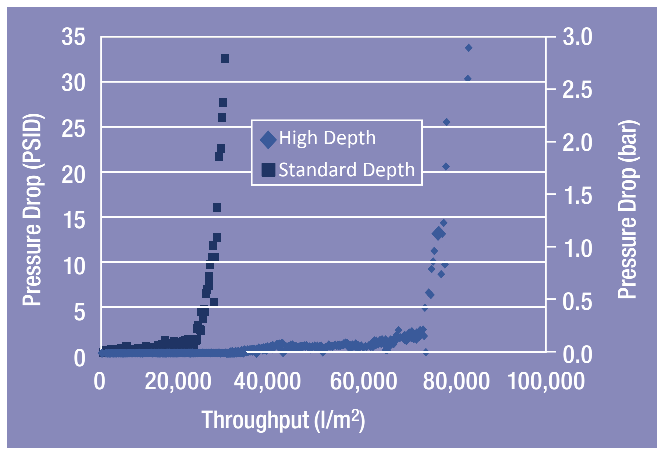


Figure 4. - On-site filtration evaluation of High & Standard depth High Flow media

Case Study, lake water testing

Three High Flow filters were tested using lake water. These were 40 & 70 µm standard depth High Flow filters and a 70 µm high depth (HFM) High Flow filter. Figure 5, shows the particle removal efficiency for particles larger than 5 µm. The difference in removal performance is statistically insignificant.

Figure 6, summarizes the throughput performance of the above filters. The difference in throughput between the 40 µm and HFM is statistically significant and is similar to the behavior that was observed with amine testing. Though not statistically significant, the throughput of the HFM was greater than the 70 µm High Flow.

Figure 7, shows the amount of contaminants retained by each of the above filters. The HFM removes and retains a significantly higher contaminant load when compared with the 40 µm and 70 µm High Flow. The higher contaminant load can be attributed to the significant depth of the HFM media. It is important to note that the performance of a filter media strongly depends on the contaminant's characteristics. The best way to secure optimal performance is by testing initially in small formats leading to scale-up and to larger formats when possible.

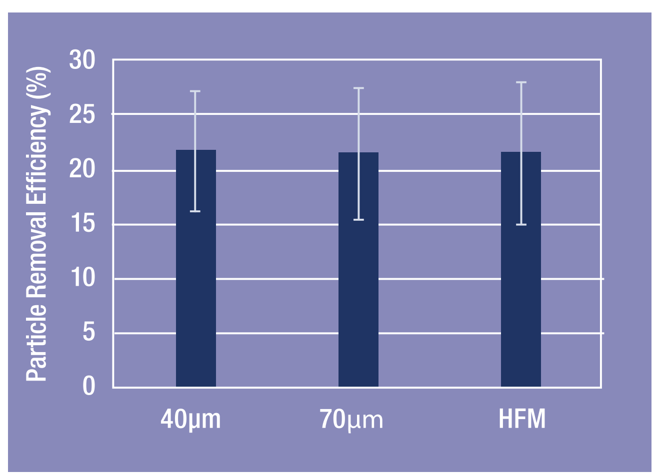


Figure 5. - Particle removal efficiency for particles larger than 5 µm using lake water

Summary

The above described new High Depth media has been incorporated into both the 3M™ High Flow and 740 Series product formats. The High Flow product version is referred to as HFM and the 740 Series product version is referred to as 740HD. In applications where the current standard 3M™ High Flow or 3M™ 740 filter cartridges have experienced short life due to presence of organic species in the fluid, it would be beneficial to test the HFM or 740HD products. The success of the test trial depends on customer definition of success and the contaminants need to be removed economically.

For new applications, the high depth filter media used in HFM/740HD products provides optimum particle removal while resists fouling by the bio-films produced by bacteria or organic hydrocarbon-based compounds.

IMPORTANT NOTICE:

The test results described in this report are, to the best of our knowledge, accurate. We make no representations or warranties to you regarding the test methodology or the test data itself. As a matter of customer service, 3M Purification Inc. will continue to work with you, the customer, to resolve any filtration related challenges encountered in the future. Ultimately it is the responsibility of the customer to determine whether or not additional testing is required and whether or not the final product is suitable for use in your specific application(s).

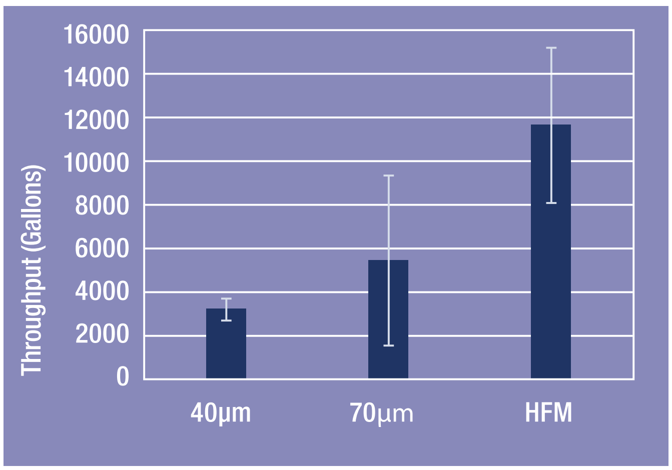


Figure 6. - Throughput comparison for 40, 70 µm High Flow and HFM using lake water

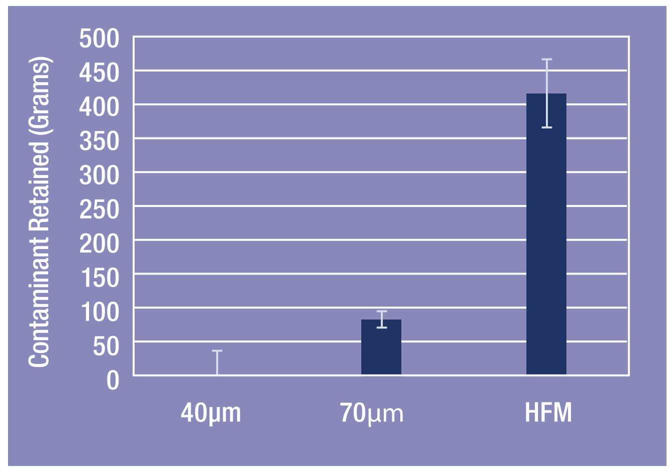


Figure 7. - The comparison of contaminant retained for 40, 70 µm High Flow and HFM using lake water

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