SPECTRUM FILTER
Effective Filtration of High Turbidity Feed Waters

Features

- Filter raw feed water with turbidity up to 100 NTU
- Produce excellent quality filtrate with turbidity of less than 0.1 NTU and SDI less than 5
- Nominal 1 µm filtration with a significant removal of sub-micron particles, colloids and organics
- Excellent pre-filtration for packed bed ion exchange or reverse osmosis
- Low installed and operating costs compared with alternative micro-filtration systems

The Spectrum Filter is able to achieve its high level of performance by using two particulate media layers. An upper layer of coarse media allows for an extended service cycle by providing depth filtration of large particles while a lower layer of very dense fine filter media provides surface filtration of smaller particles. (See Figure 1)

The nominal diameter of the filter media in the lower layer is less than the diameter of the fine garnet media and less than 20% of the diameter of the coarse sand commonly used in conventional multi-media filters (See Figure 2). The flow channels through the micro media are extremely small. The tortuous path of fine channels provides excellent retention of solids. During backwashing, the media expands to release solids.

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Figure 1

Figure 2
**Reduce Cost & Space**

The superficial flowrate (i.e., flow per surface area) of the Spectrum Filter is two to three times that of a conventional multimedia filter. This increased unit productivity results in a much smaller filter vessel diameter and an associated reduction in capital cost and floorspace. In other media filters, the high flowrate forces drive solids through the filter and into the filtrate stream. The fine media layer at the bottom of the Spectrum Filter ensures solids will not breakthrough, even at the higher operational flowrate. In fact, the filtrate quality of the Spectrum Filter at its high superficial flow is superior to the filtrate quality of a conventional dual media filter at the lower flowrate (Figure 3).

**Compare with Ultrafiltration or Micro-filtration**

The Spectrum Filter provides filtered water quality that meets or exceeds the requirements of reverse osmosis (R.O.) membrane manufacturers. Along with good operating practice, this ensures long R.O. membrane life. While the use of membrane-based pre-filtration (ultrafiltration or micro-filtration) provides marginally higher filtered water quality, the incremental benefit to R.O. membrane life does not justify the significant additional cost of membrane pre-filters.

**Service**

The Spectrum Filter operates on a similar cycle to a conventional air-scourable multi-media filter. Feed water is dosed with coagulant (polymer for high turbidity feed waters) and flows down through the media and out through the bottom of the vessel. Once a preset volume has been filtered or a pressure differential across the media reaches a preset value, backwash is automatically initiated.

**Backwash**

Backwashing involves a number of steps including a simultaneous air scour/backwash of the media to ensure effective separation of any dirt particles from the media. This step is followed by a backwash flow upward through the scouring media, that exits through the top of the vessel. The filter media efficiently resettles into two distinct layers ensuring continuous high quality filtration.

**High Quality Filtrate**

All water sources contain fine particles that are typically in the form of colloidal silt or microorganisms (i.e. algae, bacteria). If not addressed, these solids will foul downstream R.O. or ion exchange equipment resulting in poor performance and an increase in operating costs. The design of the Spectrum Filter removes these very fine particles that would otherwise pass through other media filters. It filters turbid raw waters containing suspended solids concentrations of up to 100 ppm to produce a filtrate of less than 0.1 NTU, with an average particle size of less than 1 µm nominal (figures 4 and 5) and a filtrate silt density index of less than 5.

**Minimal Initial Ripening**

The Spectrum Filter does not exhibit the ripening effect typically seen with other filters. A drawback of conventional media filters is the poor quality of water produced at the beginning of the filter run. Fine matter passes through the filter during the initial period to substantial quantities for an extended period of time (Figure 6). In order to overcome this problem and prevent any improperly filtered water from going downstream, it has been the practice to send a large volume of the initial filtrate to waste. This requirement results in large amounts of waste water and poor unit productivity. The Spectrum Filter produces a filtrate quality of less than 0.1 NTU (figure 6) after the purging of only a single column volume (CV). A conventional media filter requires a purge of 10 column volumes or more in order to attain the same filtrate quality.

**More Robust**

Surface waters are prone to seasonal and annual changes in the concentration of the suspended matter. This is a concern for conventional media filters since breakthrough of solids will typically occur if the solids holding capacity is exceeded (Figure 7). There will be no breakthrough of solids if the solids holding capacity of the media in the Spectrum Filter is exceeded due an increase in the feed suspended solids concentration. The pressure drop across the filter will merely increase. At the pre-determined pressure drop, the filter backwash sequence is automatically initiated. This operational feature ensures there will not be any contamination of downstream storage volumes or treatment equipment.

**Coagulation and Fine Filtration**

Coagulation and fine filtration with the Spectrum Filter is a proven method for removing naturally occurring organics. Studies have shown a reduction in tannic acid concentration from around 2.0 ppm to 0.35 ppm or less. This represents greater than 80% reduction (Table 1). The negatively charged organic molecules attach themselves to the positively charged metal ions from the coagulant during the agglomeration of the small particles (i.e., during floc formation). These organics are then removed with the agglomerated solids in the filter. An organic polymer can also be added to improve the coagulation and filtration processes by promoting the formation of a stronger floc that will remain intact within the filter bed. This prevents floc fragmentation and breakthrough into the filtrate stream. Naturally occurring organics, such as tannic, humic or fulvic acids, enter the feed water supply from decaying vegetation or agricultural runoff. These organics tend to accumulate on the surfaces of R.O. membranes or on anion resin in demineralization equipment. This gradual fouling will lead to poor performance and increased operating costs.
Feed Turbidity

Figure 8 shows actual performance data from a 1300 gpm Spectrum Filter system operating on raw surface water and feeding the reverse osmosis stage of an ultrapure water treatment system. Feed turbidity ranges from 3 to 80 NTU while filtrate is typically less than 0.05 NTU.

Particle Removal Efficiency

Spectrum vs. Conventional Dual Layer Media Filter

TABLE 1: TANNIC ACID REMOVAL EFFICIENCY

<table>
<thead>
<tr>
<th>CYCLE NUMBER</th>
<th>FEED TANNIC ACID (mg/L)</th>
<th>FILTRATE TANNIC ACID (mg/L)</th>
<th>% REMOVAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.8</td>
<td>0.13</td>
<td>93</td>
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<tr>
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<td>93</td>
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<td>72</td>
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<td>0.20</td>
<td>90</td>
</tr>
</tbody>
</table>

†Feed water contained 10 ppm of suspended solids and dosed with 12 ppm coagulant
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