Manz Engineering Ltd.

MEL Biological and Polishing Sand Filters

David H. Manz, P. Eng., PhD, AOE, FCAE
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1. General Description

Manz Engineering Ltd. (MEL) manufactures biological and polishing sand filters, known as MEL-BF and MEL-PF filters respectively. They are part of MEL Filter Systems or MSF which also includes the MEL Carbon Filter or MEL-CF and the MEL Roughing Filter or MEL-RF. (This paper, a brochure and other information on MEL Filter Systems is provided on the web site; www.manzwaterinfo.ca .) The MEL-BF is an important variation of slow sand filtration. It is designed to remove pathogens and other nuisance organisms but will also remove mineral and particulate matter. The MEL-PF is specifically designed to efficiently remove small mineral and organic particulate matter without use of chemicals. The design of the MEL-BF and MEL-PF are an extension of the design of the original BioSand water filter, a design based on traditional slow sand filtration. The operation of the MEL-BF and MEL-PF and BioSand filters are identical – except for surface loading rates (volume of water treated per unit of area of filtering surface per unit of time) as discussed later. The principal difference between them is their method of cleaning. The BioSand filters are cleaned using surface agitation and a gentle backwash to degas the media and the MEL filters are cleaned using an aggressive backwash without surface agitation. The advantages of the MEL filters over the BioSand filter are the ease with which the filters can be cleaned, the simplicity of design and economy of scale. That said, there are more than a million (perhaps millions) of the humanitarian household variation of the BioSand water filter being used in households and schools in disadvantaged communities throughout the world – filters that are locally constructed and successfully used to meet many of the same water treatment challenges resolved using the large MEL filters.

MEL biological filters remove pathogen causing microorganisms from water including helminths, parasites, bacteria and viruses using a process similar to that used by traditional slow sand filters. They will also remove all other types of organisms as well as mineral and organic particulate material. Post-filtration disinfection using chlorination or ultraviolet disinfection is required to completely kill or deactivate bacteria and viruses not removed by the MEL filter. (Slow sand filters will remove 90 to 99 per cent of bacteria and viruses from water.) Parasites and larger organisms, which might not be able to be killed or deactivated by chlorination, are completely removed by the MEL-BF and MEL-PF filters.

MEL polishing sand filters use surface loading rates several times that of MEL biological filters. They are used to remove small mineral and organic particulate material without use of chemicals to achieve a quality objective (suspended solids concentration or turbidity) that meets drinking water guidelines or to a quality where subsequent treatment processes such as ultraviolet disinfection or membrane filtration might be effectively used. The polishing sand filters alone have been demonstrated to provide 5-log removal of giardia cysts and very near this of cryptosporidium oocysts.

MEL filters cannot be used alone to efficiently remove dissolved substances. Dissolved substances will typically pass through the filter with little or no reduction in concentration. Some organic and inorganic toxins may be removed but additional research is required.

MEL filters cannot be successfully used to remove oily and sticky material from water. These substances will be removed by adhering to particle surfaces. However, it is not known how to clean captured oils and other sticky materials from the media.

It is recommended that all MEL filter applications be piloted to guarantee performance prior to development of prototype designs.

2. Media Bed

The design of the media bed used by MEL-BF and MEL-PF filters is very important.

MEL polishing and biological sand filters both use a media bed that is divided into two zones as shown in Figure 1. The top zone is the filtering zone and the bottom is the underdrain zone. The filtering zone is designed to remove particulate material that may include inorganic and organic material that may also have a variety of living organisms. The underdrain zone supports the filtering zone and facilitates the evacuation the filtered water. The filtering and underdrain zones may use several types and sizes of media.

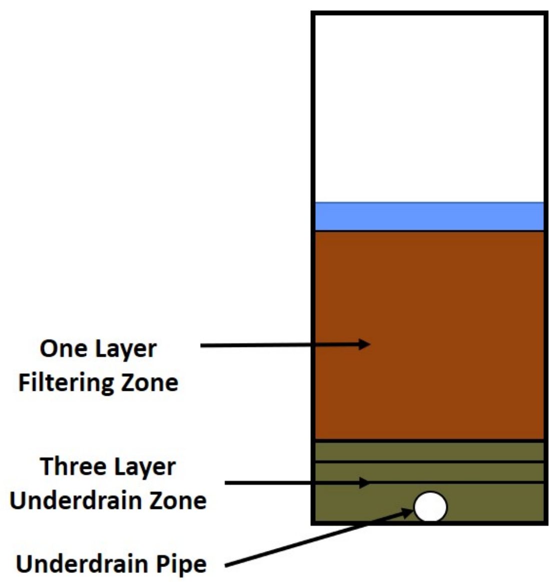

Figure 1. Media zones in MEL-BF and MEL-PF filters.

Typically, the filter media used will be well graded to include media with a range of particles sizes from 0.1mm or to 0.45mm, large enough to be supported by the top of the underdrain media. The filter media is selected such that once commissioning is completed the smallest particles are at the surface and will be able to remove the smallest particulate material of interest. Also, the filtering media must be able to be cleaned using a backwash flow rate that will not disturb the underdrain media. No filtering media is removed or lost during the cleaning process. Filter media should never need to be supplemented, removed or replaced.

1.1 Underdrain Zone

The underdrain zone is designed to allow filtered water to enter the pipe drainage network located at the very bottom of the underdrain zone. See Figure 2 which shows actual photos of underdrain pipe and layers of media used. In the case of the MEL filters the pipes have openings (circular openings, not slotted) with sufficient cumulative area to ensure that all filtered water can be evacuated with minimum head loss. The openings are distributed across the entire filter cross-section such that a vertical flow is evenly distributed throughout the cross-section of the filter (downward or upward). The bottom most layer of underdrain media is comprised of particulate material that is sized sufficiently large to not pass through the holes in the drainage pipes (and plug the pipes). The size of this media has pore spaces (openings between particles) which would likely permit the largest filtering media to pass to the underdrain pipes and plug them off – clearly not desirable. It is therefore necessary to use a second underdrain layer that rests on top of the bottom most layer that is sized so that it will not pass into the pore spaces of the bottom most layer (effective size of the second layer is approximately one-quarter that of the media used in the bottom layer). This layer is said to be supported by the layer below. If the openings of the second layer are still too large to support the largest filtering media a third underdrain layer (effective size approximately one-quarter of the media in the second underdrain layer) is required which has pore openings sufficiently small that the largest filtering media is supported. Three layers of underdrain media arranged in this fashion are usually sufficient. (The design of the underdrain media is constrained by the need to support the largest filtering media on the top of the underdrain and the size of the openings in the underdrain pipes. It is just as logical to select the size of the top layer of the underdrain media as large as possible and still support the filtering media, selecting the layer below this as large as possible and still support the top layer of underdrain, and so on, always checking to determine if the particles will pass through the holes in the underdrain pipes. When the layer has particles that will support the underdrain layers above it and not pass into the underdrain pipes, the design of the underdrain media is completed.)

(It is important to note that the backwash flow rate used in the MEL-PF and MEL-BF filters is quite low compared to modern rapid sand and pressure sand filters. Commercially available underdrain systems used in rapid sand and pressure sand filters will not work in the MEL filters.)

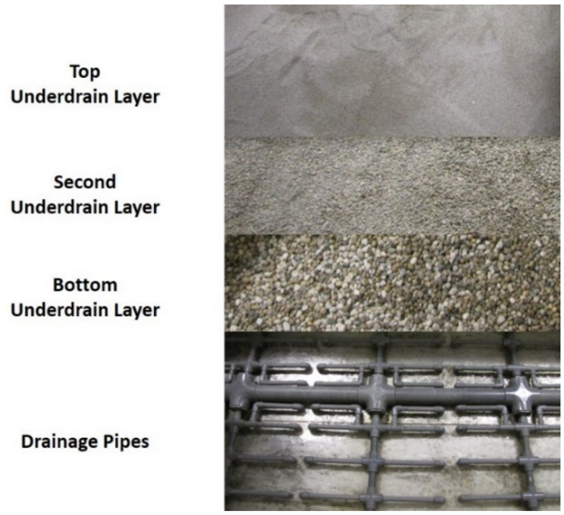

Figure 2. Photos of actual drainage pipes and underdrain layers.

1.2 Filtering Zone

The filtering zone in MEL-BF and MEL-PF filters is designed to efficiently capture particulate material of interest at or near the top of the filtering zone. MEL filters are NOT depth filters such as rapid sand and pressure sand filters in which particulate material is captured throughout the filtering zone. The filtering zone in depth filters includes the entire thickness of the filtering media and it must be cleaned before breakthrough of unfiltered water occurs or just before it occurs. (Breakthrough water is untreated and will contaminate treated water supplies.) MEL filters do not exhibit breakthrough such as that experienced by rapid sand and pressure sand filters or any other type of depth filter. Rather, as MEL filters capture material the pores at or near the top of the media plug off and the filtering rate is gradually reduced to where the filter requires cleaning using a backwash flow to restore filtering capacity.

1.3 Media used in MEL-BF and MEL-PF filters

The media used in the MEL-BF and MEL-PF filters must meet NSF61 standards when used to treat potable water. The media used in MEL-BF filters must comply with AWWA B100 80. The media used in MEL-PF filters doesn't necessarily need to comply with this standard but it is considered good engineering practice to use media that does comply.

The media used in the filtering zone of MEL-BF and MEL-PF filters has an effective size of 0.35 mm or less. Ideally, the media used is well graded and has a fraction of particles less than 0.1 mm in size. Filter sand suppliers can prepare media for use in slow sand filters but the preferred approach is to select one or more standard products to be used singly or in combination. Uniformly graded media, where particles are all the same size, would be useful but is not used because it is either not available or too expensive.

3. Commissioning and Backwash Considerations

MEL filters are commissioned using a backwash flow to redistribute the particles in the filtering zone so that the largest are on the bottom of the zone (just above the top of the underdrain zone) and the smallest are at the top or surface of the zone (top of media). The backwash flow is achieved by pumping filtered water (and unchlorinated water in the case of the MEL-BF filter), into the underdrain pipes such that it flows vertically upward through the underdrain layers and completely fluidizes all of the media in the filtering zone. This process is illustrated in Figure 3. When the flow of water is stopped the particles are now redistributed as desired.

Backwashing will not fluidize any of the particles in the underdrain zone.

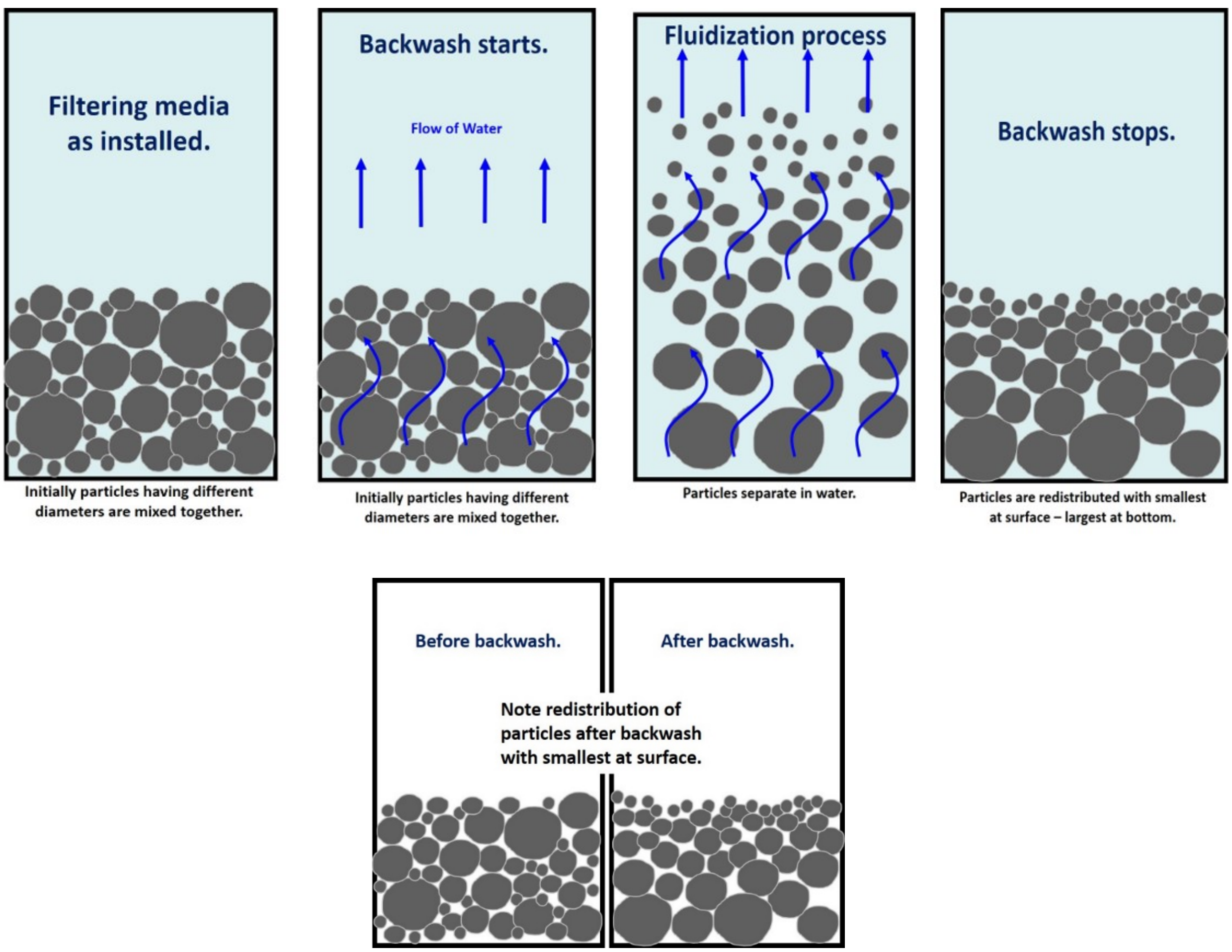

Figure 3. Effect of backwash at time of commissioning on the redistribution/ classifying of filtering media.

If two or more layers of filtering media are initially installed and the media is the same material (e.g., the same crushed quartzite) the layers will mix to form one layer – the layering of the media at time of installation is lost during commissioning. This is illustrated in Figure 4.

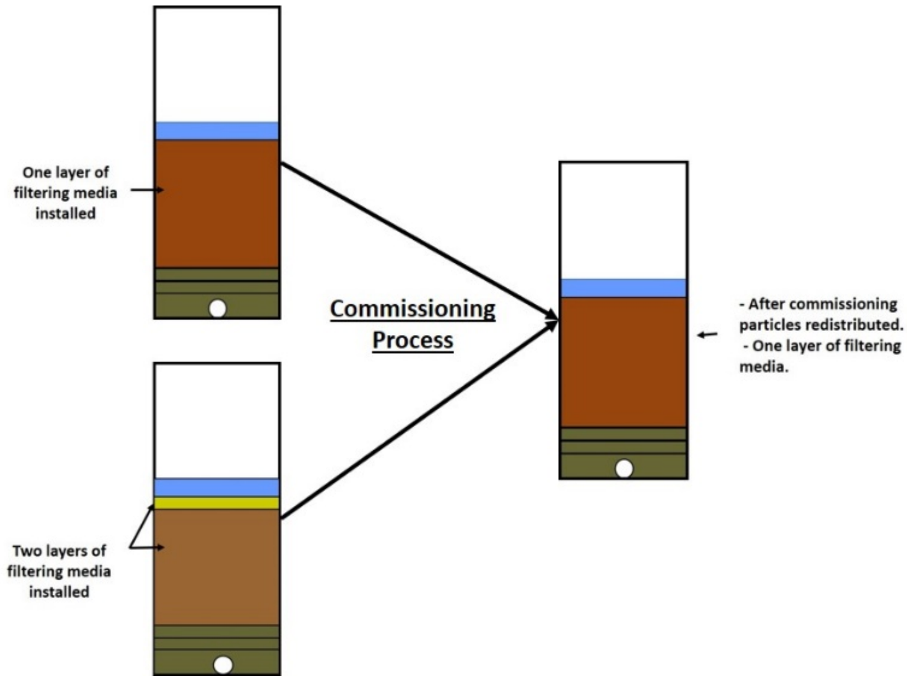

Figure 4. Effect of backwash during commissioning on one or two layers of media initially added to filtering zone.

Research and experience have demonstrated that backwash flow rates ranging as low as 4 $L/s/m^2$ may be effective but the ability to use 8 to 12 $L/s/m^2$ is recommended. (Piloting is required to determine optimum backwash rate.) Figure 3 illustrates the effect of the backwash at time of commissioning on the redistribution of filtering media.

The volume of backwash water used in a MEL filter is limited by the volume available in the filter vessel/ tank above the filtering media. This is unlike rapid and pressure sand filters where backwash flow may be several times that of the MEL filters and will be continually wasted until the wasted water has an acceptably low turbidity. MEL filters use a fraction of the wastewater produced by rapid and pressure sand filters.

Because the flow rate used to backwash rapid and pressure sand filters is so large the size of the particles in their filtering zone are much larger than that used in MEL filters. The smallest particles in the filtering zone of rapid and pressure sand filters may be the same size as the largest particles in the filtering zone in MEL filters. It is common for media used in rapid and pressure sand filters to be lost from the filter during the backwash process. The loss of media and the change in particle distribution of remaining media requires that periodically the media be completely removed and replaced (a process known as resanding). Rapid and pressure sand filters may use relatively complex designs for their filtering zone to optimize their performance, decrease frequency of backwashing and decreasing frequency of resanding. Media used in rapid sand and pressure sand filters may include activated carbon, silica sand and garnet sand and other specialized media of varying sizes. MEL filters are capable of using complex designs of the media zone as well but this has not yet proven to be necessary.

4. MEL Biological Filters or MEL-BF

When used as a biological filter the MEL filter performs similar to a traditional slow sand filter which is never backwashed. The media in the entire filtering zone in a MEL biological filter must conform to the type and effective size of that specified by industry standards for use in a slow sand filter (AWWA B100.1 and NSF61). The design of the filtering zone and surface loading rates vary with local regulatory guidelines. The minimum depth of the filtering zone is 0.35 m or greater and the surface loading rate is rarely permitted to exceed 400 $L/h/m^2$.

A MEL-RF filter, a roughing filter, may be used if the suspended solids concentration of the water is considered too great for efficient use of the MEL-BF. (Note that the media used in the MEL-RF can be tailored to effectively treat the specific type and concentration of suspended solids.)

A MEL-CF filter, a filter that uses GAC, can be used after the MEL-BF to remove dissolved organics and reduce colour. If the water is chlorinated prior to entering the filter, the GAC will not be colonized by living organisms. It is capable of removing most of the chlorine and dissolved organics, and can be expected to have a very long life. It is very important that the MEL-CF be piloted.

3.1 Operation of the MEL-BF

The particulate removal mechanisms operating in a MEL biological filter are identical to that of a traditional slow sand filter. The surface loading rates are sufficiently low (limited by local industry standards) to permit the formation of biofilm on the surfaces of the media particles located at or near the surface of the media zone. Figure 5 illustrates how particulate matter is captured and the formation of the biofilm on the particles at the surface of the filtering media. The near surface layer of the filtering zone, where the particles are covered in a biofilm, is known as the biolayer (also called a schmutzdecke). The formation of the biolayer does not depend on the development of an accumulation of organic material on the surface of the media as once thought. Biofilms, and therefore a biolayer, will develop if the raw water supply has living organisms in it and the water is well aerated. The biolayer is only a few centimetres deep. The biological processes in the biolayer capture, consume or deactivate most of the bacteria and viruses. All larger organisms are captured and consumed by the biological activity. The advantage of the MEL filter is that the size of the particles at or near the surface of the filtering zone are much smaller than traditional slow sand filters. Consequently, the area of biofilm per unit volume at the surface of a MEL filter is much larger and the MEL filter is potentially more effective in removing microorganisms than traditional slow sand filters. (The greater the area of biofilm the greater the opportunity to capture organisms.) (Parasite removal does not depend on the formation of a biofilm on the media particles.) Biofilms are not lost during the cleaning process.

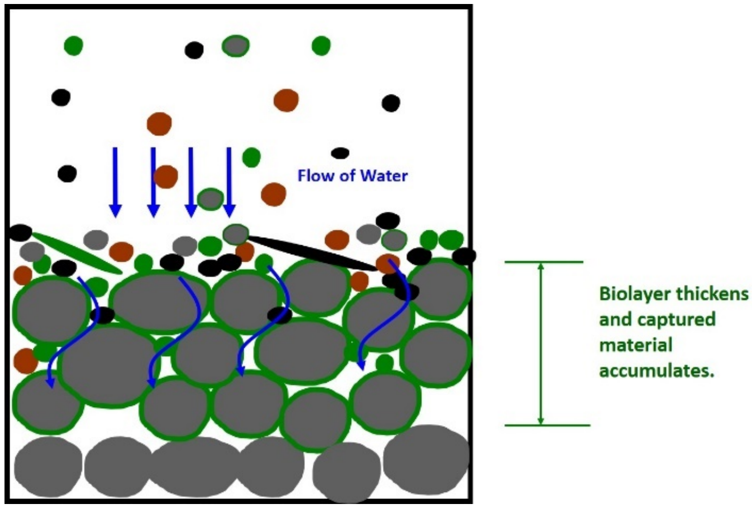

Figure 5. Capture of particulate matter and formation of biofilms and the biolayer.

The novelty of the MEL biological filter is that its operation may be stopped and started without impairing its ability to remove microorganisms unlike traditional slow sand filters which must be continuously operated to preserve performance. The ability of the MEL biological filter to stop and start operations without losing performance was first used in the design of BioSand water filters and has been successfully demonstrated in many thousands of filters in use around the world for over thirty years. The ability to stop and start filtering without loss of performance is possible because when the operation of the filter is stopped the water level above the media is allowed to decrease to a depth of only a few centimetres (paused water depth) allowing oxygen from the air above the water to diffuse into and through the water to reach the top of the filtering media and supply needed oxygen to organisms there. The biolayer is aerobic. This is illustrated in Figure 6.

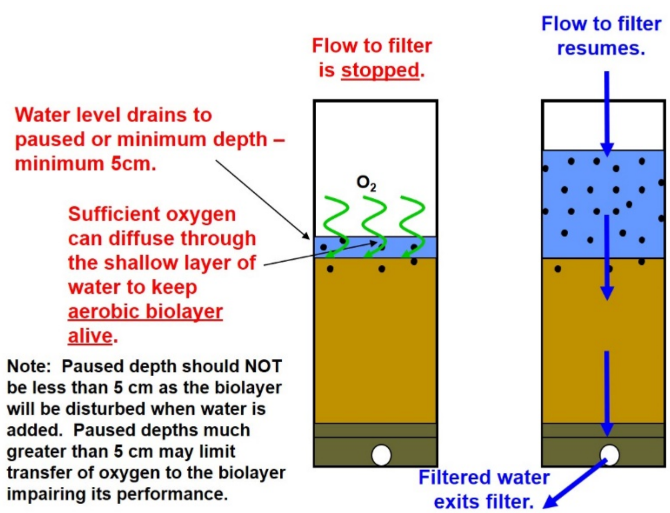

Figure 6. Preserving the performance of the filter when flow is stopped.

Also, the paused water depth must be sufficient to absorb the impact of the water when it is added to the filter when filtering is restarted. When water is added to the filter it must pass through a specially designed diffuser basin which breaks the flow into small droplets that do not have sufficient momentum to disturb the biolayer on the surface of the media.

There is biological activity throughout the entire filter which also contributes to microorganism removal. The nature of the biological activity occurring at depth is not entirely understood.

3.2 Restoring filtering capacity – cleaning the MEL-BF

Both the traditional slow sand filter and the MEL-BF filter will plug off in identical fashions – the pores at the surface of the media are gradually filled with captured particles and so restrict the flow of water.

The filtering capacity and efficacy of a traditional slow sand filter is restored by stopping filter operations and removing a limited depth of the top of the media in the filtering zone. This process will remove all particulate material that has plugged the media and responsible for reducing the flow. The same particulate matter that is removed is coated with the biofilm responsible for removing bacteria and viruses. After cleaning, a traditional slow sand filter requires a period of operation that will allow development of a biofilm on the new particles located at or near the surface of the media zone. This process is known as ripening and may take several days during which filtered water is wasted. The filtering zone used in traditional slow sand filters is sufficiently deep to allow for several cleaning processes before additional filter material must be added. Because the restoration of filtration capacity is so onerous, traditional slow sand filters are limited to treating water with low suspended sediment load and low turbidity.

MEL filters are cleaned using a backwash process as illustrated in Figure 7. The filter operation is stopped and previously filtered but unchlorinated water (water with no residual disinfection capability that would affect the organisms in the biolayer) is pumped into the underdrain system at a flow rate that will not fluidize the underdrain but will fluidize the entire filtering zone similar to that which occurs in the commissioning process. (Fluidization of the underdrain would require a backwash flow rate several times that required to fluidize the media in the filtering zone.) Upon completion of the backwash process the media in the filtration zone is left distributed exactly as before the backwash process occurred. The smallest particles with associated biofilm will still be at the filter surface and the ability of the filter to remove microorganisms is preserved. The fluidizing process disturbs the media throughout the entire filtering zone and a short period of filter-to-waste is normally required until the turbidity of the filtered water is acceptable. (Note that a small amount of particulate material is captured at depth. Normal backwashing will not necessarily remove all of this material.) No filtering media is lost such as that which occurs when rapid sand and pressure sand filters are backwashed. Unlike traditional slow sand filters, it is not necessary to remove media and replace it. Backwashing may be repeated to insure adequate cleaning prior to filter-to-waste.

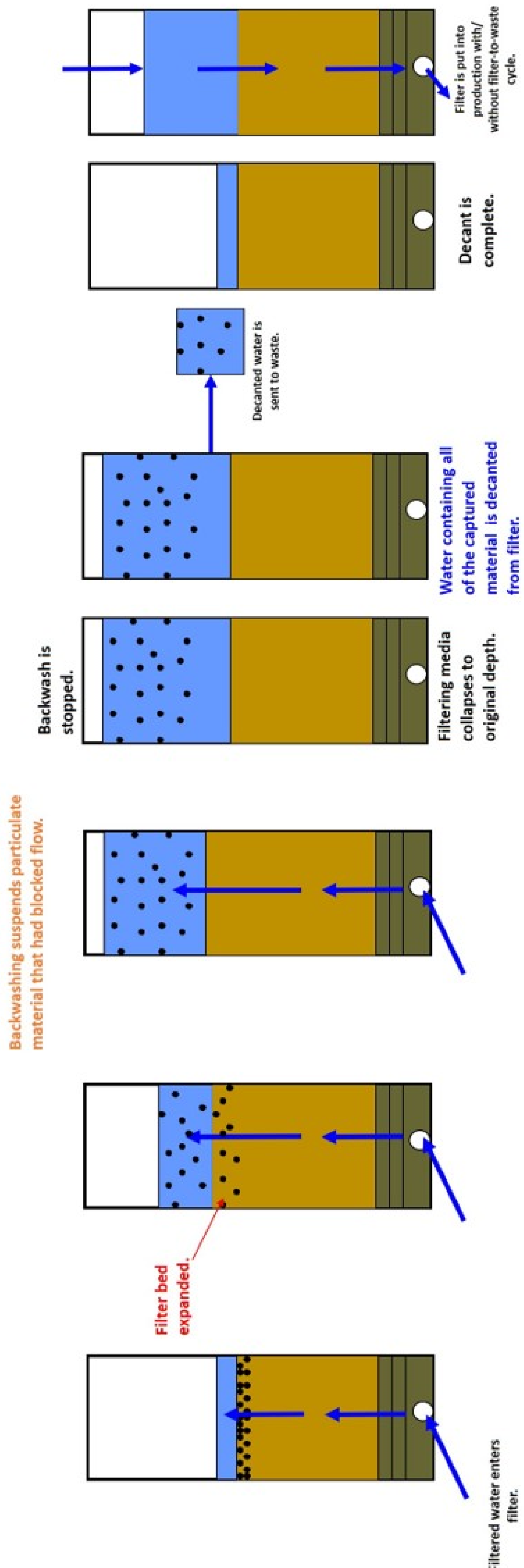

Figure 7. Cleaning a filter using the backwash process.

5. MEL Polishing Sand Filters or MEL-PF

MEL polishing sand filters are intended to be used to remove low concentrations of fine suspended solids, mineral and organic. Water may be chlorinated or unchlorinated. To date chemicals have not been used but remains an option to enhance particulate removal. The MEL-PF filters are designed similar to MEL-BF filters with a filtering zone of 0.35m. The surface loading rates may be as high as 1,200 L/h/m. In circumstances where unchlorinated water is being treated or used for cleaning, the particles near the surface will develop biofilms if there are living organisms in the water and the filters will remove a significant per centage of bacteria and viruses.

Importantly, the polishing sand filters have demonstrated a five-log removal of giardia and near that of cryptosporidium parasites whether water is chlorinated or unchlorinated and biofilms are formed or not (confirmed by independent third-party evaluations as described in MEL Technical Bulletin #2). This ability has greatly expanded the use of MEL-PF filters to successfully treat previously treated (and chlorinated) pipe-distributed municipal water supplies that have been re-contaminated during distribution (often caused by loss of pressure in the distribution system which allows contaminated surface water into the pipes). Typically, the residual chlorine of the treated water will eliminate pathogen hazards associated with bacteria and viruses but not parasites such giardia, cryptosporidium and importantly, those causing amoebic dysentery.

The typical applications are reduction of suspended sediment from surface waters and removal of oxidized iron and manganese from groundwater. Hydrogen sulfide gas may also be removed from groundwater. Arsenic is removed along with newly oxidized iron in a process known as co-precipitation. (Other metals can likely be removed using a similar process though this would need to be demonstrated by pilot studies which are always recommended for most applications of the polishing sand filter.) Reduction in the concentration of suspended solids has allowed successful use of ultraviolet disinfection and membrane filtration for removal of dissolved solids such as dissolved organics that contribute to water colour – a MEL-CF filter may be used for the same purpose.

As previously stated, MEL filters cannot be used alone to effectively remove dissolved substances, mineral or NOC (DOC) which will typically pass through the filter with little or no reduction in concentration.

The MEL-PF filter cannot be used to remove oily and sticky material that adheres to particle surfaces and cannot be cleaned from the media using a backwash process. Removal of oily/ sticky substances will require some form of chemical pre-treatment that would form particulates that could be captured and cleaned from the media. The nature of possible chemical pre-treatment would be specific to the substance intended to be removed. It is likely that significant research would be required to determine which chemical pre-treatment would work. This type of research is outside of MEL's mission.

5.1 Operation of the MEL-PF

MEL polishing sand filters remove particles at or near the surface of the filtering media similar to the biological sand filters and illustrated in Figure 4. As stated, the surface loading rate may be as high as 1,200 L/h/m^2. At these surface loading rates a small portion of particulate removal will occur deeper in the filtering zone. Surface loading rates greater than this have been found to cause compaction of the media (caused by head loss across the filtering zone) resulting in premature decreases in filtration capacity similar to plugging off of pores (restored during the cleaning process). Surface loading rates should be as high as possible but need to be verified using appropriate pilot studies. The larger the surface loading rate, the smaller the filter surface area required to treat the water and less expensive the overall filter installation. The cost of a pilot study is not significant and always justified.

The desirable method of operation is to remove all large particles that cannot be removed by the backwash method prior to the raw water entering the polishing sand filters. This may be performed using a variety of filtering methods depending on the nature of the particles suspended in the water supply. Screens, pressure sand filters, self-cleaning mechanical filters or MEL-RF filters are a few of the options available.

Mineral particles that enter the filter and not able to be suspended sufficiently long enough during backwash and removed from the filter when the wastewater is evacuated will become part of the filter bed.

Colloidal sized particles such as clay or very fine silt (often called rock flour) may not be removed. The use of chemicals such as coagulants may be effective aids but must be considered very carefully because of the uncertainty associated with the removal of resulting flocs during cleaning, complexity of chemical use, and cost. If considered, chemical use must be carefully piloted to determine effectiveness and method of management. Mineral coagulating agents are recommended.

Organic particles may be living or dead. Organisms that may need to be removed include aquatic plants, algae, a variety of aquatic animals at varying stages of development, spores, helminths (and their eggs), parasites, bacteria, viruses and bits and pieces of larger organisms that may be in the water. The quantity and nature of particulates in source water may vary with season and weather (e.g., snowmelt, rainstorms, algal blooms). The hazard any organic material presents, is that if cleaning operations are not frequent enough, the organic material may accumulate on the media surface and form large flocs that might be difficult to remove using otherwise routine cleaning processes and must be mechanically removed. There are many different species of algae and their ease of capture and removal may be quite different. Removal of some types of algae actually improves with pre-chlorination, a process that should be evaluated at the bench and pilot scale if considered an option.

Iron and manganese can be removed from water supplies, typically from groundwater sourced from wells. On occasion the iron and manganese will already be oxidized (hydroxide form) and are able to be removed without pre-treatment. If the dissolved iron and manganese are not oxidized, they may be oxidized with low doses of chlorine (usually sodium hypochlorite) that would need to be added to the filtered water before storage anyway. After the chlorine is added the water is temporarily stored and gently agitated in a small tank, called a contact tank, prior to being fed to the filters. The contact tank allows the oxidized metals to floc and form larger particles that the filters are able to remove. If the water is complexed (e.g., naturally chelated by dissolved organics in the water, NOC), stronger oxidants such as potassium permanganate, ozone or chlorine dioxide may be used and chlorine added after filtration to meet regulatory guidelines prior to being stored. Care must be taken not to use additions of oxidants that exceed maximum additions of chemicals as described in NSF/ANSI/CAN 60. Bench and pilot scale studies are very important.

Hydrogen sulfide and sulfate and iron reducing bacteria may be found in wells alone or associated with dissolved iron and manganese. Chlorination will oxidize the hydrogen sulfide and kill the sulfate and iron reducing bacteria. If the water is considered to be under direct influence of surface water, there is the possibility that giardia and cryptosporidium may be present as well. Chlorination sufficient to oxidize dissolved iron and manganese or the hydrogen sulfide alone will kill or deactivate bacteria and viruses and the MEL-PF will remove the parasites if present. The multiple barrier approach may require ultraviolet disinfection and addition of chlorine as required by regulatory agencies prior to storage. It is worth noting that the presence of sulfate or iron reducing bacteria will foul most pressure sand filters including greensand filters to the extent that their media cannot be thoroughly cleaned due to particles sticking together. Treatment capacity is lost due to the gradual development of short circuiting of flow through the media. Media will require periodic replacement. Fouling of this nature cannot occur in MEL-PF filters which will remove the sulfate and iron reducing bacteria similar to any other microorganism.

5.2 Restoring filtering capacity – cleaning the MEL-PF

The filtering capacity of MEL-PF filters is restored in exactly the same manner as that used to restore MEL-BF filters. Filtered or filtered and chlorinated water may be used. Optimum backwash flow rates may be determined using a pilot scale filter but limited to less than 12 $L/s/m^2$ or less depending on the media used. Backwash rates of $4L/s/m^2$ are usually effective.

If the filters are used to remove iron and manganese it is possible to reduce wastewater to zero (almost). The ferric and manganese hydroxide flocs are concentrated in the wastewater removed from the filter. A simple settling tank will allow the flocs to settle and concentrate on the bottom of the tank. The concentrated sludge can be periodically drawn off and disposed of on land or with the sludge in a local municipal wastewater treatment facility. The clarified water can be returned to the transfer tank and filters.

6. Piloting the MEL-BF and MEL-PF Filters

Most of the potential applications of MEL-BF and MEL-PF filters can be evaluated using both bench and pilot scale studies. Figures 8, 9 and 10 show photographs of a MEL bench scale filter and two pilot scale filters, 30cm diameter and 60cm diameter.

Bench scale studies are usually performed in a laboratory though they can also be performed on-site. They are primarily used to determine if the filters can remove particulate material of interest. All processes pertaining to removal of mineral particles and large living and dead organisms, can be evaluated at the bench scale. Success at the bench scale may lead to pilot scale studies – depending on the specific treatment issue being considered. Bulk samples of water to be treated (20 to 40 litres) are supplied to the testing laboratory according to MEL instructions. Bench scale studies can usually be performed in a matter of days.

Backwash related concerns require pilot scale studies. Pilot scale studies that evaluate the removal of iron and manganese may be completed in a matter of days. Pilot scale studies of particulate removal from surface water may require several months to properly consider all of the variations of the quality of the source water with season and weather. It is recommended that pilot scale studies should be performed by MEL or in close collaboration with MEL.

Figure 8. MEL Bench scale filter.

Figure 9. MEL 30 cm pilot scale filter.

Figure 10. MEL 60 cm pilot scale filter.

7. Available Filters

MEL filters are available with the following dimensions:

- 2m x 2m x 2m manufactured by MEL and shipped with media to site.
- 2m x 4m x 2m manufactured by MEL and shipped with media to site.
- 4m x 4m x 2m manufactured by MEL and shipped with media to site.
- 8m x 8m x 2m tank manufactured on site and appurtences, pipework and media supplied by MEL.
- 16m x 16m x 2m tank manufactured on site and appurtences, pipework and media supplied by MEL.
- Custom designs may be provided for additional fee.
- Existing slow sand filter installations may be retrofitted to use MEL filter technology.
- Designs are available for the use of MEL filter technology for use in disadvantaged communities worldwide.

Photos of the 2m x 4m x 2m and 4m x 4m x 2m filters are shown in Figure 11.

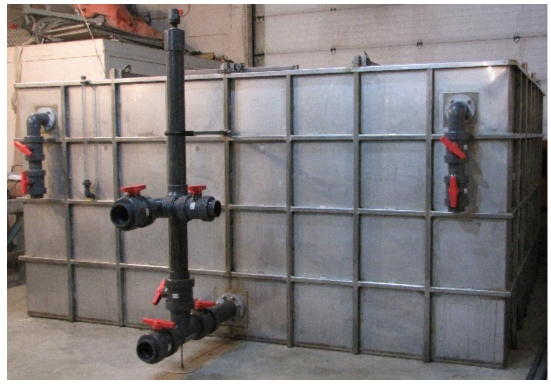

Figure 11. Photos of the MEL 2m x 4m x 2m filter and the MEL 4m x 4m x 2m filter.

Smaller versions of the MEL filters are the Manz BSF 60 and the Cabin Clean Water Filter (CCWF) that are available from a sister company to MEL, Davnor Water Filters Ltd.   Photos of these filters are shown in Figures 12 and 13.

The Manz BSF 60 is able to treat 60L/h when operated as a biological filter and up to 240L/h when operated as a polishing sand filter. It is used in a similar manner to the larger MEL filters. The operation and cleaning processes are identical. This filter and its earlier BioSand filter variation has been successfully used to provide potable water to Canadian households for over twenty-five years.   The MEL BF60 can also be used for limited piloting of larger scale MEL filter applications – particularly those considering iron and manganese removal.

The CCWF is intended to provide limited amounts of potable water for use in a single household at a filtration rate of 12L/h. If the water source is other than water from a previously treated municipal piped water supply the filtered water should be disinfected using chlorination. (Parasites that cannot be killed or deactivated by chlorination are removed by the filter.)   The CCWF has a very wide range of applications that are described in detail on the web site; www.cabincleanwaterfilter.com and in www.manzwaterinfo.ca .

One possible use of the CCWF is bench scale evaluation of treatment options considered for the larger MEL filters.

Figure 12. Photos of the manually and automatically operated Cabin Clean Water Filter.

Figure 13. Photo of the Manz BSF 60 filter.

8. Construction of MEL-BF and MEL-PF Filters

Construction of MEL-BF and MEL-PF filters is very tightly controlled by MEL to provide superior quality control and maximum flexibility in their use while limiting unwanted modifications to design prior to or during installation. Most of the manufacturing is performed by MEL under subcontract.

The filters consist of three elements; a vessel or tank, speciality pipework and appurtences, and the media. The tank is specially designed to accommodate the pipework, appurtences, and the media and to facilitate transport. MEL provides all of the elements as part of the purchase price. The tanks are constructed of stainless steel and the pipework is Schedule 80 high density polyethylene. The tanks are shipped mostly assembled without media which is supplied separately to be installed on-site. The largest filters that can be transported by truck transport are 4m wide x 4m long x 2m deep. Examples of filters being loaded and transported in this fashion are shown in Figures 14 and 15.

Figure 14. MEL 2m x 4m x 2m filters being loaded and transported.

Figure 15. MEL 4m x 4m x 2m filter being loaded and transported.

The tanks may be constructed of other materials such as aluminum or fibreglass or constructed on site using concrete according to designs specified by MEL. MEL will always supply the pipework, specialty appurtences and media.

Filters can be manufactured to be transported fully assembled with media installed (fully portable). The pipework will need to be manufactured using material that can withstand the jarring that will occur during transport. Completely portable filters simply need to be backwashed prior to being put into operation.

Filters are usually manually operated and cleaned though they can be remotely monitored and the operation and cleaning can be partially or fully automated, a feature that may be important particularly for installations that require centralized or remote monitoring and operation.

9. Engineering Support

Engineers interested in MEL filters will be provided the MEL brochure and this document to assist them in their assessment of the potential utility of the MEL technology to solve their specific treatment problem.

MEL is interested in knowing exactly what the treatment problem is in order to make informed recommendations. MEL needs the following information:

- Description of the treatment problem including some idea of how the availability and quality of the source water supply may vary with season or weather.
- Recent complete water quality analysis of source water that will be used in design.
- Treated water demand.
- Regulatory concerns.
- Description of present and previous treatment methodology used to treat the water and a description of the success of these methods to treat the water including a description of the problems that were encountered.
- Description of treatment technologies being considered.
- Opportunities for wastewater disposal.
- Energy availability.
- Location of client and nature of access to location of water treatment plant. (Transport limitations.)
- Other special concerns.
- Budget limitations.
- Time line for provision of treatment technology.

MEL will identify appropriate filter technology that should be considered including descriptions of relevant previous projects that have used MEL filters. Budget pricing and conditions of sale will be provided.

Should the engineer decide to proceed with consideration of MEL filter technology, MEL will prepare a budget for MEL to provide consulting pertaining to further consideration of the treatment approach that might be used (consulting fees appropriate for a specialist in water treatment engineering). The budget will include consulting fee, the costs for bench scale evaluation if needed and estimates of costs for pilot scale (on-site) evaluation of MEL filter technology and report preparation.

If bench scale evaluations are considered necessary MEL will provide instructions for the acquisition and transport of batch samples to MEL laboratory.

If the engineer decides that MEL technology will be used, MEL will provide all of the necessary technical details of the MEL filtration technology, (specifications, drawings, sample manual), to prepare a detailed design. MEL will review the proposed use of MEL filters with the engineer.

10. Installation Considerations

A minimum of two filters should be used in an installation. Two or more filters can be used together in a group or cluster to provide desired filtration capacity. At least one extra filter, beyond that needed to meet the required maximum treatment demand, is recommended to provide backup should one of the filters be taken out of service.

It is important to note that MEL filters are used in parallel. Each filter is operated and cleaned independently of the other filters. When a filter requires cleaning, it is isolated, cleaned and put back into service without disturbing the operation of other filters.

Installations are supervised/ evaluated by a MEL engineer.

Installations of the 2m x 4m x 2m filter and the 4m x 4m x 2m filter are shown in Figures 16 and 17.

Installations of MEL type clusters of cast-in-place concrete 4m x 4m x 4m filters are shown in Figure 18. Where possible MEL recommends use of the transportable stainless-steel filters.

The 2m x 4m x 2m filters and smaller can be skid mounted or located in shipping containers (seacans).

Figure 16. Photos of MEL 2m x 4m x 2m filter installations.

Figure 17. Photo of MEL 4m x 4m x 2m filter installation.

Figure 18. Photos of cluster of six 4m x 4m x 2m cast-in-place MEL type filters.

11. Commissioning, Training and Technical Support

Filter installations are commissioned when the entire treatment facility is operational. Commissioning is supervised by a MEL engineer. It is advisable that the individuals who will be operating the treatment plant be present during commissioning (and filter installation if possible) as this will provide a very good training opportunity. A thorough manual is provided for the filters which also describes where replacement materials can be obtained if needed. MEL engineers are available to provide technical support when requested.

12. Advantages of the MEL-BF and MEL-PF Filters

Advantages of MEL-BF and MEL-PF filters include:

1. Effectiveness (guaranteed performance when appropriately piloted).
2. Simplicity and flexibility of design (may use variety of construction materials and methods). Necessary construction materials available worldwide. Installation and commissioning are not complex.
3. Easily evaluated using bench and pilot scale studies.
4. Compact compared to traditional slow sand filters.
5. Only slow sand filter technology that can be operated on a demand basis.

6. Scalable – systems available to treat tens of litres to millions of litres per hour.
7. Low capital cost.
8. Simplicity of operation.
9. Minimum operation training.
10. Minimum operator attention.
11. Minimum maintenance requirements.
12. Minimum use of chemicals.
13. Minimum energy requirements.
14. Minimum pressure requirements for raw water feed.
15. Restoring filtration capacity/ filter cleaning uses low pressure backwash. Media is not scraped. Resanding is not required. Mechanical surface agitation is not used.
16. Filter media is not subject to air binding.
17. Breakthrough of untreated water into the treated water supply is not possible.
18. Minimum production of wastewater and waste sludge.
19. Wastewater easily managed (disposed of) because no chemicals used in treatment.
20. Wastewater may be recycled with only the thickened solids going to waste – clarified liquid returned to filter.
21. Modular – treatment systems may be easily expanded in small or large increments to meet future demands.
22. Easily used with other pre- and post-treatment technologies including reverse osmosis, nanofiltration, GAC, ultraviolet disinfection and others.
23. Manual or automated operation.
24. Portability associated with prefabricated MEL Filters.
25. Appropriate for both readily accessible and remote applications.
26. Potential to retrofit existing traditional slow sand filters.
27. Commissioned and decommissioned in increments as required.
28. Several successful projects worldwide. Project descriptions available on request.

13 Comments

The MEL filter technology has been under development for thirty years. It is the only commercially available slow sand filter that can be successfully cleaned using backwash. The technology is mature and well tested. The applications are well understood.

MEL filter technology has a global market.