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Technical Description of Operation of Manz Slow Sand Filter™ (MSSF) and Manz Polishing Sand Filter™ (MPSF) and Comparison of the MSSF/MPSF to Traditional Sand Filter Systems

The MSSF invented in 2006, is the next generation slow sand filter intended for pathogen removal for community use. The novelty of the MSSF relates to effectively taking two well established technological developments and combining them resulting in a slow sand filter which has better or the same characteristics as a traditional slow sand filter without any of its operational disadvantages. The MSSF may be demand operated and cleaned using a backwash process.

Whereas the MPSF is not intended for pathogen removal, it employs the same basic design concepts as the MSSF. It does not rely on biological processes to provide treatment, only those features which exploit the exceptional particulate removal capability of traditional slow sand filtration. The backwash processes used for cleaning the MPSF greatly expand the scope of slow sand filtration to many non-traditional applications.

The MSSF uses a variation of cleaning whereby the upper media layers are fluidized to clean the filter. Fluidizing the media bed to clean a filter is well established in the use of rapid and pressure sand filters. In contrast, traditional slow sand filters must be periodically cleaned by manual scraping. Dr. David Manz invented a novel cleaning process enabling slow sand filter technology to be cleaned using a backwash process. The biolayer does not require re-development every time the filter is cleaned as in the case of scraping. The cleaning process of the MSSF requires a few minutes to complete rather than several hours or even days in the case of the traditional slow sand filters. Traditional slow sand filtration becomes impractical if the water to be treated has high turbidity (high concentration of suspended solids) since cleaning may need to be performed too frequently and the operating cost becomes prohibitive. The ease of cleaning of the MSSF results in a significantly greater scope of applications in terms of the range of quality of water that may be treated since frequency of filter cleanings is not an impediment.

Some of the main design characteristics of the MSSF are as follows:

- The MSSF uses a unique filter bed with the same or better filtration characteristics as traditional slow sand filtration. The MSSF is cleaned by fluidizing the upper portion of the media bed and eliminating resulting wastewater. This is achieved by employing a media bed that performs similar to those used in slow sand filters and incorporating a backwash system similar to that used in rapid and pressure sand filters. The backwash is only intended to break up the surface layer (where virtually all of the waste material is collected) and resuspend captured material, unlike the backwash process used by rapid sand filters or pressure sand filters where the backwash process must not only fluidize the bed; but, must also permit the scouring and flushing of captured material from well within the filter bed itself. The backwash of a rapid sand or pressure sand filter also must be long enough to

ensure that all of the captured particles have been flushed from within the filter bed itself. It is important to emphasize the relative ease of cleaning that the Manz Slow Sand Filter™ and the Manz Polishing Sand Filter™ provide due to backwashing under low pressure, only fluidizing the top portion, not the entire filter bed. Filtered water is used for backwash.

- The flow of filtered water is controlled using a 'weir-type' outlet system (outlet standpipe) connected directly to the filter underdrain system similar to that used with traditional slow sand filters. During normal operation the flow of water into the filter and the maximum depth of water over the filter bed are established by mechanical float valves attached to the raw water inlet pipes within the filter itself. The flow of water into the filter cannot exceed its production. The combination of the permissible maximum head on the filter bed and restricted flow rate eliminates the risk of compaction of the top layer of the media bed. The erosive power of untreated water entering the top of the filter is eliminated as the water enters the filter.

- Once it is determined that filter production is unacceptably low, filter action is isolated and backwash water is allowed into the underdrain system. Treated water is used for backwashing. The backwash of a MSSF is intended to break up the media surface (where virtually all of the material is collected) and resuspend captured material. The wastewater produced during the backwash process is removed using perforated pipes located along and attached to the interior walls of the filter. The perforated pipes are attached to a siphon spillway system that also acts as an emergency overflow system. The entire filtration plant is divided into cells that can be cleaned independently and produce flow rates and volumes of wastewater that can be discharged and disposed of economically. The MSSF may be put into production immediately after cleaning.

- The media bed used in a MSSF consists of at least five layers (depending on scale of filter) of differently sized crushed quartzite (silica) each meeting the material characteristics required for slow, rapid or pressure sand filters as stated by the American Water Works Association (AWWA). The upper two layers or filtering layers use uniform graded media that meet or exceed the specifications for slow sand filtration. The bottom three layers of the media bed or underdrain allow uniform vertical flow, downward and upward, through the filtering layers while filtration is in progress and even distribution of the water across the entire bottom of the filter bed during a backwash. The depth of the underdrain layers may vary with filter capacity while the depth of the filtering layers is constant.

In summary the main distinctions between the MSSF/MPSF and traditional slow sand filtration are having greater application:

- Traditional slow sand filters are generally used only to remove pathogens and very little particulate matter because the maintenance is relatively difficult, time consuming and media requires replacement. These limitations are overcome by the MSSF/MPSF.

- Rapid and pressure sand filters are primarily used to remove particulate and possibly parasites if used in combination with significant pre-treatment. Alone, they are not effective

in removing bacteria, viruses and parasites. These limitations are overcome by the MSSF/MPSF.

- Alternative treatment systems used for arsenic removal may require complex pre- and post-treatment, pH adjustment, generate larger volumes of solid waste, the treatment technology is significantly more complex and requires a high skill level operator; none of the disadvantages occur using the MSSF/MPSF which may also have greater arsenic removal efficiency.

The MSSF/MPSF are simple to operate and to clean, they have low operating cost and produce very little waste water. The MSSF/MPSF method of cleaning is a limited backwash of the surface layer which may be initiated automatically or manually. The MSSF/MPSF are simple to operate and may not require chemicals to achieve desired performance.

The MSSF/MPSF can be constructed using a variety of materials with concrete walls, stainless steel, medium density plastic, aluminum and fibreglass. The system may be constructed on site or prefabricated for installation on site. The filter can be manually or automatically operated and cleaned.