MEL Filters – Brief History of Development of the Technology to August 2022

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The development of Manz Engineering Ltd. (MEL) filters and the MEL Filter System (MFS) took over 25 years and continues to this day. New experiences continue to teach how to better use the technology. This history is a brief summary of the various stages of the development of technology. Clearly, it provides an outline for a book which will be written.

The significant developments are:

1. 1988 to 1989. Visited disadvantaged communities in Kwazulu, Natal, South Africa and the Island of Davao, Philippines where the challenges to obtaining sufficient safe water for household use were learned.
2. 1990. Reviewed available literature on traditional slow sand filter technology and developed a model for how slow sand filters were able to remove turbidity and pathogens from water; and why these filters failed.
   The concept evolved as to how a 'household scale' slow sand filter could be constructed, operated and maintained. It was recognized that the debris accumulation on the surface of the sand, traditionally called the schmutzdecke, was not the primary agent responsible for pathogen removal. Rather the organisms responsible for the removal of bacteria and viruses were located at or near the surface of the sand in a slow sand filter and that they were aerobic. Oxygen supply to these organisms needed to be maintained even when there was no flow through the filter. The innovation introduced was to ensure that the water level above the surface of the sand was sufficiently shallow when the flow of water, that contained dissolved oxygen, into the filter was stopped and allow oxygen in the air above the water to diffuse through the water layer to the organisms on and in the sand and keep them healthy. It later became clear that the individual particles in the layer of sand at or near the surface became coated with a biofilm that was able to capture microorganisms and sustain an ecosystem that was able to capture, consume or otherwise deactivate pathogenic organisms. This layer was subsequently named the 'biolayer'. (The term schmutzdecke was considered confusing and eventually dropped.)
   Cleaning a slow sand filter actually meant removing the material (organic or mineral) plugging the pores in the biolayer and limiting flow through the filter and that this material could be removed by agitating the upper few centimeters of the filtering media, the biolayer, to resuspend the offending particles into the water layer above. This water, the 'dirty' water, could then be removed (decanted or drained) and the surface of the media smoothed level. The particles which possessed a biofilm and constituted the biolayer were left in place and the ability of the biolayer, the filter, to remove pathogens was retained. It was no longer necessary to remove a layer of sand to restore filter capacity and filter to waste while a new biolayer was developed.
   It was recognized that the biolayer must not be disturbed when water was added to the filter. It was believed that this could be achieved by using a perforated plate that the water must flow

through that would break the impact of the water to form small droplets whose impact was absorbed by the layer of water and did not disturb the biolayer and impair its performance. The height of the filter was limited to that which people of normal height could operate conveniently. This meant that the thickness of the filtering layer was limited to the minimum thickness specified for traditional slow sand filtration.
(Note at this time it was considered essential that the design of the household filter conform as much as possible to traditional slow sand filter design and so gain peer acceptance.)

3. 1991. The household filter innovation was demonstrated in the laboratory of the Department of Civil Engineering at the University of Calgary as part of a fourth year Civil Engineering project. It was proven effective. The household slow sand filter was born and was originally named the 'Manz Filter'.
   The technology was assigned to the University of Calgary and a patent was applied for and subsequently granted.
   The first 'found filter designs' were produced using suitable plastic containers, wash basins and commercial sand.

4. 1993 and 1994. A graduate student was recruited and a research program established in the Department of Civil Engineering or the University of Calgary.
   A limited demonstration of the Manz Filter was proven to be a successful, culturally acceptable, intervention in poor households in Nicaragua. They used the filter, shared it with their family and neighbours and experienced significant health improvements after only a few weeks of use.

5. 1994. The technology was further demonstrated in households of the Mapuche Indians near Temuco, Chile where it was further discovered that the media used in the filter needed to be obtained from pristine sources to avoid unwanted contamination and that the filter was very effective in removing oxidized iron from well water.

6. 1994. The first concrete filters were developed using a wood mold typical of those used in concrete manufacturing facilities in Nicaragua. (There were several fourth-year engineering projects exploring different methods of filter production and the technical staff of the Department of Civil Engineering provided significant assistance.)

7. 1994. The first community scale demonstration of the local manufacturing and use of the concrete filters in Nicaragua. This was very successful right from the beginning. For bizarre political reasons at the University of Calgary the project was abandoned. The silver lining to this event was that the people continued to use the filters without outside supervision and came to highly value the technology because of the apparent health benefits from its use.

8. 1994. Limited pilot project in Honduras using found filter design.

9. The wood mold was replaced by a steel mold to produce the filter bodies.

10. 1994. Simultaneous with the implementation of the community scale Nicaragua project, the first plastic variation of the filter was developed to fast-track manufacture and distribution of the filters to disadvantaged households in Luanda, Angola. The doner financed a laboratory in the Department of Civil Engineering at the University of Calgary that could be used to research the filter technology. (This was the first experience with a militant NGO who convinced the doner that trucking water was a better option and sabotaged the project!)

11. 1995. The pathogen removal capabilities of the Manz Filter (bacteria, viruses, Giardia and cryptosporidium) were demonstrated by the Government of Canada National Water Research Centre with funding from the International Development Research Centre of the Government of Canada (IDRC).
    IDRC subsequently funded a household filter demonstration project for the Mapuche Indians in Chile.

12. The community scale project in Nicaragua became 'famous' and demand for instruction on the construction and use of the Manz Filter rapidly developed.

13. 1995. The Manz Filter was given significant support from Samaritan's Purse, Canada and the Rotary Club of South Calgary (Stampede Park) for a humanitarian project in Ethiopia. This project was later funded by the Canadian International Development Agency (CIDA).

14. The need for commercial filter products was encouraged by the Department of Agriculture of the Government of Canada (PFRA) to allow its use in rural households in Western Canada. Davnor Water Treatment Technologies Ltd. was formed to exploit the commercial potential of the Manz Filter (under license from the University of Calgary). Plastic filters continued to be developed. The name of the filter was changed to the Canadian Water Filter and then to the BioSand Water Filter.

15. Filter media suitable for use when treating potable water was sourced from reputable suppliers who were able to maintain very good quality control.
    This was the first occasion two layers of media were used for the filtering layer. The layers were made from crushed quartzite. They had effective sizes of 0.15mm and 0.35mm and conformed to the accepted criteria for filtering media used in a slow sand filter.
    There was a three-layer underdrain system consisting of quartzite particles with effective sizes of approximately 1mm, 5mm and 15mm (plus the underdrain piping).
    The filter is gravity operated and did not need to be supplied with water under high pressure.
    Mechanical methods were developed to agitate the surface of the filter media during the cleaning process.
    Technology was developed to evacuate wastewater to a shallow depth (now called the paused depth) without disturbing the sand surface using syphon technology.
    An underdrain system was developed to remove filtered water.
    A backwash technique was developed that used the same underdrain system to degas the media and eliminate air binding.

Automated filter operation was developed using float valves that controlled the flow of water into the filter through perforated basins (now called diffuser basins) that broke the impact of the raw water flow.
Filter use was combined with pre- and post-filtration treatment. Pre-treatment using sodium hypochlorite to oxidize iron, manganese and hydrogen sulfide was developed. Post filtration treatment could include water softeners, granular activated carbon filters, ultraviolet disinfection and reverse osmosis. A second patent was applied for and subsequently granted through the University of Calgary.

16. Short course content and delivery methods pertaining to the construction and use of the concrete filter in developing countries were refined. The courses were provided away from the University of Calgary in the commercial facilities of Davnor Water Treatment Technologies Ltd. IDRC and Samaritan's Purse Canada funded training on the construction and use of the concrete filter in Costa Rica. IDRC later funded a training course in Indonesia.

17. The BioSand Water Filters developed into a product line with capacities ranging from 12L/h to several thousand litres per hour. The diameters ranged from 20 cm to 10 metres. Filters were manufactured using polyethylene, stainless steel and cast-in-place concrete.

18. Davnor sought and obtained significant investment which conflicted with its charitable activities. The humanitarian version of the BioSand Water Filter continued to be developed and supported by a local NGO, Centre for Affordable Water and Wastewater Technology (CAWST) that was founded for that purpose.

19. Davnor became a publicly traded company on the Alberta Stock Exchange. Much was learned regarding company management needs, business development, manufacturing, local and international marketing, financing, corruption, etc. Also, the technical limitations of the BioSand Water Filter became clear – it was not effective treating water with high concentration of suspended solids, the cleaning mechanism became a manufacturing challenge for the larger filters and the filters could not be economically scaled.

20. 2004. Ultimately, Davnor became insolvent and its license to use the patented technology from the University of Calgary was terminated.

21. 2005. The commercial BioSand Water Filter was replaced with a technology named the 'Low Operating Head Polishing Sand Filter' or LHPF. The design of the LHPF was precisely the same as the BioSand Water Filter. The media bed used in the LHPF was identical to that used in the BioSand Water Filter. The difference between the BioSand Water Filter and the LHPF was that backwash flow rate was increased to where it could be used alone to provide cleaning. The backwash flow rate was intended to fluidize only the top layer of the filter media where the pores were plugged with captured particulate material. It was assumed that it would be possible to limit the backwash flow rate so that it only fluidized the top most layer of the filtering media if it had an effective size of 0.15 mm, a uniformity coefficient less than 2 and was only 5 cm deep in contrast to the second filtering layer which had an effective size of 0.35 mm, a

uniformity coefficient approximately 2 and was 30 cm deep. It was thought that this would sufficiently agitate the surface layer to resuspend particulate matter so that it could be evacuated using syphon evacuation similar to the BioSand Water Filter. The LHPF was considered sufficiently different from the BioSand Water Filter technology that it did not infringe on the patents pertaining to the BioSand Water Filter. The LHPF was the only slow sand filter that could be cleaned using a backwash. This greatly expanded the use of slow sand filter technology.

22. The LHPF technology was implemented by a consulting engineering firm in the design of a water treatment plant used to remove low concentrations of manganese oxidized using sodium hypochlorite. The water treatment plant is located in Stavely, Alberta. Six 4m wide x 4m wide x 1.5m deep filters were designed. They have operated very well since 2007. Though it was proven that in this instance it was possible to use a backwash flow rate that would fluidize only the top layer and adequately clean the filter the backwash flow rate was later significantly increased to improve cleaning and reduce the frequency of cleaning. It is certain that when the backwash flow rate was increased the layering of the filtering media at time of installation was lost.

23. The apparent success of the first project led to the formation of a Canadian company to exploit the LHPF technology. The company was owned David Manz and a partner. The understanding was that Manz would support the technology and the partner would ensure there was sufficient financing until the company was profitable or sold. U.S. and Canadian patents were applied for. There were important differences in the applications: The U.S. application emphasized the ability to backwash a slow sand filter and the Canadian patent emphasized both the ability to backwash a slow sand filter and the design of the filter bed to the extent that it specified the material and effective size of the material used in each layer of the bed. Both patents stated that the layering of the filtering media (top two layers) at time of installation be preserved after backwashing was complete.

24. The success of the first project also led to the attempted use of the LHPF technology in a second plant using cast-in-place concrete. The technology was extensively piloted and it was found to be effective in removing high concentrations of iron, manganese and hydrogen sulfide which had been previously oxidized using sodium hypochlorite. The primary advantages of the LHPF were the limited production of wastewater and elimination of biofouling by iron and sulphate reducing bacteria. However, it was also found that the filter media could not be adequately cleaned by using a backwash flow rate similar to that used in the previous plant (where the layering of the filtering media was preserved). A much greater flow rate was found to be necessary and it was uncertain that the use of the greater backwash flow preserved the layers of filter media at the time of installation. Subsequent detailed particle size evaluation of the filtering media in the pilot filter by labs in the University of Calgary indicated that it did not. The media bed (0.15mm and 0.35mm layers) had been completely fluidized and classified during the backwash process resulting in the particles distributed with the largest on the bottom of the filtering media, resting on the top layer of the underdrain media, and the smallest at the

surface. The treatment plant worked very well and was considered a success. The project won provincial and national awards.

25. A third treatment plant using cast-in-place concrete and twice the capacity of the previous two treatment plants was being considered for removal of complexed iron and manganese and hydrogen sulfide using the LHPF technology. This plant used media that was different from that specified in the Canadian patent application (creativity by the consultant and contractor) and also implemented the higher backwash flow rate. Fortunately for all, a limited small-scale study demonstrated that the different media was satisfactory and was subsequently installed. Chlorine dioxide was used to oxidize the iron and manganese (sodium hypochlorite did not work). An important innovation was the use of clarifiers to separate the solids from the wastewater which could not be disposed of nearby. The clarified water was returned to the filters and the small amount of solid sludge was disposed of in a community lagoon. There was no liquid waste.
    The filters worked very well and the client was satisfied.

26. Manz Engineering Ltd., MEL, wholly owned by David Manz who is a licensed professional engineer, was originally permitted to provide engineering support to the marketing of the LHPF technology to avoid non-compliance of the company marketing the LHPF technology with the Association of Professional Engineers and Geoscientists of Alberta. Unfortunately, this overture was rejected.

27. The demand for filters that are constructed using cast-in-place concrete was found to be very limited. Demand from contractors and consultants for filters that were capable of being transported to site for subsequent installation appeared in late 2012. These enquiries were replied to but the projects referred to did not materialize and there was no further communication with the interested parties. In a way this was fortunate because the company that owned and marketed the LHPF technology did not have the resources to develop new filter innovations and was insolvent by December 2012.

28. 2013. After the apparent failure of the company intended to commercialize the LHPF technology, MEL was approached by other companies to supply portable slow sand filters that could be cleaned using backwash. MEL understood that the media it would use in the filters and the method of cleaning the filters must not infringe on the Canadian LHPF patent.
    MEL developed a conceptual design for a portable filter.
    A local Hutterite Colony was discovered who were very skilled in manufacturing using stainless steel and was interested in expanding its business opportunities.
    MEL accepted the project with a fifty percent down payment on an estimated selling price. This was a gamble. Mel hoped that it would at least break even.
    MEL, together with Hutterites, designed the first portable 2m x 4m x 2m backwashable portable stainless-steel filter. The integrity of the wall design was independently confirmed by structural engineers.

MEL ultimately supplied two portable filters complete with media that satisfied the clients and avoided problems that had been encountered with unwanted creativity from consultants and contractors.

29. Filters were developed for bench scale evaluation and pilot scale evaluation of the use of MEL filter technology.

30. A later project required several 4m x 4m x 2m stainless steel filters. This was also a new design and was manufactured by the same Hutterite Colony.

31. MEL filters became known as the MEL-BF and the MEL-PF. They are two filter products in the MEL Filter System or MFS that also included a roughing filter, the MEL-RF and a granular activated carbon filter, the MEL-CF.

32. Demand for larger capacity filters required the development of 8m x 8m x 2m and 16m x 16m x 2m filters. The tanks are constructed using cast-in-place concrete designed by client's engineer according to specifications supplied by MEL. All piping and speciality appurtences are supplied by MEL. Contractors will construct the tanks and install all piping and speciality appurtences.

33. The novelty of the larger MEL filters suggested the development of two smaller filters.
    The Cabin Clean Water Filter or CCWF with a maximum treatment capacity of 12L/h. It is intended to supply safe drinking water to rural and urban households around the world and so avoid the dependency on bottled water unsustainable treatment methods.
    The second filter is named the Manz BSF 60. The Manz BSF 60 is able to treat 60L/h when operated as a biological filter and up to 150L/h when operated as a polishing sand filter. The operation and cleaning processes are identical. The Manz BSF 60 is used in a similar manner to the larger MEL filters and the BioSand Water filters sold by Davnor Water Treatment Technologies Ltd. The Manz BSF 60 filter and its earlier BioSand filter variation have been successfully used to provide potable water to Canadian households for over twenty-five years. The MEL BF 60 can also be used for piloting larger scale MEL filter applications.

34. MEL continues to market the MEL Filter System or MFS.

35. Davnor Water Filters Ltd. markets the Cabin Clean Water Filter and the Manz BSF 60.

See web sites; www.manzwaterinfo.ca and www.cabincleanwaterfilter.com .