

Biological Water Treatment is the Solution

Dr. Hans Peterson, Safe Drinking Water Foundation,

www.safewater.org

As was stated in the previous editorial “Poor Quality Raw Waters Need More than Chemical Treatment”, it was in 2002 that Aboriginal Affairs and Northern Development Canada (AANDC) and Associated Engineering (AE) were at a loss for how to deal with Yellow Quill’s poor quality raw water.



Yellow Quill’s raw water collected in the treatment plant (left), Saskatoon’s raw water collected from the South Saskatchewan River upstream from Saskatoon on the same day

AE had produced a report with half a dozen treatment technologies for Yellow Quill and AANDC to consider, but AE was not able to give the community any assurances that any of the suggested technologies would work or indeed meet the Guidelines for Canadian Drinking Water Quality.

The options for AANDC were not good and it did not seem possible that chemical water treatment would be the solution. AANDC, in the end, suggested that AE hire me to try to resolve the issues Yellow Quill was facing with their water. I was reluctant as I felt an engineer, not a biologist, should tackle Yellow Quill’s water treatment issues. Think about it, 99% of all water treatment in the world is based on chemistry and physics, 99% of all people working on water treatment are engineers. So, for AANDC to suggest to AE to hire a biologist seemed to me like a leap of faith.

However, upon closer examination unresolved challenges in drinking water treatment are almost exclusively caused by bacteria. In fact, bacteria can really be considered to be water quality.

Let me explain:

All natural water sources whether from 10-1,000 m below ground, a river, or a lake, have one thing in common. They all contain compounds which bacteria can use to grow and prosper. Raw water is to bacteria like one huge smorgasbord that has gone through a blender and then mixed into the water.

This is the kind of water that all water treatment plants around the world have to treat. The mix of food and the amounts vary, but even in a pristine mountain stream there are clear signs of a smorgasbord.

Conventional groundwater treatment is based on using chemistry to remove or oxidize some parts of the smorgasbord. Oxidation (potassium permanganate, chlorine, etc.) is used to change the composition of the smorgasbord. This way, we are able to remove iron, some manganese, and a few other compounds. However, in doing so, ideal conditions are generated for specific bacteria, such as manganese oxidizing bacteria that are given the exact conditions where they will thrive. When bacteria get to live in the conditions they like and then get lots of food (the smorgasbord) the bacteria will be happy and grow rapidly resulting in slime layers in Reverse Osmosis (RO) membranes, in the treated water reservoirs, and in the distribution system.

Even when only a few, say two bacteria, have the ideal conditions these two bacteria may double in 15 minutes and then double again in another 15 minutes. After only five hours there are 2,097,152 bacteria! For water users this spells poor quality water even if it was not too bad leaving the water treatment plant. Also, this causes fouling of the RO membrane and rapid membrane failure.

At Yellow Quill the existing water source was contaminated by an upstream wastewater discharge and it was decided that it would be better to try to make use of the extremely poor quality groundwater than to try to fix the contaminated surface water. The R&D, piloting, and the final solution at Yellow Quill centered on how to make an extremely poor quality groundwater source drinkable. The end result of our R&D was the development of the Integrated Biological and Reverse Osmosis Membrane (IBROM) treatment process, a process that was recognized at the United Nations in New York in 2005.

In conventional chemical treatment of groundwater the different treatments aim to generate particles and then trap those particles. This way 500 million particles are generated per litre of chemically treated water at Yellow Quill. However, when using biological treatment all of the bacterial food remains in solution until the bacteria have ingested the food and retained it either inside the cells or in a layer outside, but tied to the bacterial cells. In the picture below the left bottle has been biologically treated and no particles were formed even after sitting in the bottle for years. Contrast this to the bottle on the right where the same water has just been exposed to air and 500 million particles per litre are formed within an hour.



Biologically treated (left) and untreated (right) Yellow Quill groundwater

During the biological process the bacteria have gained energy and bound the contaminant without generating any particles. So, in a way, biological treatment is all about not generating any oxidized particles. The water in a biological groundwater treatment plant will remain clear throughout the biological treatment process. This allows for very long filtration runs typically 10 to 20 times longer than for chemical treatment. This saves both operator time and water needed for backwashing.

When using biological pretreatment which uses iron bacteria to remove iron, and nitrifying bacteria to remove ammonium, and other bacteria to remove organic material ahead of an RO membrane to complete the treatment, we end up with water where every single scrap of food has been removed from the smorgasbord.

By the time this water reaches the RO membranes there are not even any breadcrumbs left. This is the reason that an IBROM at Pasqua First Nation has never required its RO membranes

to be cleaned even after operating for seven years. The RO membranes at Pasqua are also producing the same high quality water this year as they did in 2005; contrast this to chemical pretreatment systems and you will be hard pressed to find such a system that is able to produce the same quality water even after three months of operation. Chemical damage is virtually a given in such pretreatment systems ahead of ROs.

The IBROM system has been designed to remove even the smallest breadcrumb and, in addition, it is done in a way that leaves the operator in 100% control with state of the art remote technologies to allow the operator to observe and control the entire process from wherever there is an Internet connection. If ever a problem arises, troubleshooting can be undertaken and the problem can be resolved remotely ensuring that the production of high quality drinking water is always a given.

The IBROM system was developed with the realization that meeting current guidelines was nowhere near sufficient to produce safe drinking water from poor quality water sources. We carried out years of research, which is still on-going in many native communities. We used science at every step of the way, testing, changing, improving, and working with operator input until the IBROM system has become one of the most efficient water treatment processes in the world. There were two AANDC employees, Jouko Kurkiniemi and Earl Kreutzer, who spearheaded support for the IBROM development. Without Jouko's and Earl's steadfast support the development of the IBROM would simply not have happened.

I walked with Earl Kreutzer into the official opening of the Yellow Quill water treatment plant, the first IBROM plant to be built. Earl turned to me and said: "You know Hans I used to fear coming to Yellow Quill because we had done such a poor job of the water here, but now I think I could be elected Chief!"

The Safe Drinking Water Foundation has argued against water treatment systems that cannot meet the Guidelines for Canadian Drinking Water Quality and is proud of having been involved with the development of the IBROM system, a system that not only meets the Guidelines for Canadian Drinking Water Quality, but also U.S. and European regulations as well as WHO recommendations for calcium and magnesium.

Another advantage of the IBROM is the production of biologically stable water, which means there are no opportunities for bacteria to multiply anywhere, there just is no food left for them. The SDWF is recommending the IBROM process and any other system that can produce truly safe drinking water from really poor quality water sources in a sustainable manner. So far, we have not found another system that can. SDWF is striving to make truly safe drinking water affordable to rural communities in Canada and elsewhere.