WATER ONLINE

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Biological Filtration: The Future Of Drinking Water Treatment?

By Laura Martin

Biological Drinking Water Treatment

For years, Canada's aboriginal communities struggled to deal with poor-quality drinking water.

Their cold, brackish groundwater was packed with high levels of calcium, arsenic, and a variety of other contaminants, and was nearly impossible to treat effectively. At one point in 2006, there were 86 First Nations in Canada under boil-water advisories, according to Health Canada.

Many had given up on the idea that these aboriginal communities would ever have truly safe, clean drinking water. As a last resort, a group of scientists decided to try an unconventional method that had struggled to gain acceptance for decades — biological drinking water treatment.

“We looked at a string of conventional treatments, and they didn’t work,” says Hans Peterson, a microbiologist and the Safe Drinking Water Ambassador for the Safe Drinking Water Foundation in Canada. “Biological filtration has not been historically accepted, at least not in North America, but it showed promise and is up and coming.”

Peterson and his group designed a water treatment system that uses naturally occurring bacteria instead of chemicals to remove contaminants from water, and then treats the water a second time by reverse osmosis (RO). Conventional RO systems using chemical disinfectants were attempted in the First Nations previously, but the RO membranes had to be replaced after just one year due to chemical and microbial fouling. The RO membranes in Peterson’s new integrated biological and reverse osmosis membrane (IBROM) treatment system could last up to 20 years.

“For water that is as bad as this was, using RO is absolutely necessary,” says Peterson. “So we designed a system that could optimize that process, and that had to be a biological treatment system.”

Today, 16 full-scale treatment plants in Canadian First Nations utilize Peterson’s IBROM treatment system. Boil advisories have been lifted all over the country. Treating the poor quality water in Canada would have never been possible without the use of bacteria, Peterson says.

“Biological treatment is going to be the future of drinking water treatment,” he says.

Peterson isn’t the only one who believes in the advantages of biological drinking water treatment, which has been growing in acceptance and popularity over the last five to ten years.

“More and more utilities are implementing it, you are seeing it discussed at conferences, regulators are tuned into it and are starting to develop guidelines around it,” says Jess Brown, the chair of the Biological Drinking Water Treatment Committee for the American Water Works Association (AWWA). “People think of biological treatment as a wastewater process. But really it is a very natural and effective process.”

Compared to other drinking water treatment technologies that sequester contaminants and then remove them, biological treatment destroys contaminants entirety and is able to remove multiple contaminants at the same time. This cuts down on **s**ludge production and bacterial regrowth. Biological treatment can be used to remove natural organic matter, color, chloroform, perchlorate, nitrate, nitrite, bromate, iron, manganese, selenate, chromate, arsenate, and a variety of other contaminants. It eliminates the need for chemical oxidation prior to filtration or settling, eliminates the need for chemical reduction methods, and produces innocuous end-products, thus reducing the risk of a contaminated concentrate stream.

“In conventional treatment systems there is a constant battle between disinfection and disinfection byproducts (DBPs),” says Brown. “With biological treatment there are minimal to no chemical additions required, so you remove disinfection byproduct precursors.”

Cutting back on chemicals can save a treatment facility a significant amount of money as well, says Peterson.

“We have a surface water plant that used to use $15,000 worth of chemicals per month. Now, with the biological filtration system they only use $100 worth,” says Peterson. “With a conventional treatment system the footprint is just too high and the water quality is too low.”

Implementing a biological drinking water system is fairly simple; it is a basic “old school filtration system,” says Brown. But the relative rarity of the technology up until now does present some obstacles. A lack of education is the biggest challenge.

“There are no current manuals of practice or guidance manuals,” says Brown. “So when you start out, you can’t go and get a manual and that feels less comfortable. But that will change.”

In Canada, Peterson and his team have worked diligently to get operators up to speed. An apprenticeship program has been created, as well as several training programs and guides.

“You can’t take a cookbook off the shelf and do this,” says Peterson. “We are writing the cookbook as we speak.”

The AWWA is also working to educate the public. In March they hosted the 2013 Biological Treatment Symposium, which focused on the benefits of engineered and passive biological treatment systems from research and utility perspectives. Over 30 different technical sessions were offered.

As with any new technology, startup costs may also hinder some utilities. In large cities with a lot of water infrastructure, a dramatic change like moving to biological treatment would involve pilot testing, which could be expensive. Right now the technology is best for smaller, rural communities struggling with water quality, says Peterson.

Many academics and industry researchers have dedicated their time to making biological treatment more accessible and easier to understand. As manager of Carollo Engineers’ Research Group, Brown leads the firm’s biological drinking water treatment initiative. Other firms have similar initiatives.

“We’ve really been digging into the nuts and bolts of this and we understand it better,” says Brown.

Brown feels that now, more than ever, is the time for biological drinking water treatment to come to the forefront. Costs of handling water treatment residuals are rising, there is a greater push for green technologies, more regulations limiting the formation of DBPs, and new contaminants that are particularly responsive to biological degradation are on the rise — all factors that make biological treatment an effective solution.

“We get calls weekly from people interested in biological drinking water treatment,” says Brown. “There are still a lot of folks that are hesitant, but I think as we grow the number of plants out there that are using it, we will start to see it a lot more. There is a big, big push in the industry to go toward this.”

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Jhon carlvo
a year ago

The future of drinking water treatment? This is it. Chemical Solutions' water treatment products are designed to reduce the number of chemicals required to treat a wide range of drinking water applications. I highly recommend The Vortex Water Revitalizer™ for the best water filter system today.

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Odota Deo Wilbert
2 years ago

Dear Hans I landed on this information while searching for a multi-throng solution for water treatment for rural communities. I'm moving on to recommend this for full scale roll out but wonder if there are modules existing for wide scale use. I will need this information in my inbox at odotadeo@gmail.com as soon as possible. Regards

o o Reply • Share ›

Timothy Woldt
6 years ago

Is biological wastewater treatment being done anywhere currently in apartment complexes or shopping malls. I assume their size makes them logical locations for water purification activities. At the very least excess water can be contained by nearby orchards.

o o Reply • Share ›

Grant Gillies
6 years ago

Is there a small-scale system in place that could be installed in a private home, and could this also be applied to a desalination process such as for boats in salt-water. I am assuming the treatment equipment and/or process is patented. Very interested to see how this could be made available to the masses.

o o Reply • Share ›

selina
7 years ago

I would like to know if this process can be used to treat galamsey water bodies. I would be glad if this is possible so we can help my country Ghana.0243015858

o o Reply • Share ›

more
8 years ago

Now, doesn't it seem like a great idea to install a water filtration system? You will no longer have to jeopardize your family's health with drinking water that has passed through ancient and decaying pipes to reach your home. A good water filtration system will clean your water of drugs, chemicals, and bacteria. The best investment of your life may be your water filtration system!

o o Reply • Share ›

aditya rathi
8 years ago

Hello Peterston, Was going through the post where you challenged the conventional chemicals oriented way to purify water with a biological.terminology IBROM. We are the RO plant manufacturers in domestic sector. Would like to.know more about IBROM and it's installation and functioning for if we could merge it with the conventional way or could try manufacturing the biological purification plant proposed by you under your surveillance. Highly impressed with the idea. Hoping for a reply from your side. Thank you

o o Reply • Share ›

Len
9 years ago

From the time immemorial, the nature has made it easier for us to breathe fresh air, get safe drinking water from the underground resources, and cleanse the environment automatically, with the help of hidden scientific processes, which have now been followed by

resources, and cleanse the environment automatically, with the help of hidden scientific processes, which have now been followed by the modern technicians for carrying out air & water purification, with the help of activated carbon. Thanks! Len

o o Reply • Share ›

CZ **Carlos Zuleta Araya**

9 years ago

Um sistema eletroquÃmico de tratamento com recuperaÃ§Ã£o de hidrogÃªnio combinado com um reator UASB com coleta de biogÃis, nÃ£o seria uma soluÃ§Ã£o barata, limpa, segura, sustentÃivel e mais completa? estou trabalhando neste projeto, gostaria a sua opiniÃ£o e/ou comentÃirio, seria muito importante para meu projeto [Translation: "An electrochemical treatment system with recovery of hydrogen combined with a UASB reactor with biogas collection, it would not be, clean, safe, sustainable and most complete cheap solution? I'm working on this project, I would like your opinion and / or comments would be very important for my project."]

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G **G.S.Nagender**

9 years ago

Dear Dr. Peterson, I am working water treatment field in India , I India many villages not getting safe drinking water It is highly contaminated due to so many reasons .Am very much interested your design of Biological Filtration system can you provide details of this process and min plant capacity of 1000 Lt/hr . Wt is approx cost.

o o Reply • Share ›

L **luis**

9 years ago

Hi Dr. Have do you working with water hyacinth(eichornia crassipes) for municipal water tratment?

o o Reply • Share ›

EG **Ed Gardyne**

9 years ago

Isn't this an argument for slow sand filtration? My father ran a gravity driven 20MGD slow sand filtration plant (designed in 1866) serving the city of Aberdeen for 35 years. He always maintained slow sand was the best filtration method. Although it was labor intensive skimming and washing sand, he had the filters so finely tuned he could run them for 100's of days between resanding and the 'Schmutzedecke' biology took care of Crytosporidium etc. When he retired in 1997 they lost his expertise and the filters became more mechanical than biological. They then shut all the filters down and replaced them with nano-filtration membrane plants. He scratched his head at this before he died in 2011. For the record he also designed small scale slow sand filters for small communities and private water supplies.

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DB **David Baer** ↗ Ed Gardyne

9 years ago

Sand, as other media, can support biological activity, but it is far from an ideal support. Obviously, sand has other advantages in terms of mechanical filtration and entrainment of contaminants, but it is not a good adsorbent in its own right. You make an excellent point, in that while sand filtration can be effective, it takes expert management to continue to operate in an optimum manner. Not all Water Treatment plants have the kind of expert management that this would require to work well, even if it is a modestly expensive system. AWWARF has been working on developing system approaches that can used more broadly by many WTP operators.

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DB **David Baer**

9 years ago

It should probably also be mentioned here (which was not apparent in the article) that ozonation (or some Advanced Oxidation Process, AOP) is necessary to degrade many higher molecular weight organics to smaller molecules that can be digested by biologically active beds (supported by either GAC or other media). Several major cities (such as Toronto, Canada and Tampa Bay, Florida) already rely on biologically active beds to purify drinking water for their residents.

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HA **Hassimi Abu Hasan**

10 years ago

Dear Dr. Hans Peterson, Since you use integrated Biological filtration with RO system for drinking water treatment, do you still used chemical treatment like coagulation/flocculation before the biofiltration unit because river water quality is bad in term of color and turbidity. As my knowledge the conventional water treatment unit consists of grit chamber, coagulation/floccuation, filtration, and disinfection. Thank you H. Abu Hasan

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SC **Sandy Cavanaugh**

10 years ago

Dear Dr. Peterson, I'm working on a STEM curriculum for middle school children in which the focus is on water purification. I was very excited to run across this article and am extremely interested in your design of Biological Filtration. Do you see any possibilities for

designing a biological filtration system in a classroom? Can you direct me to any sources so that I can better understand the process? Greatly appreciated, Sandy Cavanaugh, D.Ed.

o o Reply • Share ›

DH **Dr. Hans Peterson** ➚ Sandy Cavanaugh

10 years ago

Hi Sandy, The STEM curriculum is very interesting as you try to connect students with real environmental issues. Understanding the scientific underpinnings of these issues could help move these issues forward. For more than 100 years water treatment has been the forte of chemistry and physics and there have been advances in terms of disinfection and removal of particles from raw water sources. Moving forward we will still make use of these advances, but, in addition, we will aim to address issues that chemistry and physics have failed to resolve. 1)The removal of dissolved organic compounds. Coagulation and filtration will remove lipophilic compounds (fat-loving), but will leave hydrophilic compounds (water-loving) compounds in the water. The hydrophilic compounds are a major source of food for bacteria. 2)Removal of specific inorganic compounds, such as arsenic and ammonium. Again, As3+ and ammonium are excellent energy sources for bacteria. 3)Removal of reduced gases. These gases include hydrogen sulfide (rotten egg smell) and methane and they can be removed with expensive physical units, but as these gases are great food for bacteria, biofilters will effectively remove these gases. There are several additional advantages to use biology to treat drinking water and this has lead me to give presentations with the title: "The demise of chemistry and the emergence of biology in drinking water treatment". In my opinion, we cannot afford chemistry, and the footprint of chemical water treatment plants is too large and the quality of the treated water is too poor. I am convinced that within the next 20 years biology will take over from chemistry with biology becoming the prime mode of water treatment.

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NH **Nicole Hancock** ➚ Sandy Cavanaugh

10 years ago

Hello Sandy, Thank you for your question, I am the Executive Director of the Safe Drinking Water Foundation and wanted to direct you to an educational program which we have developed about biological water treatment. It is called Operation Water Biology and it teaches students about biological water treatment including aspects such as iron, ammonia, chlorine and chloramine. For each of these there is a discussion explaining what it is and its importance to drinking water treatment. There are also lab activities for each which allow students to work with small amounts of these substances and see them in action. Students will demonstrate the idea of chlorine demand, create chloramine through a simple chemical reaction, test local samples of drinking water for chlorine and ammonia, and filter water samples with iron oxidized by different processes to determine if one is superior. Every lesson includes additional suggested activities and resources, along with references to other sources of information. For more information please visit: http://www.safewater.org/education/school-program... and the program is also available in French. Kits can be purchased here: http://www.safewater.org/sales-order?lang=eng&amp... and we also have six other educational programs, two of which have educational kits, to find out more about our educational programs please visit http://www.safewater.org/education/school-program... e-mail me at info@safewater.org or call me at 1-306-934-0389 and I will be happy to answer any questions you have. Sincerely, Nicole M. Hancock

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JD **Jaideep Dudhbhate**

10 years ago

This is very interesting. Can you share some more information on biological process used? Thanks

o o Reply • Share ›

DH **D.C. Hettiarachchi**

10 years ago

13.12.2013 Is this a compartmentalized oxidation/reduction system for different pollutants or a consortium of different microorganisms working together in a single chamber growing on a substratum? D.C.Hettiarachchi from Sri Lanka

o o Reply • Share ›

DH **Dr. Hans Peterson** ➚ D.C. Hettiarachchi

10 years ago

Hi D.C. Hettiarachchi, If we look at typical groundwater sources and many surface water sources Central Canada has some of the poorest quality raw water on earth in terms of chemical contaminants. We have hydrogen sulphide, methane, iron, ammonium, manganese, dissolved organics including color and bioavailable organics, arsenic, uranium, selenium, bromium, fluoride, chromium and the list goes on. Traditionally regulatory agencies have looked at compound specific treatment, which could be iron, manganese and arsenic. This will not produce safe drinking water. The key with the treatment technologies we work with is that we know we need to treat more than a dozen contaminants, not two or three. Only by treating more than a dozen contaminants will we achieve truly safe drinking water. The biological processes we use are tailored to the specific contaminants that we need to remove and we can use one or several biological filtration tanks depending on the chemistry of the raw water sources. We will typically use 2 to 4 tanks. Each tank will have a material that is suited for the establishment of the bacterial consortia that we like to house there. We maintain optimum conditions for the specific bacterial consortia that we have in each tank allowing contaminants to be removed one by one ending up with a biologically stable water that we can treat using tight RO membranes without fouling or scaling.

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MD **Mike Dempsey**

10 years ago

How does this form of biological treatment differ from sand filtration, as used in the UK since Victorian times?

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DH **Dr. Hans Peterson** → Mike Dempsey

10 years ago

Hi Mike, Lots. Like night and day. Inefficient biological treatment consists of using any material that biofilm forming bacteria may settle on. Sand is likely the most inefficient of those materials. Think of it as your ability to pack as many bacteria as you can into a certain volume. In sand most of the bacteria can only attach to the outside surface where they cling on for dear life worrying more about remaining stuck on the sand grains than about cleaning up the water. Development of efficient biological treatment has centered on the use of very different materials. These materials have one thing in common, spaces inside the grains allowing for much larger bacterial densities per unit volume. Examples of such materials include Granular Activated Carbon (GAC). GAC has both micro and macro pores inside the grains and a main problem with this is size, most pores are too small for bacteria to inhabit. We need Japanese hotel rooms, small rooms that are just sufficient to get in, but we don't need tiny closets nor do we need ball rooms. Thinking along these lines Saint Gobain has developed an inert ceramic material that they call Filtralite and that is the material we have used in all of our full-scale biological water treatment plants (IBROM plants). This material has very low attrition (loss) rates and doesn't suffer from one issue that plagues GAC, the release of fines (loaded with bacteria) into the process stream.

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JA **Jaime Alvarez**

10 years ago

I think it is very interesting and I woul like to have more information about Peterson membranes

o o Reply • Share ›

AV **Alberto Ventura** → Jaime Alvarez

9 years ago

Jaime: Somos una compaÃ±ia EspaÃ±ola que utilizamos esta misma tecnologÃa. Tenemos plantas funcionando en EspaÃ±a y en todo el mundo. Si te interesa podemos contactar. [We are a Spanish company that used the same technology. We operate in Spain and worldwide plants. If you are interested you can contact.] Alberto Ventura www.thisiswater.eu

o o Reply • Share ›

DH **Dr. Hans Peterson** → Jaime Alvarez

10 years ago

Hi Jaimie, Thanks for your kind comments. I have spent more than 20,000 hours studying the optimization of biological filtration in the lab, in pilot-scale, and in full-scale water treatment plants. I have come to realize that bacteria can do things that are not attainable by chemistry. Harnessing this bacterial power is my life's goal and the development of the Integrated Biological and Reverse Osmosis Membrane (IBROM) process was my biggest step in this direction. I am continuing the development on the IBROM process and we have now gone from Version 1.0 to Version 2.8. The quality of the biotreated water is such that we have been able to run water treatment plants for 8 years without cleaning the tight RO membranes that we use. We meet all international regulations for treated water quality. If you would like to find out more you can write me a note to hans.peterson@yahoo.com or you can google hans peterson water and you will get more than 3 million hits.

o o Reply • Share ›

B **B.S.Raman** → Dr. Hans Peterson

9 years ago

Dear Sir, My name is B.S.Raman contacting you from India. I have been in chemical industries. Like Fertiliser, petroleum Refining, Coastal based Gas Turbine based Power generation plant (PSEG global, USA is a partner in that venture) . I am qualified in Chemical Engineering And chemistry specialized in the field of Enviironmental Engineering and Water Technologies. I am 76 now and after retirement at the. Age of 65, under the flagship of our family trust called SBMSCHARITABLE charitable Trust , we do community service in Rural area and also conduct seminars to create awareness on WAtER. IBROM process will be very useful In India especially at rural level. I am interested to get more details of the "Bioreactor and micro flora". We can get pilot plant studies at University level and subsequently set up treatment plants. At present in many villages , sewage and liquid waste generated reaches the river or canal causing more pollution.t Expecing an early reply, Kind regards B.S.raman E-mail ID :- bsr38in@u

o o Reply • Share ›

AV **Albert Ventura** → B.S.Raman

9 years ago

Ms. Raman: We are a company that has biofiltration also. If you are interested, we are starting in India and would like to help rural areas. Albert Ventura www.thisiswater.eu

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