Addressing Challenges in Biological Safety of Drinking Water

By Gene (Guenadi) Rabinski, Ph.D.

In the last several years, we have seen several major disasters where shortages of adequate drinking water supplies have been a critical problem. In addition, natural water sources are being polluted by contaminants that arrive from far abroad by air and rainfall. Moreover, industrial waste leaking into natural water resources has resulted in the presence of contaminants, which were unseen even a few years ago, such as nano-particulate matter.

For years, the biological safety of drinking water has been based on a reactive approach, where water samples of finished municipal drinking water and bottled water were tested on a periodic basis. Such tests require at least one day, and sometimes several days, to complete. In addition, water samples are typically only a few milliliters of water in volume. Unlike dissolved chemical contamination, distribution of biological contamination in source water is highly non-homogeneous. Assessment of microbiological safety of large volumes of potable water (usually, in several thousands/millions of gallons) based on the analysis of a very small water sample may often be inaccurate. In the event a biological contaminant is found in such a small water sample, the implication is that citizens might have already consumed unsafe water. Such situations are not rare. In addition, consideration of possible situations where a biological contaminant may be intentionally introduced to drinking water by an unknown entity is becoming more common. In the modern world, the presence of biological contaminants in drinking water of all types poses a critical danger for our entire society.

Most modern, widely used drinking water treatment processes in both municipal drinking water and bottled water markets (such as flocculation, coagulation, gravity filtration, activated carbon adsorption, disinfection, microfiltration and nanofiltration, UV and RO systems) do not guarantee the continuous safety of drinking water. This is primarily due to unexpected variations in the quality of source water, the possibility of micro-cracks in filtration media, etc. Yet, the US EPA, FDA and Health Canada are increasingly concerned with the impact on public health arising from drinking water treatment chemical byproducts.

Modern threats require modern solutions. These include the need for continuous, high-volume water monitoring devices for biological safety, capable of *in-situ* detection of a broad range of biological contamination. Many so-called on-chip biodetectors that have been proposed for this purpose, while having been shown to work well with a certain type of contamination in a lab environment, are virtually useless in a practical application: biological contaminants may be surrounded by and/or attached to and/or hidden in other particles, allowing them to avoid detection by on-chip detectors. Furthermore, and most importantly, these detectors can typically process only a few milliliters of water per minute. This may be sufficient for a lab application but not for an on-site application in a potable water treatment/bottling facility, where millions of gallons of water are processed on a daily basis, in which microbiological contamination is not homogeneously distributed, as mentioned above. Instead, microbiological contamination is often presented by randomly occurring spikes that, based on statistical distribution, would typically not be detected by a device with a water throughput of a few milliliters per minute.

Taking into consideration the non-homogeneity of dispersal of microbiological contamination in water, the ideal on-site *in-situ* detector must at least satisfy the following criteria:

- Be capable of *in-situ* processing of at least a few thousand gallons of water per day
- Be capable of detecting a very wide range of microbiological contaminants
- Must be able to automatically collect a suspicious sample for further in-depth analysis in a certified water testing laboratory.

There are many *in-situ* chemical and radiological analytical devices available on the market, used for emergency and backup drinking water production. Often, detection of randomly occurring, dangerous biological contamination in source water takes at least several hours (and sometimes days) in a certified lab, whereas detection of chemical and radioactive contamination usually takes just a few minutes. High-volume water monitoring devices for *in-situ* detection of wide-range biological contamination should be capable of addressing ALL potential biological threats, while potable water producers should be looking into employing chemical-free drinking water treatment processes.

Such a high-water-volume monitoring device has been successfully developed. Its principle of operation is based on a proprietary non-destructive method of *in-situ* diverging suspended solids from a relatively large and statistically sufficient water volume (> 10 k gal/day) to a detector chamber, where a type of each captured object is *in-situ* determined (biological, organic but not biological, or inorganic), and then concentration and size of all captured *biological* objects is automatically determined, notwithstanding whether biological particles are attached to or hidden inside other particles. The device can also alert the operating staff of a water processing facility to dynamic change of user-defined parameters of biological contamination including, but not limited to, concentration range, size range and the trend. A sample of suspicious biological contamination can be automatically captured based on user-selected criteria for further analysis in a licensed water laboratory.

About the author

Gene (Guenadi) Rabinski, Ph.D. (physics) is President of R&D Innovative Solutions Inc. and the developer of the Innosol instrumentation family (in-situ, large-volume, microbiological contamination detection devices) and state-of-the-art emergency and backup water purification devices. Previously, he was an Adjunct Professor in the Department of Physics at the University of Ottawa, Canada. Dr. Rabinski has more than 25 years experience in managing complex research, development, and new product introduction programs and projects. He has created and successfully implemented several inventions, including but not limited to, instrumentation for the water industry.

About the company

R&D Innovative Solutions Inc. is a federal-level, privately owned, incorporated business formed in 2002 with the head office located in Ottawa, ON, Canada. The business conducts high-level research, development and consulting services for Canadian and US customers, as well as development and commercialization of new innovative instrumentation. More information can be found at www.waterbiosafety.com.