The evolution of decentralized treatment using chambers

by Dale McLure

The onsite industry as a whole has evolved dramatically over the past 15 years. The need for new approaches to decentralized applications and environmental demands have spurred this change and challenged scientists, regulators and product manufacturers to develop new ways of thinking about how decentralized wastewater treatment is accomplished and managed. Another catalyst for change has been the desire to develop sites that might have been deemed undesirable in the past. This demand has arisen because of the high cost of available land in many areas.

An increased awareness regarding the need to protect environmentally sensitive areas has resulted in more restrictive building and development codes, including onsite wastewater system design and installation regulations. These regulations have been and continue to be amended to preserve and protect natural resources and public health. They have also been the catalyst for new thinking in terms of onsite wastewater system design and the development and use of advanced wastewater treatment and disposal technology.

Factors that can impact a site and cause it to be considered environmentally challenging may include lot size, proximity to bodies of water or environmental preserves, physical barriers that impede onsite wastewater system construction or regulatory restrictions that limit construction. The growing supply shortage of easy-to-build sites and the associated escalating prices are causing individual buyers, developers, and builders to purchase land that presents construction challenges in general and, more specifically, with onsite wastewater treatment and disposal.

Large community systems using chambers are being designed by engineers due to their large storage capacity.

Regulations for leachfield sizing and construction have changed to accommodate challenging development conditions

While the housing construction market is not within the scope of onsite wastewater system regulator responsibility, single-family home construction is a major element of the Canadian economy and is affected by onsite wastewater system regulation. Fluctuations in housing starts can have a profound effect on local and provincial economies. The relative ease or difficulty of site development can be a function of the standards by which onsite wastewater systems are sized and constructed. If regulations can keep pace with scientific and technological developments, historical constraints on single-family home construction can be responsibly amended or reduced through adjustments to regulations. Such adjustments can allow land development work to proceed on parcels that may not have been developed otherwise.

Adjustments to regulations may include approving new treatment and disposal system technologies. An example of disposal system technology approval is manufactured leachfield products such as plastic leaching chambers, which provide a more efficient means of delivering effluent to the final treatment system. Additionally, with the creation of these new and revised regulations, the regulatory community at the provincial levels is increasingly embracing systems that incorporate advanced technologies.

To make responsible changes, regulators have to consider current research findings and integrate those findings into leachfield sizing and construction regulations. Historically, regulations for conventional stone and pipe leachfields were developed based less on science and more on a trial-and-error process. Many regulators are now reviewing the available scientific research findings and third-party testing data and reexamining onsite policy accordingly. This has resulted in a shift away from older onsite system designs to the approval of new technology and advanced applications for both treatment and disposal of wastewater. With the regulatory shifts have come further innovations in onsite wastewater systems, providing a dramatic increase in the number of options for onsite systems. In combination with the shift to new technologies, regulators are revising land use policies that consider the array of onsite wastewater system options. Adjustments to these policies have and will continue to be made based on local development and environmental objectives and philosophies.

Challenges for installers, engineers, system designers and developers

Installers earn a living from onsite wastewater system installation, and as the number of developable building lots using conventional means decreases, installers must also rely on advanced systems and technological innovations to maintain their business. Where repair work is an installer's mainstay, chamber systems and advanced treatment options can provide a means for upgrading a failing system using reduced space.

Similar to installers, engineers and onsite wastewater system designers rely on site design work for their existence, including onsite wastewater system design in many regulatory jurisdictions. With increasingly difficult building lots available for development, the onsite wastewater system engineer or designer is moving toward the innovative space-saving and flexible technologies that can be easily adapted to site conditions. A representative example is an articulating chamber product that can be installed at a reduced size and contoured to match the available landscape.

Where developers and builders rely on new construction for their business, the size and construction of the onsite wastewater system frequently influences the way land can be used and developed. The availability of advanced technologies in onsite wastewater systems has allowed developers and builders increased flexibility with respect to land use. Because these systems can occupy smaller spaces, developers and builders have more alternatives related to land use options.

New products and applications to the rescue

One of the greatest recent benefits of this has been a new generation of products that enhance treatment, ease installation and reduce management dilemmas. Chambers have been at the forefront of this new product and applications movement because of their versatility and effectiveness.

Over the past 30 years, chambers have evolved dramatically in design and are now commonly used for onsite treatment in basic and advanced applications. The first chambers to be used commercially were constructed of concrete and installed in New England in the early 1970s. These initial concrete "gallery" chamber systems or "ameration chambers" (USEPA, 1980) were more efficient than previous traditional stone and pipe systems. They were, however, heavy and unwieldy to transport and labour intensive to install. It became clear that an alternative material was needed to manufacture chambers that would not sacrifice strength, durability and treatment performance.

The rapid advancement of plastics technology made plastic the next logical step in the evolution in chamber design. Several years of research and design culminated with the introduction of plastic chambers to the marketplace in 1987. Today, plastic chambers are manufactured by four different companies and have become widely accepted by installers, designers and regulators. It is estimated that one in every four wastewater treatment systems constructed in the United

RO system saves Canola processor 965,000 gallons of water

Canbra Foods Ltd. is one of the largest and oldest Canadian-based canola oil producers. As Canbra's manufacturing process demands the use of a large amount of steam, the plant requires a large amount of city makeup water.

Challenge

In order to maintain the purity of the incoming water, the company used a basic softening system with the use of sodium zeolite softeners. The softening system, however, was not nearly as efficient as Canbra would have liked. There were other problems as well. The amount of water required by the system was excessive. What's more, it also used a tremendous volume of salt, which not only created a huge expense but also ultimately proved detrimental to the environment. And finally, fuel consumption in the boiler house was a concern to Canbra, since the burning of fuel is a major contributor of greenhouse gases to the atmosphere. Consequently, while the softener system was somewhat useful, Canbra was convinced that a different system would be more effective and decided to look for alternatives.

The question was, which alternative would be best? Canbra could have obtained a fairly high quality of water using a weak acid cation system but in the end those systems would have cost twice as much as the original softening method. In addition, it would have required the company to bring sulphuric acid on site, which would not only be cumbersome but also potentially hazardous. It would have also required the construction of degasifying towers, a significant expense and an engineering challenge.

Canbra needed to have ultrapure water because without it, they would experience corrosion problems in their return systems. In the end, this would not only harm the system but would negatively impact the overall manufacturing process.

Solution

Canbra had initially formulated a plan to proceed with a weak acid cation system. However, after conducting some in-depth research, Canbra personnel determined that reverse osmosis (RO) may be a potential solution. Subsequently, GE Infrastructure, Water & Process Technologies (W&PT) provided Canbra with a Reverse Osmosis system. The system is used to supply high purity makeup water to the boilers.

Results

From June 2004, when the system was first installed, until June 2005, Canbra will have saved 965,000 gallons of water. Part of this water savings is due to the decreased demand for softener regeneration, a process that uses 3,500 gallons of water each time. In addition, by using only a ton of salt every day and half, about 230 tons of salt were saved. Finally, the RO system has helped the company reduce fuel consumption in the boiler house by 15 percent, which translates to a reduction of over 3,000 tons of green house gases in the atmosphere every year.

Canbra has achieved significant cost savings by reducing the amount of water treatment chemicals added to the boiler for water treatment by 80 percent. These are chemicals, like the salt and green house gases, that will no longer find their way into the environment.

GE Infrastructure, Water & Process Technologies

States today is a chamber system. While the principals of treatment remain the same, plastic chambers offer tremendous benefits over their concrete predecessors and even greater benefits when compared to the older methods of installations that involved stone and pipe trenches.

Chambers evolve in response to the need for new applications

Advances in chamber design have resulted from the needs of the market and the direction of the regulatory community. Initially, chambers were used for the leachfield component of the onsite wastewater treatment system. As the needs of the industry evolved, designers and installers began to specify the technology for a number of differing applications. What they found is that the chamber is highly adaptable and effective for specialized system designs and treatment needs.

In addition to the traditional use in septic system leaching trenches and beds, chambers have been used in sand filters, mound systems, community systems, constructed wetlands, wastewater treatment plants, with pretreatment devices and at-grade installations.

New chamber designs offer even more flexibility in system design and installation and provide enhanced onsite wastewater system treatment.

The exfiltration gallery at the Port Burwell Sewage Treatment Plant in Bayham, Ontario includes approximately 220 metres of Infiltrator High Capacity H-20 chambers. The construction of the bed includes 300 mm of clear stone as a base.

Advanced chamber system designs and applications

Community systems using chamber technology

Engineers designing large community systems have preferred specifying chambers due to their large storage capacity. Commercial facilities can be subject to large peak flows that the chamber can readily retain. These decentralized cluster septic systems serve multiple residential dwellings or commercial establishments. They use technologically advanced filters, pumps, tank configurations and drainage chambers to provide a higher level of treatment. Decentralized cluster systems treat wastewater and return it to the ground very near to where the wastewater was generated as opposed to transporting it long distances to a centralized sewer facility. The driving force behind this trend is the high cost of sewers and lack of quality land available nationwide, forcing builders to consider developing sites that would have previously been deemed unusable due to location or geology.

Sand filters

Some sand filters today are designed utilizing the benefits of chamber technology. Chambers provide increased distribution coverage, allowing the effluent to be applied over the entire surface area of the bottom of the chamber. A sand filter is a type of packed bed filter that has been used for over a century. Newer packed bed technologies consist of peat, textile or foam media and are generally very reliable, providing good treatment.

A sand filter nears final construction as the Infiltrator chambers are placed on the filter material. The chambers allow a better effluent dispersal and gas exchange.

At-Grade systems

At-Grade effluent treatment systems are private onsite sewage systems that provide final treatment of sewage effluent so that water can be safely returned to the environment. Safe use of this technique relies on the successful removal of contaminants in the applied effluent by filtration, chemical reaction, and biological activity in soil. These systems are becoming increasingly popular in Alberta and are being considered for residential and commercial installations to address soil conditions, including shallow limiting layers and/or low permeability.

Wetland treatment systems

Natural wetlands have been used as convenient wastewater discharge sites for as long as sewage has been collected. By the early 1970s, research into the treatment capabilities of natural wetlands lead to the development of engineered, or "constructed" wetlands that replicated the cleansing capabilities of these natural marsh systems. Wetland treatment systems are typically used to polish treated wastewater, and are often designed as multi-function treatment and wildlife habitat systems.

These systems may be large commercial or community systems, or small wetland treatment cells serving an individual home. One of the most common types is the subsurface flow (SSF) constructed wetland. Effluent is treated through shallow subsurface channels in which emergent plants are established. The treatment cells produce a high quality treated effluent that is required to be disposed to the subsurface. Chambers have frequently been specified for the wetland cell and the subsurface disposal applications due to cost savings and chamber reliability as compared to older traditional construction options. In areas with sensitive soils, the ease and speed of installation and minimal construction traffic (less time to be exposed to rainstorms and construction machinery) can protect the structure of the soil and its infiltration capacity.

Wastewater treatment facilities

A great example of the use of chambers in extending the life of wastewater treatment facilities is in Bayham, Ontario at the Port Burwell Sewage Treatment Plant. Here the outfall discharges to a creek in close proximity to Lake Erie. Expansion of the plant required a major upgrade to the outfall extending out a distance into the lake. The creek could not assimilate the increase in minimum contaminants and therefore an outfall to the lake was proposed.

After an extensive investigation of options, an onsite solution was recommended to convert the outfall to an exfiltration bed utilizing chambers. The chamber system saved considerable cost and also provided additional pollutant removal. The benefit of installing an exfiltration bed at the treatment plant is the a reduction in phosphorous. Additional phosphorous will be removed by the natural ability of the soil to absorb the nutrient, thereby removing the impact to the sensitive lake environment.

Biofilters

Chambers are also now being specified in biofilters. A biofilter is a bed of organic media that is used to scrub objectionable odours from the air. Odourous air vented from compost facilities, rendering operations and pumping stations can be passed through a biofilter, removing ammonia and reducing sulphur compounds, such as mercaptans, amines, and VOCs. These odours are biodegraded to odourless substances in the biofilter. Water flowing through a biofilter will leach these non-toxic chemicals from the media, lengthening the life of the media. These biofilters benefit by the use of chambers compared to other past traditional methods. According to Lew Naylor, Ph D. of Black and Veatch Corporation, chambers used in biofilters can improve air distribution through the media, provide more efficient drainage, increase media life, ease construction of the biofilter and simplify media replacement.

Conclusion

Engineers, designers, installers and regulators now have many options to choose from in non-conventional, advanced onsite wastewater systems. With the increase in options have come a broader acceptance and a new look at technologically advanced onsite wastewater systems by the onsite wastewater management industry. However, change can come slowly and some seasoned onsite industry veterans continue to depend upon older technology for onsite system design, construction and regulation.

As the need to develop less desirable land increases, there has been much progress in the development and the acceptance of advanced onsite systems and the science behind these technological advances. Most provinces and local health officials have created or revised regulations that accommodate advanced onsite systems, including chamber leachfields, at reasonable sizing reductions, as well as treatment units. Continued product testing and research are needed for advanced onsite wastewater treatment technologies to identify associated capabilities and limitations.

For manufactured leachfield products, this work includes third-party checks on dimensions, performance and liquid storage capacity. For treatment units, this work includes investigation of the expected level of treatment during various usage conditions and long-term system reliability. These data will spur the continued development of more effective and cost efficient alternatives. These alternatives will provide options for onsite wastewater treatment that will enable better protection of natural resources and make possible building and usage of challenging sites.

The introduction of chamber technology over thirty years ago was a revolutionary step in the increased effectiveness and acceptance of standard and advanced onsite systems. The benefits of chambers are becoming recognized by many disciplines to solve a myriad of problems. Community systems have benefited with the increased storage capacity, sand filter performance has been enhanced by better distribution coverage, and wetland treatment systems reliability has been enhanced.

In the future we will surely see many new system designs and advanced treatment options developed in response to changing environmental and economical needs. As designers and engineers are challenged to create innovative solutions to the world's wastewater problems, chambers will be in the forefront of those solutions. This versatile product and its applications will continue to evolve to meet a vast range of challenges as the future unfolds.

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