

Wastewater treatment goes underground

Locating the reactor in wastewater treatment plants underground offers the potential to lower visual and odour impact. Here, Paul O'Callaghan describes a plant system that can take the reactor system down approximately 300ft.

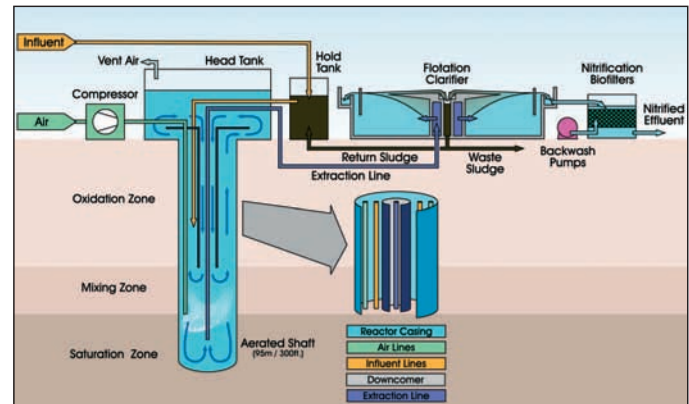
Wastewater treatment plants can be unsightly, noisy, odorous, and take up large areas of valuable real estate. An easy solution to all of this is to stick it in the ground. A vertical shaft, 90m deep and 3m in diameter, can typically provide biological treatment capacity for approximately 20,000m³/day of municipal sewage (80,000 population equivalent) and occupy just 20 to 30 per cent the footprint of a conventional treatment plant. The concept of treating wastewater in a vertical shaft in the ground is not a new one. ICI first developed the process in the early 1970s. Since then, there have been over 200 facilities constructed worldwide.

What differentiates vertical treatment technologies from other processes is the use of an in-ground vertical shaft to provide the aerobic biological treatment. There is nothing magical about the biological process. Bacteria use oxygen to oxidise biological oxygen demand (BOD) to carbon dioxide - basic activated sludge, tried and tested. There are, however, significant process advantages to the in-ground reactor, most notably the exceptionally high oxygen transfer efficiencies that can be achieved by introducing air at depth. The solubility of air in water increases with pressure, which, in turn, increases with depth. At 1atm, the theoretical solubility of oxygen in water (at 20°C) is approximately 9mg/l; while at 10atm (approx 90m), it is 90mg/l. The effects of pressure combined with the long bubble retention time as it travels 90m upwards in the reactor provides oxygen transfer efficiencies in excess of 70 per cent. Less air supplied means less air to be vented and scrubbed and lower energy costs. Another feature of the process is the high mixing energy available due to long bubble retention time and rapid circulation around the reactor. This reduces the floc size from 200µm in a conventional activated sludge plant to 50µm in a 'Vertreat' plant, and, in this case, size matters. A smaller floc is more efficient at taking up oxygen from solution, and dead cells are more readily degraded as they are not trapped inside large flocs.

Vertreat plants can be located closer to centres of population due to their low foot print requirements, while ease of odour control and minimal visual impacts, due to the below ground reactor and absence of large open tanks. Primary settlement is not required prior to a Vertreat. This provides savings in land purchase costs and sewerage and pumping costs to remote sites.

Drilling shafts into the ground is nothing new. Joseph's well in Cairo, Egypt was constructed in the 17th century BC and was dug nearly 90m into solid rock. Conventional drilling techniques, for oil and water wells, are used for shafts of up to 3m diameter. Larger shafts are more economically built using mining techniques.

The flotation clarifier is an inversion of the traditional secondary clarifier in that solids are floated to the top of the reactor as opposed to settled by gravity. When the effluent is withdrawn from the reactor and exposed to atmospheric pressure, dispersed and dissolved air that is liberated due to depressurization is used to float separate the microbial



A schematic of the Vertreat wastewater treatment plant.

biomass from the treated effluent. Solids are float thickened to 4 per cent solids versus the 1 per cent solids typically achieved in a gravity secondary clarifier.

So with all of these factors weighing heavily in favour of providing wastewater treatment plants underground, why are the majority of plants are still being constructed using above-ground shallow tankage? Firstly, market conservatism: there is a natural wariness, particularly in the municipal market, against what are perceived to be 'new technologies'. There are, in fact over 200 plants operating successfully worldwide, the majority of which are in Japan. This, however, provides little solace in the north American market, where there are currently just four vertical treatment plants in operation.

Secondly, the current procedure for wastewater treatment plant procurement begins with site selection. The site is purchased, generally making allowance for a conventional treatment plant with its associated odour and visual impact. So by the time it comes to tendering for a technology, a large, remote site has generally already been selected and purchased, and the economic advantages of using a less remote, smaller footprint site have already been lost.

For wastewater treatment applications where low visual and odour impacts, minimal footprint requirements and low operational costs are required, however, Vertreat represents a competitive technology.



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