Innovative Aeration Retrofit of Existing Failed Septic Systems Around Lake Livingston, Texas - A Case Study

Terrell R. Hoage, Ph.D. Department of Biological Sciences, Sam Houston State University, Huntsville, TX. 77341
Paulene Johnson, RI, Septic-Hydro-Tec, Goodrich, Texas
Mark Waters and Richard Gerard, Water Quality Lake Livingston Project,
Trinity River Authority, Livingston, TX.

Introduction

Vacuum Bubble® Technology (VBT™) creates micro bubbles of air that are neutrally buoyant. The bubbles are created under a partial vacuum and, as a result, the internal pressure of the bubbles is lower than that of the surrounding water. Consequently, the bubbles collapse to an average dimension of 0.25 mm in diameter. Because of their small size and neutral buoyancy, the bubbles remain in the water for many minutes. These micro bubbles increase the oxygen transfer potential in the water which, in turn, enables aerobic bacteria to consume the organic waste in the water.

Background

Texas's 3.2 million septic tank systems have begun to show the problems of age as 50% show varying degrees of failure. These anaerobic systems fail when undigested solids are washed into the field absorption area and clog the flow. Continued buildup of solids completely obstructs the waste removal and the tanks become occluded and must be pumped repeatedly. The addition of aeration units after the anaerobic tanks reduce the problem but cannot solve the problem since the anaerobic tanks are still there and continue to build up sludge residue and create anaerobic odors. The answer to the problem is to reduce the solid content and clean up the water running through the system. Once the water has been cleaned the next problem is how to dispose of it effectively with reuse as an important alternative.

This report deals with the restoration of septic tank systems previously approved on small lots in subdivisions developed in the early 1970s. As the systems have increased in usage, field obstruction in a small drainage area dictated by Lake Livingston access has resulted in several homes being restricted or eliminated from occupancy due to the drainage of sewage into the surface water and Lake Livingston. These units were designated as non-livable and tenancy restricted.

To solve the problem of reduced field absorption area, an innovative approach using aeration as modified into a universal waste water system was presented to the Trinity River Authority Lake Livingston Project. Several designs were set forth after reviewing the data gathered through cooperative research with the TRA, Sam Houston State University, Septic Hydro-Tec (Goodrich,TX) and Polk County Environmental services. Studies on low dose applications were started in 1985 and approved by Polk County. In December 1992, a project was initiated through cooperative efforts between the TRA Lake Livingston Project and Sam Houston State University. A two tank anaerobic system was set up using the Southland Wastewater System (Hoage and Hoage, 1992) as a source. The two 500 gallon fiberglass tank system was set up to process 300 gallons of wastewater per day in an anaerobic mode. This 14 week run was sampled two times each week and the samples taken and tested by TRA for BOD, TSS, pH, Temp., DO, and coliform counts.

At the end of 14 weeks, an aeration unit was placed in the first tank just in front of the effluent tee and the waste cycle continued for another 10 weeks with TRA taking and testing samples. With no other alteration than the addition of aeration in the first chamber, there was a 50% reduction in BOD and TSS with coliform counts reduced by 90% over the previous anaerobic action.

A second experiment (Figure 1) was set up using a single 500 gallon fiberglass tank with a baffle separating one third of the waste mass just in front of the effluent tee. An aerator was placed in front of the baffle and 300 gallons per day of raw sewerage from the Texas Landing Development (Hoage et al, 1993) was pumped from the wet well into the tank each day. The effluent was directed into a 30 square feet free access sand filter which was designed to handle 10 gallons of aerated waste water per square foot of surface area. In this arrangement, the filtered waste water was tested for BOD, TSS, DO, Coliform, and Ammonia/Nitrites. In this test the BOD was reduced by 90%, TSS reduced by 85%, Coliform reduced by 96% and the DO in the filtered water averaged 5.2ppm. Tests were conducted by Eastex Environmental Labs according to the EPA Standard Manual.

Figure 1. Tank test system using vacuum microubble aeration pretreatment at Texas Landing on Lake Livingston.

APPLICATIONS

A third test conducted at Texas Landing produced the same level of reduction as measured previously. After these results were analyzed, TRA approved the installation of this innovation in the Bob Nelson property (Hoage et al, 1993, Figure 2) which had a failed system with reduced absorption area that was occluded with solid wastes. Septic Hydro-Tec flushed the field lines using bacterial digestion and restored the absorption field. The innovative design stipulated an aerator in the first of two septic tanks with a modified clarifier and filter designed to retain suspended solids for digestion. The second tank was fitted with a submersible pump that lifted the water to a holding tank that regulated water flow into a free access sand filter designed to landscape specifications. The water from the sand filter was then routed into the cleaned field lines. After one year of operation, there has been no odor, no line obstruction, no overflow into the holding tank, and no field absorption problems even after heavy holiday and summer occupation. A 30" rain in October of 1994 failed to affect this or any of the aeration systems installed.

Figure 2. System design for the Bob Nelson residence on Lake Livingston.

Another innovative system was designed to handle field flow problems at the Roy Walker (Figure 3) site which required cleansing of the field lines and the installation of a new underground self-cleaning emitter system (Figure 4). This too, required landscaping design to fit the space and terrain on a small lakeside lot.

Figure 3. Innovative design for the Roy Walker site that corrected a 100% failed field and tank system using the existing tanks.

Figure 4. Examples of underground emitters placed in a 10" trench and filled with chopped rubber and covered with 100 mesh groundcloth

Filter Type	Site	Test	Value Range	Average
Non-sand filter	Koltys	BOD	5.4-6.0 ppm	5.3 ppm
		SS	3.2-3.2 ppm	3.2 ppm
Non-sand filter	Brock	BOD	1.0-25.0 ppm	16.0 ppm
		SS	5.4-7.5 ppm	6.7 ppm
Non-sand filter	Schlemmer	BOD	3.5-11.4 ppm	8.7 ppm
		SS	20.8-26.5 ppm	22.9 ppm
Sand filter	Foster	BOD	3.5-7.5 ppm	5.5 ppm
		SS	5.2-8.0 ppm	6.1 ppm
Sand filter	Nelson	BOD	4.5-15.0 ppm	10.5 ppm
		SS	11.0-52.0 ppm	32.7 ppm

Table 1. Effluent sample values collected in December 1994 at aeration retrofitted systems on Lake Livingston, Texas.

The David Cartier lake lot (Figure 5) was another reduced lot size requiring landscaping and the use of aeration and added emitter lines to correct the dosing problem for the limited land space. By the addition of self cleaning emitters and clean aerated wastewater, the field absorption area was efficiently used.

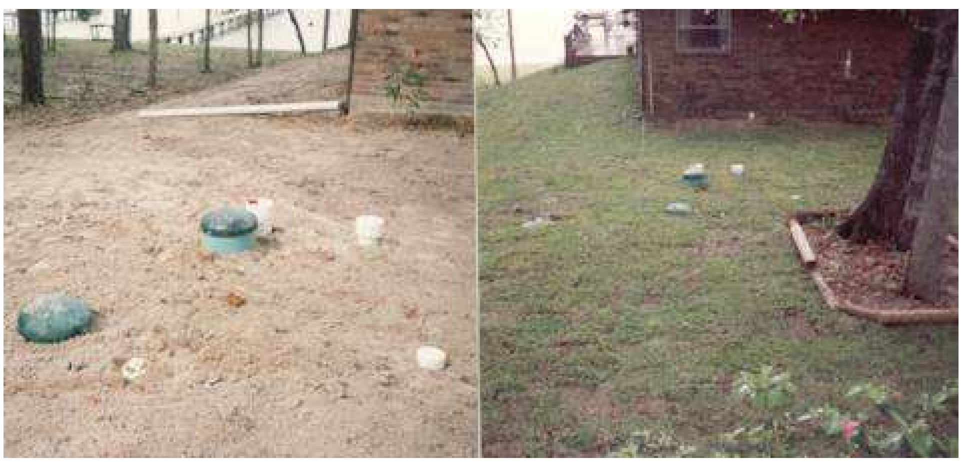

Figure 5. Corrective applications to the existing tank system of the Cartier site.

Clay absorption areas presented a real challenge to the Chuck Hogue lake lot (Figure 6) runoff problem. To remove the solids that readily obstructed the field lines an aerator was again positioned in the first of the existing tanks and the remaining tanks were converted to clarifier and pump tanks for dosing the water where it was most useful. Since the house was situated on a clay bank, it was suffering from severe foundation problems due to the wet-dry cycle that produced swelling and shrinkage in the clay. These forces had cracked the foundation and caused cracks in the brick veneer of the two story house. Emitters were placed around the house such that the clay would retain a constant moisture level and alleviate the swelling-shrinking cycle. This water came from the aeration sand filter design previously designated and adapted to this situation.

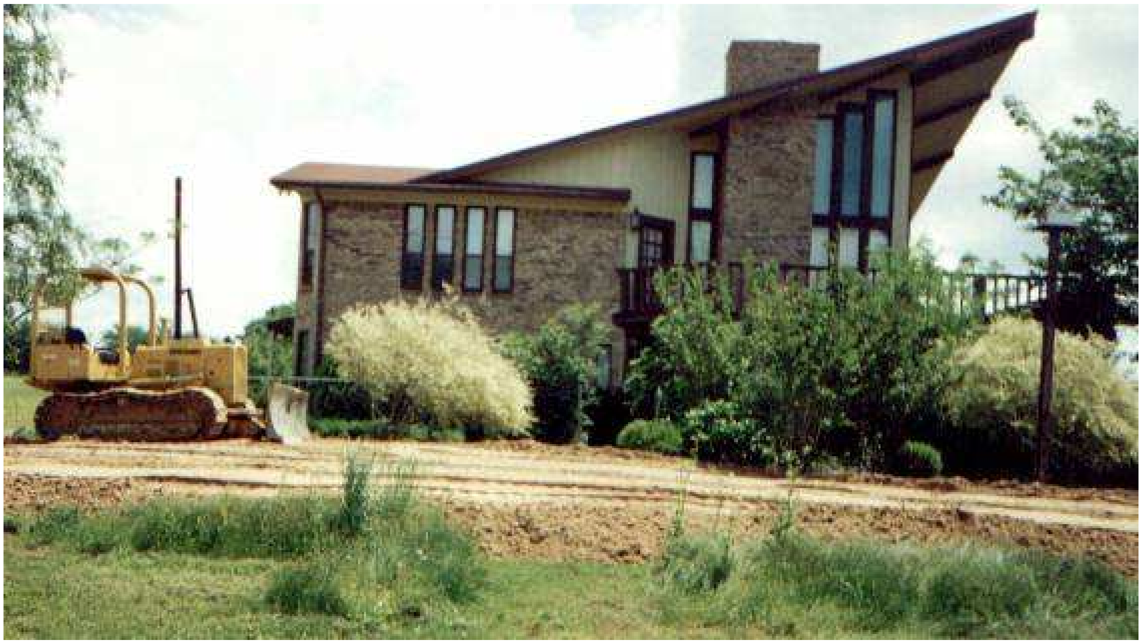

Figure 6. Remediation of a 100% failed system at the Hogue site.

The Vick Koltys lake lot (Figure 7) presented a 20X35 foot working area with a 100% failed system. Both tanks were filled with sludge and the field lines were completely obstructed. The tanks were pumped and cleaned and the field lines were bacterially treated and flushed to restore flow to normal rates. An Aerob-A-Jet[1] aerator was installed in the first tank, a clarifier fitted to the effluent tee and a pump tank generated from the third tank. The system is 100% restored using the old tanks and lines.

[1] In 2003 the trade name 'Aerob-A-Jet' was discontinued and replaced with Vacuum Bubble® Technology (VBT™). As this paper preceded that change, the integrity of the paper, as originally written is preserved in this version.

Figure 7. Conversion of a holding tank system at the Kolyts site.

Perhaps the most challenging conversion was to the Margaret Foster property (Figure 8) which had four holding tanks and no field lines. The location of the house and the drainage area to the lake restricted the use of field lines. The four tanks were cleaned and the first tank was converted to an aeration chamber with the addition of the clarifier filter. The second tank was converted to a pump tank and the two remaining tanks were designated as back-up holding tanks for heavy or excess flows. The pump tank was directed to an above ground free access sand filter located next to the property line by the driveway. This was landscaped to look like a flower bed and emptied into field lines by the garage. Additional field lines were placed in the front yard (limited 850 square ft area) and designed to receive pumped water from tank #3 for dispersal. Under heavy flow beyond the carrying capacity of the sand filter and front yard, tank # 4 was designated as a holding tank to be pumped and hauled as necessary. After seven months of summer activity, all systems are operating without need of a pump truck.

Figure 8. The Foster residence restoration of a holding tank system.