WATERTIGHT SEPTIC TANKS: NO MORE EXCUSES

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ABSTRACT

The septic tank — a 150-year-old technology — is still the "heart" of virtually all onsite systems and most decentralized wastewater collection systems. In fact, septic tanks are very efficient anaerobic digesters that require no energy input and yet reduce contaminants in incoming raw wastewater by two-thirds.

In spite of the importance of the septic tank to the onsite industry, tens of thousands of leaky and/or structurally substandard tanks are still installed every year in the United States. If the onsite wastewater industry is to be taken seriously by the mainstream, quality components must be available — beginning with the septic tank, the one component that is common to virtually every system.

While the industry continues to be plagued with poor-quality tanks, some manufacturers do produce high-quality, watertight, structurally sound tanks. Typically, these high-quality tanks are found in locales that actually require manufacturers to prove (i.e., test) that their tanks are watertight and structurally sound.

In order for high-quality tanks to proliferate, the following key issues must be addressed:

- The onsite industry must define, understand, and acknowledge the reason why watertight and structurally sound septic tanks are important.
- Current national tank standards must be improved (current standards are inadequate) and adopted.
- 100% of all tanks must be water tested in the field during installation.

Key Words: septic tank, watertight, structurally sound, standards

BACKGROUND AND DISCUSSION

The ongoing industry-wide problem of structurally inadequate, leaking septic tanks is well established, and has become more apparent with the increasing use of effluent sewer collection systems and onsite pretreatment systems over the past 25 years.

The commonly held view — that the onsite industry does not have a widespread leaking tank problem — has been perpetuated by the following factors:

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1. The majority of septic tanks in the US are still used on standard gravity drainfield applications, where problems created by leaky tanks are often not readily apparent. In contrast, leaky tanks are exposed quickly when used in effluent sewers and onsite pretreatment systems where control systems and/or system management is in place.

2. Most jurisdictions do not require water testing of every installed septic tank. Only Oregon enforces this requirement on a statewide basis. People are often shocked to discover the extent of the problem when thorough investigations are launched.

3. Common myths claim, "Leaky tanks will seal themselves up over time," and, "It doesn't matter if a tank leaks…it all goes in the ground anyway." For a discussion of why it's not okay for a tank to leak, see Mark Gross' paper entitled "Watertight Tanks." (Gross, 2004)

4. Many jurisdictions that do require water testing require the tank to be watertight only up the outlet invert. This kind of test can provide a false sense of security, because groundwater and surface water can still enter any leaky joints above the outlet.

5. Septic tanks are usually buried without access risers to grade. Only Oregon and Wisconsin require access risers to grade on a statewide basis. It is not realistic to expect that tanks will be routinely inspected for leakage or the need for septage pumping, if one has to dig (and often locate first!) to perform the inspection. The end result is that no maintenance is done until there is a failure. At this point, a pumper is typically called in, who then charges an hourly rate to find and expose the septic tank access, which normally exceeds the cost of a riser and lid.

While no nationwide studies have been performed to determine the percentage of installed tanks that leak and/or fail structurally, a quick review of a few effluent sewer collection systems and localized tank studies provides a glimpse into the types of problems that are common:

1. In the late 1970s, Glide, Oregon, installed what was, at the time, the largest effluent sewer in the United States, with nearly 500 tanks. One of the earliest dilemmas faced by the project's engineers was how to get watertight tanks. No regional tank manufacturers were willing to bid the tanks with a one-year warranty on watertightness, as called for in the specifications. The first 75 tanks brought in, fiberglass tanks built in Colorado, failed at a rate of over 90% during the above-ground water test prior to installation. The project engineers ended up designing a structurally sound, watertight concrete tank that local manufacturers were willing to build. Both concrete and fiberglass tanks were used on the final 400+ installations.

2. In the early 1980s, the community of Dexter, Oregon, installed an effluent sewer for approximately 100 homes. The first 96 tanks installed were polyethylene. All collapsed within one year and were replaced with concrete tanks. The collapsing tanks allowed infiltration — along with lots of silt — into the tanks and collection lines. Three months after startup, flows to the recirculating sand filter were more than 10 times the average flow due to the infiltration. Some tanks were reportedly one-third full of silt. The volume of silt that made its way through the collection system was a major contributing factor for the need to reconstruct the recirculating sand filter eight years later.

3. In 1990, Penn Valley, California, had an effluent sewer installed using approximately 225 concrete 1000-gallon tanks. In 1991, it was estimated that approximately 75% of these tanks were leaking (infiltration), mainly from the joint created between the monolithically cast tank and its set-on-top lid. A video camera was inserted into many of the tanks to document and observe the infiltration, which in some cases actually exceeded the capacity of the tank's discharge pump.

4. In 1996, the City of Browns, Illinois, installed an effluent sewer with approximately 100 "clamshell" concrete tanks. The first 22 tanks delivered leaked at the midseam. The tank manufacturer repaired these tanks in the field and then began using an improved sealing method on the remaining tanks. After the project was completed, the tank manufacturer reported that a monolithically poured tank would have been a better design to meet the watertight specification.

5. In 1995-1996, Mohave County, Arizona, water tested 500 septic tanks. At the beginning of the testing, approximately 80% of all tanks failed the water test. Note: the water level in the tested tanks was raised only to the invert of the outlet, so that seams, joints, and tank lids above this level were not tested. By the end of the test period, 22% of the 500 tanks had failed the "partial" water test. (Bishop, 1996; McCloy, 1995)

6. In 2002, Clermont County, Ohio — a progressive county that uses many advanced onsite systems — implemented a requirement that all septic tanks must be water tested at the time of installation. This new requirement led to many tank manufacturers and installers trying to repair tanks in the field. In fact, one local manufacturer now refuses to sell tanks in Clermont County because of this rule. The State of Ohio is now considering making this rule mandatory statewide. (Benson. 2003)

7. In 1991, Grant County, Washington, presented a report (Glassco, 1991) on leaking septic tanks indicating that, of the tanks they tested during installation, nearly every one leaked and had to be repaired. The study also claimed that 95% of tanks statewide are inspected "dry" and do not receive liquid until after they are buried.

8. In the early 1990s, a small 30-home effluent sewer was installed up a ravine just outside Los Gatos, California. Fiberglass tanks were originally specified, but the installing contractor convinced the engineer to accept a polyethylene tank. Many of the tanks collapsed and were replaced, or, because of the tough terrain, were encased in concrete to prevent further collapse.

9. In the past three years, two effluent sewers in Arkansas, The Bridge subdivision and Shilo Creek, have had multiple polyethylene tanks collapse and require replacement. (Nealey, 2004)

10. In 2001-2002, an Arkansas firm purchased more than 100 fiberglass tanks, shipped to them in halves. After assembling the tank halves, they water tested every tank and found not a single one to be completely watertight. Every tank had to be repaired; most had 10 or more leaking spots, and sometimes as many as 40 pinhole leaks. (Nealey, 2002)

11. In 1994-1995, the City of Gloucester, Massachusetts, installed the first phase (278 tanks) of its effluent sewer. A specification was written for structurally sound, watertight tanks, and regional tank manufacturers were invited to submit tanks that met the specification. None was submitted, and the City ended up buying fiberglass tanks shipped from California.

These examples are just the tip of the iceberg and represent experiences of only a handful of people. If one has any doubt of the seriousness of the problem, go to a few of the local tank manufacturers, fill a tank completely to its soffit (with inlet and outlet plugged with a cap) and watch what happens. More often than not, the tank will leak. To test structural integrity, pull six or seven inches of mercury vacuum on the tank. The percentage of resulting structural failures will surprise many. Granted, some manufacturers build nearly all tanks 100% watertight and structurally sound; this is not the case, however, for the majority.

Some Differing Views

A recent National Precast Association article (Frank, 2004) suggested two main reasons many in the onsite industry think there is a significant problem with leaky concrete tanks: (1) because "…of a few bad apples that have damaged the reputation of the industry," and (2) "…regulators…do not…consistently specify and enforce conformance to appropriate standards." While reason (1) severely underestimates the problem and is an unfair label, reason (2) is right on the mark. The leaky tank problem—for all types of tanks, not just concrete—is far more widespread than a "few bad apples." While there are likely a few unscrupulous producers (as there are in virtually every industry), it is not really a fair assessment of all the tank manufacturers producing leaky tanks. Because of the nearly universal lack of testing and enforcement of watertightness, many manufacturers simply don't know their tanks leak or don't think it matters. And even if they are aware of the importance, many can't build a truly watertight tank and compete when there's not a level playing field in their market.

It has been proposed in a draft NOWRA tank model code that tanks and appurtenances could be watertight to different conditions, depending on site conditions and risks associated with inflow and/or outflow from a non-watertight tank. For example, "classifications" could be developed in which a tank is watertight to the inlet, outlet, top seam, or riser connection. This is a bad approach. There is never any guarantee infiltration will not occur. Even if high ground water conditions are not present, surface runoff and saturated soil conditions from rain events can cause infiltration.

Some have argued that a drainfield could be sized to account for extra water. Since the "extra water" is not quantifiable and could amount to thousands of gallons per day, this is not a practical solution.

SOLUTIONS AND RECOMMENDATIONS

So how do we overcome this industry-wide problem? Industry must adopt the following:

1. Provide loading conditions for which all septic tanks should be designed and on which national standards should be based.
2. Require structural calculations that show a tank's ability to withstand the loading conditions.
3. Require documented testing — both structural and watertightness — of each model a manufacturer makes. Do periodic testing to ensure quality is maintained.
4. Require watertightness testing of every single tank at the time of installation.

Loading conditions and testing methods are provided below.

Septic tanks — whether they are used for "standard" gravity drainfields, advanced pre-treatment, or effluent sewers — are almost always buried in the ground. They are, therefore, subject to loading conditions that can be quantified. All tanks should be built to withstand the following loading conditions.

Recommended Loading Criteria:

- There shall be 130 lb/ft^3 for minimum weight of saturated backfill, or 100 lb/ft^3 for unsaturated backfill (500 lb/ft^2 minimum).
- Minimum lateral loading shall be 62.4 lb/ft^3. Lateral loading shall be determined from ground surface.
- The tank shall also support a concentrated wheel load of 2500 lb. Note: This does not mean the tank is designed for traffic, but instead recognizes that tanks may be occasionally or accidentally driven over.

Four typical loading conditions should be analyzed:

1. Four-foot bury + full exterior hydrostatic load (groundwater to grade).
2. Four-foot bury + full exterior hydrostatic load + 2500 lb. wheel load.
3. One-foot bury + unsaturated soils + 2500 lb. wheel load.
4. Tank full, interior hydrostatic load and unsupported by soil. This case represents the tank full of liquid at 62.4 lb/ft^3. This condition addresses seam and haunch stress-strain relationships that occur during watertightness testing, as well as poor soil bedding conditions that provide inadequate support.

Allowing tanks with installation limitations that fall below these suggested loading conditions can be problematic. Some manufacturers limit groundwater levels above the tank bottom, prohibit tanks from being completely pumped out, prohibit tanks from being used as pump tanks (because of liquid level drop), or prohibit installation in certain soil types. Reasons not to allow "installation-limited" tanks include the following:

1. It is not common for the site conditions of every tank installation to be evaluated properly and effectively. Potential seasonal groundwater conditions are often difficult to predict, especially when influenced by surface water runoff.

2. Ensuring that a septic tank doesn't get pumped when groundwater reaches a certain level is not a practical approach.

3. It is very common to bury tanks down to four feet. All tanks should be designed to at least this minimum.

4. Contractors are often making the judgment call on whether site conditions are adequate for a tank with installation limitations. However, most contractors do not have the soils and/or engineering background to do a proper site analysis.

Proposed Minimum Testing Requirements:
In addition to undergoing an engineering analysis that shows a tank can withstand the four loading conditions above, all residential size (2000 gallon or smaller) septic tanks should be able to pass two easily performed tests:

1. The first is the “parking lot” test to validate watertightness and some structural loading conditions (Load Case 4 in the “Recommended Loading Criteria” above). This test involves placing a tank on top of the ground with no external support, and then completely filling it with water. The tank should be 100% watertight with minimal deformation; in other words, the tank should be usable as it sits above ground. This test should be performed over a 24-hour period to account for water absorption (primarily concrete) and creep (primarily polyethylene and polypropylene).

2. The second is a vacuum test to validate structural strength. With the tank standing unsupported on the ground, a vacuum of minimum 6.5 in. Hg (equiv. to 3.2 psi or 7.4 ft of water pressure) is pulled on the tank, approximating the load on an empty tank buried four feet, water to grade, and a 2500-lb wheel load. This level of vacuum is maintained over a minimum eight-hour period. Deformation criteria are the same as in the parking lot test. It’s important to remember that the 6.5-in. vacuum is a minimum and does not consider any safety factor. The tank should be capable of withstanding a higher vacuum level, depending on a desired or necessary safety factor that is applied. Note: A vacuum test is not recommended to verify watertightness. It is possible for a tank to pass a vacuum test, but fail a watertest for the following reasons:

   - It can take a very long time for a vacuum drop in a tank with pinhole leaks.
   - Water can wick (by capillary action) through a tank that has passed a vacuum test.
   - The internal vacuum can pull joints and seams airtight that would otherwise leak with the forces of a watertest.

   While the above two tests do not necessarily need to be performed on every tank, a manufacturer should be required to perform these tests periodically to ensure the tank is being manufactured properly. Some of the more savvy manufacturers perform a quick (approximately 30 minutes) version of the parking lot test on every tank to eliminate having to deal with repairs in the field.

3. EVERY septic tank must be water tested in the ground, either before backfilling or after partial backfill. In this test, the water level is brought up two inches into the access riser, so that the inlet, outlet, and riser connections are all proven to be watertight prior to final backfilling. If risers have joints between sections, they also must be tested for watertightness. Note: The common complaint that water is not easily available is not a good excuse. Every tank should be started up full of fresh water and never allowed to fill up only with raw sewage.

CONCLUSION

NOWRA's Model Tank Code should include the recommended loading criteria and testing methods outlined above. Further, existing septic tank "standards" are inadequate in terms of structural requirements and watertightness testing requirements, and should be updated to reflect the level of loading and testing provided here.

Without high quality, long-lasting components — starting with the septic tank — our industry will continue to suffer from the reputation of delivering temporary solutions until the "real" sewer comes. The benefits to our industry, to the environment, to and our customers of truly structurally sound, watertight tanks is well worth the extra effort required to produce them.

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