The Effect Of Household Chemicals On Septic Tank Performance

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Abstract

Maintenance of sewage treatment systems is useful to identify dead septic tanks and to determine the cause, which is often heavy use of detergent with bleach or heavy disinfectant use in general. When detergent without bleach is substituted, treatment typically recovers completely.

A field experiment to quantify the effects of household chemicals was carried out using low-strength wastewater dosed at a diurnal rate to four 100 L pilot-scale septic tanks and calibrated to four-day residence time. Mixtures of detergent with bleach and bleach pucks were used, with dose concentrations calibrated to tank size and to laundry or toilet volumes.

After a one-week start-up period, chemicals were dosed for 2 weeks, stopped for 2 weeks (by accident), and started again for 4 weeks, followed by 2 weeks of no chemicals. The experimental run was divided into two sets, **Set A** with no chemicals dosed and **Set B** with chemicals dosed. *Average %BOD removal*s were calculated at each sampling day and a "paired t-test" was employed to compare the significance of the differences between Tests and the Control for each set.

The paired t-test on BOD removal rates showed that for **Set A** (no chemicals dosed) there were significant differences between the pilot-scale septic tanks receiving detergent (ST-1 – 75% poorer removal efficiency) and BOTH chemicals (ST-4 – 71% poorer removal efficiency) at the 95% confidence level, primarily due to the divergent effluent BOD concentrations found at the beginning of the experimental run. Towards the end of the experimental run, after chemical dosing is ceased, all pilot-scale septic tanks seemed to perform equally indicating that septic tanks recover quite readily. ST-3 receiving flus

statistical difference between total coliforms in the septic tank receiving bleached or unbleached laundry.

A similar study was performed by Novac et al. (1990), in which the effects of marine holding-tank chemicals on the performance of septic tanks were evaluated. In this study, both slug doses and gradual doses of the chemicals were tried and the COD removal efficiency was used as a performance indicator. Similar to Washington et al. (1998), they found that the septic system recovered quickly, since the chemical was flushed out of the tank by new wastewater influent (without the chemical). Above a certain critical dosage, it was found that the chemicals were fatally toxic to microbes, and the COD removal efficiency did not recover completely. Below the critical dosage, only inhibitory effects were found as the COD removal efficiencies recovered completely.

Vaishnav and McCabe (1996), developed a laboratory anaerobic sludge respiration test to the assess safety of consumer products in septic tanks. They identified three different types of data on the consumer products that would help assess their impact on septic tank systems. This data includes the effect of consumer products on microbial activity in domestic septic tanks, the effects of the products on settling of solids and the effects on the net adsorption of products onto septic tank sludge. Using cumulative gas production tests, they found that the 96-hour NOEC (no observed effect concentration) of dry bleach on the respiration of anaerobic sludge to be 625mL. They concluded that the use of "Safe for Septic Tank" dry bleach in septic systems is acceptable. However, this was based on the assumption that dry bleach does not adversely affect the settling of solids in the septic tank.

The adverse impacts of household bleach use in septic systems were also shown in a monitoring program at the Dorset MOEE Office (Jowett, 2001). In this monitoring study, septic tank effluent was sampled and analyzed for a wide range of parameters including fecal coliform bacteria and BOD. An anomaly in the septic tank effluent 255 days into the monitoring study where a rapid decline in fecal coliforms and a rapid increase in BOD had occurred simultaneously. This anomaly was explained to be an isolated bleach event that was due to bleaching the facility's plumbing. After the bleach use was ceased, septic tank effluent recovered completely within one week. However, later on due to a change in the cleaning staff and subsequent excessive use of disinfectant cleaners, the septic tank gradually died over a period of two months.

These studies show that the addition of laundry detergents and household disinfectants do have adverse impacts on the treatment capabilities of septic tanks. The treatment capability is directly related to the viability of the microbes inside the septic tank. High concentrations of household disinfectants and laundry detergent in wastewater can produce toxic effects, whereas low concentrations can cause little or no effects. These studies indicate that the septic systems recover quickly when the addition of these harmful chemicals

EXPERIMENTAL APPROACH

An experimental approach was used to investigate the effect of household chemicals on the treatment performance of septic tanks. The chemicals selected for the experiment include laundry detergent with non-chlorine bleach and sanitary toilet pucks. This section describes the pilot plant experiments- including rationale for the chemicals and concentrations that were selected, an overview of the experimental apparatus and the sampling protocol, and analytical me

Overview of Experimental Apparatus

The experimental apparatus consisted of four 100 L pilot-scale septic tanks running in a parallel dosing scheme as shown in **Figure 2**. The apparatus was located outside and housed in a wooden box for protection from rain and sunlight. Raw sewage was taken from one of the septic tanks in the Blue Springs Golf Course sewage treatment plant in Acton, Ontario. This treatment plant utilizes Waterloo Biofilter® Units to aerobically treat the wastewater (Jowett and McMaster, 1995) and incorporates recirculation of treated effluent back into the golf course septic tanks. Consequently, the raw sewage from golf course septic tank, which is dosed to the pilot-scale septic tanks was a very dilute wastewater (low BOD, TSS and ammonia).

Figure 2. Layout Schematic of the Experimental Apparatus

A timed-dosed control panel was used to control an effluent pump located inlet and outlet were located 3” and 2.5” from the top of the pilot-scale septic tanks, respectively. Inside each septic tank, 1”- 90º elbows were fitted onto the inlet and outlet. This was done to simulate baffles that dissipate the velocity of influent flow, helping to minimize stirring of solids within the tank to promote sedimentation and to minimize short-circuiting. A hole was also cut on the top of each tank to allow for an opening for the disinfectant chemical feeds.

The chemical disinfectants were prepared in solution form and dosed to three of the pilot-scale septic tanks using peristaltic pumps, with doses calibrated to tank size and to laundry and/or toilet volumes. Three of the pilot-scale septic tanks were dosed with chemicals: one with detergent only; one with sanitary bleach puck only; and one with BOTH chemicals. The fourth pilot-scale septic tank acted as the control with no chemical addition.

The outlet of each pilot-scale septic tank was attached to a sampling port that stored approximately 2-litres of effluent. The sampling ports were made of 4” PVC pipe, capped at one end, with a 1” hole drilled on the side for overflow. The overflow is spilled from the sampling port onto an epoxy-coated steel tray fitted with a drain. A piping connection from the drain directed the pilot-scale septic tank effluent back to the golf course septic tank, away from the location of the submerged effluent pump to minimize the chances of contaminating the raw sewage influent.

Sampling Protocol & Analytical Methods

Raw sewage influent samples were obtained from the riser on the golf course septic tank in the vicinity of the submerged pump. Effluent samples were taken from the sampling ports from each pilot-scale septic tank. Samples were taken at a frequency of approximately twice per week.

Five-day biochemical oxygen demand (BOD or BOD_5) is the most widely used parameter that is commonly used to measure septic tank performance. This determination involves the measurement of the dissolved oxygen used by microorganisms in the biochemical oxidation of organic matter over a 5-day period (Metcalf and Eddy, 2003). BOD is an indirect measure of the organic material in a wastewater, and was used to assess the removal efficiency of biological matter of each pilot-scale septic tank. The lower the effluent BOD concentration, the better the treatment efficiency.

Fecal Coliform bacteria indicate the presence of sewage contamination and the possible presence of other pathogenic organisms (Crites and Tchobanoglous, 1998). For the purposes of this experiment, Fecal Coliform was used as an indicator for the health of the septic tank. A low Fecal Coliform

Results

Raw sewage and effluent BOD results from the experiment for **Set A** (no chemicals dosed) and **Set B** (chemicals dosed) are plotted in **Figures 3a and 3b**, respectively. The two different sets are plotted separately to distinguish between the five different time periods and for better clarity. Both Figures show that the effluent BOD concentration varies on a day-to-day basis. The reason for such a large variation is that the influent sewage from the Blue Springs golf course septic tank also varies on a daily basis. The strength of the sewage coming from the golf course septic tank depends on the commercial success of the golf course clubhouse and banquet hall and the amount of re-circulation of treated effluent from Waterloo Biofilter Treatment system back to the golf course septic tanks.

Figure 3a. Set A (No Chemicals Dosed) – Raw Sewage and Effluent BOD

Figure 3b. Set B (Chemicals Dosed) – Raw Sewage and Effluent BOD

A summary of the results and calculations for **Set A** (no chemicals dosed) and **Set B** (chemicals dosed) are summarized in **Table 2a & 2b**, respectively. *%BOD removal* was calculated for each sampling day (**Equation 1)** and was averaged to calculate *Average %BOD Removal*

As expected, the pilot-scale septic tank receiving BOTH chemicals had the highest average effluent BOD of all the tests during periods of chemical dosing (**Set B**). The plot on **Figure 3b** shows that the effluent BOD from ST-4 (BOTH) was consistently the highest on every sampling day, with the exception of an anomaly occurring at 44 days after startup, where the ST-4 (BOTH) effluent BOD was lower than the control. This anomaly is also seen for ST-1 (Detergent) and ST-3 (Bleach Puck), where the effluent BOD also falls below the Control at 44

Table 2b. Set B (Chemicals Dosed) – Summary of Results

Location	BOD					Fecal Coliform			
	n	Avg. BOD (mg/L)	Avg. % removal	% Difference compared to *Control*	p	N	Avg. LOG Fecal Coliform (CFU/100mL)	% Difference compared to *Control*	P
Raw Sewage	14	46 ±12	-	-	-	9	5.43 ±0.52	-	-
ST-2 ***(Control)***	14	38 ±12	16 ±16	-	-	9	5.22 ±0.41	-	-
ST-1	14	46 ±18	2 ± 27	88% lower	0.018	9	5.18 ±0.22	6% higher	

re-circulation of treated Biofilter effluent back to the septic tank. The Waterloo Biofilter® system converts most of the ammonia in the wastewater into nitrate, with ammonia values typically below 1 mg/L (Jowett et al, 2001, ESE). The re-circulation of low ammonia effluent decreases the overall ammonia concentration in the septic tank, where the raw sewage is drawn to feed the pilot-scale septic tanks. This is another factor that may increase the susceptibility of the microorganisms to the toxic effects of household chemicals in this particular experiment. In the study performed by Washington et al (1997), they found that any free chlorine residual entering a typical household wastewater collection system would be eliminated because it would rapidly react with high concentrations of ammonia and reducing agents contained in the pipe walls.

Limitations of the Field Study

Field studies to evaluate the effect of chemicals on septic systems are long-term, involve a variety of chemicals analyses and are costly (Vaishnav and McCabe, 1995). The parameters that may have been beneficial to this study but were omitted due to financial constraints include: Total Suspended Solids (TSS), Ammonia (NH_4) and pH. Knowing these parameters may have helped in answering some of the uncertainties with the raw sewage. An increase in the number of samples and a longer experimental run would also have improved the reliability of statistical significance tests.

Another problem that occurred with the field study was to create an environment that provided constant conditions for each pilot-scale septic tank. The experimental apparatus was contained in a wooden box in an outdoor environment. Although the box provided protection from precipitation and the sun, the pilot-scale septic tanks were still susceptible to any temperature fluctuations that may have occurred throughout the experimental run. The temperature effects are also an unknown element- but are most likely controlled for because all pilot-scale septic tanks would be exposed to the same conditions.

Delivering equal sewage doses was also an issue. It was very difficult to ensure that each pilot septic tank was equally dosed. Calibration checks were performed approximately every two weeks. The volume dosed to each pilot scale septic tank seemed to be inconsistent. Before the experiments began, sewage flow was adjusted and calibrated using ball valves. It was not possible to calibrate these settings without disrupting the experiment.

There may have also been some problems with the preparation of the household chemicals as well. A fresh batch of household chemical solutions was prepared on a weekly basis. When household chemicals are in water solution, they tend to lose their disinfecting power gradually over time. Therefore, the disinfection strength of the chemicals would have varied throughout the week. The chemicals were also added directly into the pilot-scale septic tank instead of adding it into the influent raw sewage. It is possible that the chemicals were not well-mixed inside the pilot-scale septic tanks, and may have washed out of the tank sooner than would be expected.

CONCLUSIONS

1. Household disinfectants do have an adverse effect on septic tank BOD treatment performance. They affect treatment by a combination of inhibiting microbiology in the septic tank and also interfere with the settling ability of solids. Continuous use of disinfectants at recommended concentrations are not enough to completely destroy the bacteria in a septic system. Combinations of disinfectants have a more pronounced effect on septic tank performance than using disinfectants individually.

2. There is a large day-to-day variation in sewage strength in septic systems. The field study showed a wide range of BOD concentrations.

3. Septic tanks recover quickly when household chemical dosing is stopped. The quick recovery is primarily due to the wash out of the inhibitory chemicals.

4. Fecal Coliform concentrations in the effluent are not impacted by regular use of disinfectants, dosed on a continuous basis. This agrees with the studies found in literature.

RECOMMENDATIONS

In future research, improvements should be made on the experimental apparatus to better simulate actual septic tank conditions. Higher strength sewage should be used to represent the concentration of BOD and ammonia found in domestic sewage. Another improvement would be to mix the disinfectants with the incoming sewage instead of dosing directly into the tanks. Addition of baffles and installing 2 compartments would also better simulate actual conditions found in a septic tank.

The initial inconsistency of the treatment performance between pilot-scale septic tanks at the initial startup (before chemical dosage) can also be avoided by increasing the start-up period to achieve steady-state. Controlling the dosage so that the pilot-scale septic tanks are more evenly dosed would also improve on the inconsistencies. It would also be necessary to run the pilot-scale s

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