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 flush puck solution (29% poorer removal efficiency) showed no significant difference compared to the control.

The paired t-test for **Set B** showed that the differences between ST-1 (88% poorer removal efficiency) and ST-4 (200% poorer removal efficiency) compared to the Control were significant at the 95% confidence level. The addition of flush puck solution (ST-3) seemed to actually improve *%BOD removal* (31% higher removal efficiency), but the difference was not statistically significant compared to the Control. Fecal Coliforms were typically lower than the Control, but not diagnostic, suggesting no widespread 'kills' at these levels of chemical addition. Dead septic tanks are caused by greater use of disinfectants than used in this experiment.

KEYWORDS. Disinfectants, septic tank performance, treatment efficiency, toxicity to septic tanks, anaerobic inhibition, anaerobic toxicity, detergent, bleach, toilet pucks.

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INTRODUCTION

Conventional septic tank systems consist of a septic tank to hold and treat raw sewage through settling of solids and digestion by anaerobic microbes. This is followed by a soil leaching bed to treat septic tank effluent by aerobic microbes and to disperse the now-treated effluent into the natural environment. The septic tank is assumed to treat sewage to an acceptable quality before being discharged to the leaching bed.

The key to effective sewage treatment is the proper design, installation, periodic maintenance and responsible operation of septic tanks (Poe, 2001). The latter of these criteria constitutes what is put into a septic tank system. Since the systems are largely microbial in function (Trevors, 1993), excessive use of household disinfectants and chemicals can seriously hinder septic tank treatment and produce effluent that is too strong for the leaching bed or treatment unit to handle. If the septic tank is not properly maintained, this can lead to an accumulation of solids, which would eventually be flushed into the soil absorption trenches, plugging up pipes and soil pores.

Although there is substantial anecdotal evidence that household disinfectants and chemicals can hinder or even kill the septic tank action, there is limited scientific investigation on their effect on the microbiological system of a septic tank. In the experiment presented in the paper, the method used to assess the impact of chemicals on the treatment capabilities of a septic tank is to compare BOD removal and Fecal Coliforms in septic tanks with and without chemical addition.

LITERATURE REVIEW

This section presents studies that assess the toxicity and inhibitory effects of various chemicals on the ability of septic tanks to treat wastewater.

Gross (1987) determined the amounts of specific household chemicals required to completely destroy bacteria in a septic tank. The household chemicals used in this study included: liquid chlorine bleach, HTH (high test hypochlorite), Lysol and Drano Crystal. Domestic septic tanks were dosed with different concentrations of chemicals to determine the amount required to completely destroy the entire microbial population. The effectiveness of each chemical was assessed by measuring the decrease in total coliform units with respect to concentration of disinfectant and time. Gross found that slug dosages of chemicals are more harmful than gradual dosages and that the microbial populations recovered quickly after the disinfectant doses were stopped.

The work of Washington et al. (1998) had the primary objective of determining the fate of adsorbable organic halide from household bleach in a septic system and a secondary objective of assessing the effect of bleached laundering on septic tank performance. The COD removal efficiency was used as the measure of septic tank performance. Total coliforms concentrations were used as the measure of septic tank health. It was found that the COD removal was 40-50% in the septic tank prior to laundry addition whereas COD removal of only 25-35% was attained after the addition of laundry wastewater (bleached and unbleached). However, they found no 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 are ceased and consequently washed out of the system. Microbes in the septic tank are susceptible to both bacertiostatic (non-lethal) and bactericidal (lethal) effects, which depends on the concentration of the harmful chemicals added to the septic tank. Moreover, the addition of laundry detergents and household disinfectants may also affect settling, which can also adversely impact septic tank performance.

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 methods used.

Selection of Household Chemicals

Based on past experience working in the on-site wastewater industry, many of the problems associated with poor septic tank treatment were remedied by discontinuing the use of common household chemical products. Two of the most common products often encountered in the field are laundry detergent with bleach and sanitary toilet pucks. The products tested in this experiment include a Two-tablet Sanitary Bleach Puck System and Granular Laundry Detergent with non-chlorine (oxygen-based) bleach.

The two-tablet Sanitary Bleach Puck System is a commercially available product and is designed to clean and deodorize toilets. When the two tablets are placed in the flush tank and submerged, a portion of each puck dissolves in the water creating a cleaning/disinfecting solution. When the toilet is flushed, the cleaning/disinfecting solution is sent directly into the septic tank. Fresh water enters the toilet tank and the process repeats. The principal ingredients of disinfection are organic chlorine bleach contained in the bleach tablet. Chlorine is a commonly used chemical for disinfection of water and wastewater (Metcalf and Eddy, 2003) and produces germicidal effects through oxidation reactions including oxidation of cell protoplasm, protein precipitation, modification of cell wall permeability, and hydrolysis.

The granular detergent used in this experiment is also commercially available. The manufacturer claims the laundry detergent will kill up to 99.9% of the germs in a load of laundry. The principal ingredient of disinfection is the peroxy acid pernonanoic acid, which is not as effective as chlorine (Gamble 1998). It is believed that peroxy acids cause anti-microbial activity by denaturing proteins and enzymes and increasing wall permeability by disrupting hydryl- (-SH) and sulfur (S-S) bonds (McDonnell, 1999).

Granular detergents also contain surfactants that aid in the removal of grease and oils. According to Scherbakova et al. (1999), surfactants can affect living cells by impairing the functioning and integrity of biological membranes causing liquefication of the membrane, impairing barrier properties and potentially killing the microbe. Surfactants may also have impacts on the settling of solids as well.

These two chemicals (granular detergent and sanitary bleach puck) were selected for this experiment because of their commercial availability and because they are commonly used in the household.

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).

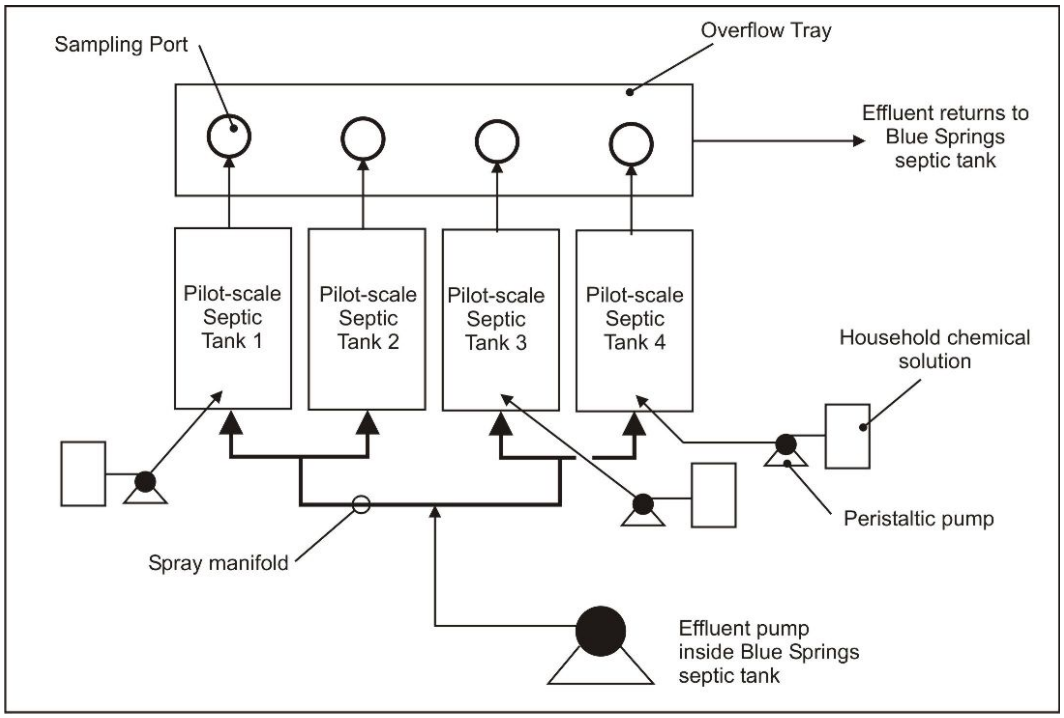

Figure 2. Layout Schematic of the Experimental Apparatus

A timed-dosed control panel was used to control an effluent pump located inside the golf course septic tank. The control panel was connected to a house timer calibrated to achieve a diurnal dosing (once in the morning and once at night). Diurnal dosing was chosen because it accurately represents household usage of water (Tchobanoglous and Schroeder, 1985). Raw sewage from the golf course septic tank was pumped into a manifold to equally distribute sewage into each pilot-scale septic tank. Flow was controlled such that each pilot-scale septic tank provided a four-day hydraulic retention time. A four-day retention time was based on the assumption that the average daily flow is half of the daily design flow and septic tanks in Ontario require two-day design retention time.

The pilot-scale septic tanks were made from 100 L polyethylene rectangular tanks which rested on a wooden support table to ensure that they were all level. To prevent sewage backflow, the 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 count would indicate a low microbial population (unhealthy tank) and a high count would indicate a high microbial population (healthy tank). Reduction of fecal coliform in wastewater is accomplished by using chlorine or other disinfectant chemicals.

It was hypothesized that the household chemicals would hinder septic tank treatment performance, with higher concentrations of disinfectants having more impact (i.e. BOTH chemicals dosed to ST-4). In theory, the disinfectants would either kill or inhibit the microbes, making them less viable, causing a higher BOD and a lower Fecal Coliform count in the effluent, which is shown in the studies done by Gross (1987) and Jowett (2001).

RESULTS AND DISCUSSION

The entire experimental sampling run is divided into two distinct sets. In the first set, chemicals were not dosed to the pilot-scale septic tanks. In the second set, chemicals were dosed to the pilot-scale septic tanks. In total there are five different dosing periods. **Set A** (Time periods 1, 3 and 5) represents the times when chemicals were not dosed and **Set B** (Time periods 2 and 4) represents the times when chemicals were dosed. The entire experiment ran for a total of 72 days following the dosing schedule shown in **Table 1.** This dosing strategy was devised to investigate the effects of addition of chemicals on a continuous basis for a long period of time (2 weeks – 1 month) and the ability of septic tanks recover when the chemical addition was discontinued.

Table 1. Dosing Schedule

Time Period	SET	Chemicals Dosed	Start Date – Finish Date	Duration
1	A	No	Day 0- Day 5	5 days
2	**B**	**Yes**	**Day 5- Day 18**	**13 days**
3	A	No*	Day 18- Day 29	11 days
4	**B**	**Yes**	**Day 29 – Day 62**	**33 days**
5	A	No	Day 62 – Day 72	10 days

*Dosing was accidentally stopped. Set B denoted in **BOLD**

Operational problems were encountered after time period 2. At the start of time period 3, a peristaltic pump had short-circuited. This caused the circuit breaker to trip shutting off the power to all four peristaltic pumps that were dosing the household chemicals. The sewage dosing pump, control panel and household timer operating the effluent pump (dosing sewage) were not affected because they were controlled on a separate electric circuit. After this mishap, the operation ran smoothly without any problems for the remaining duration of the experiment.

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.

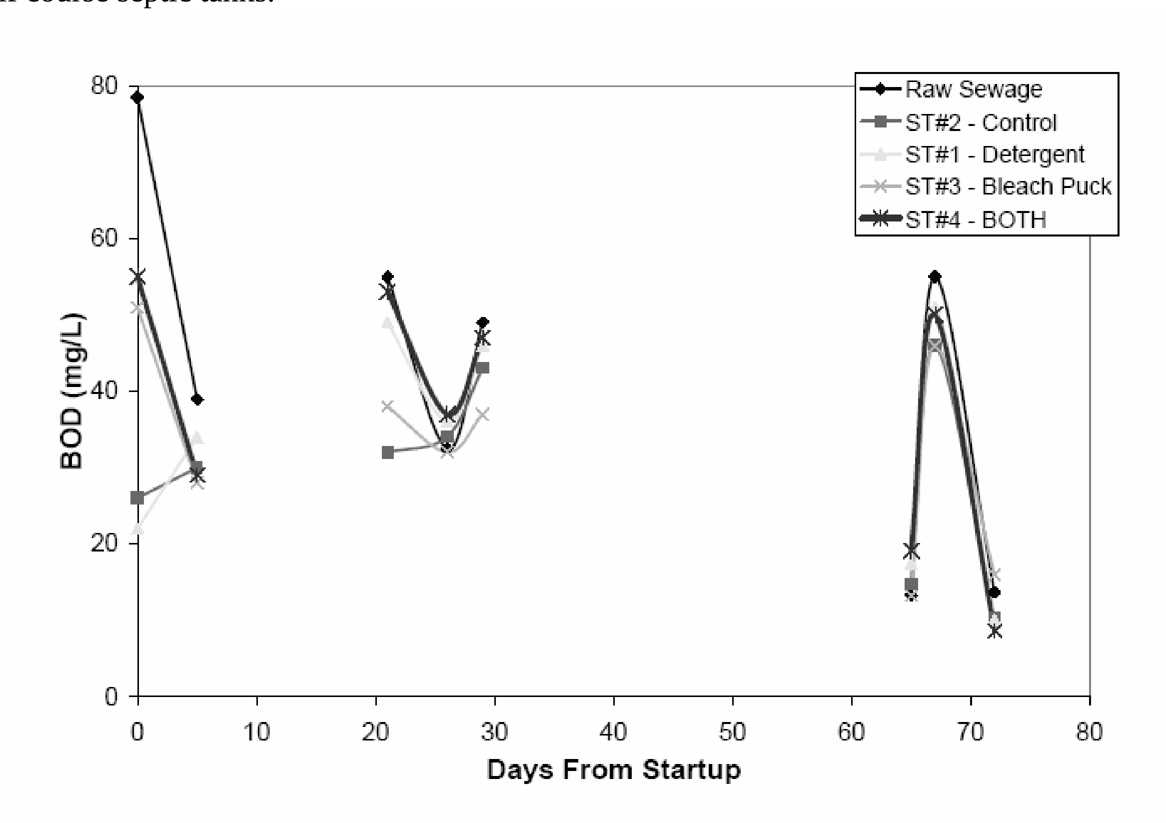

Figure 3a. Set A (No Chemicals Dosed) – Raw Sewage and Effluent BOD

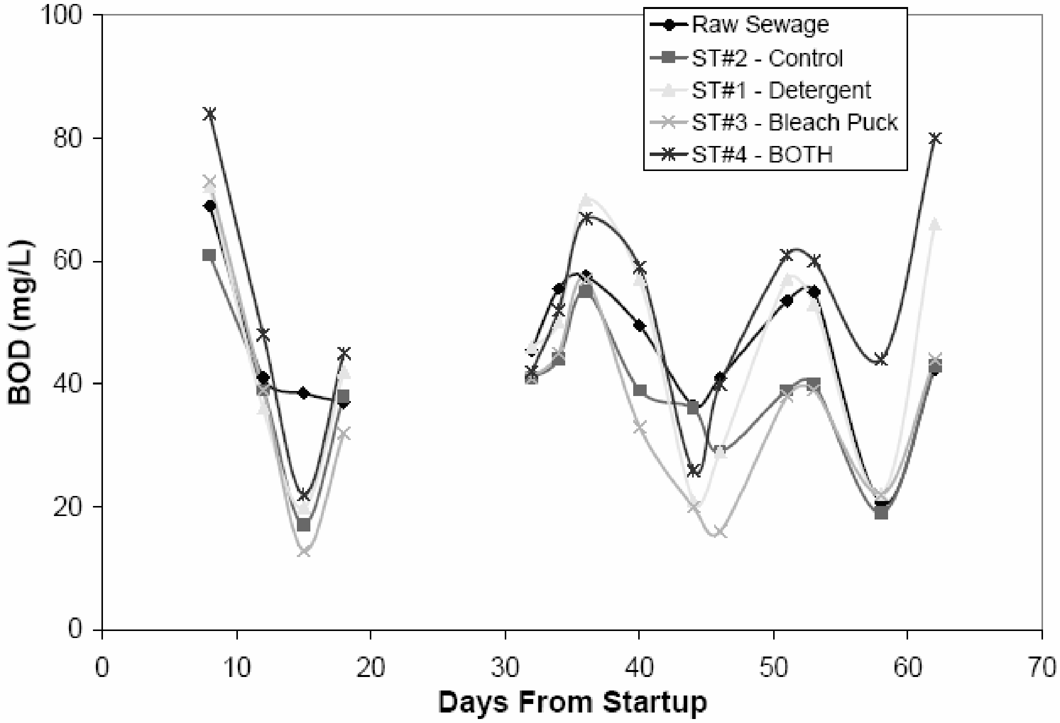

Figure 3b. Set B (Chemicals Dosed) – Raw Sewage and Effluent BOD

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* (**Equation 2)**. This was done so that a paired t-test could be used to test for statistical significance between the Tests (ST-1, -3 & -4) and the Control (ST-2).

As shown in **Table 2a** (**Set A**- No chemicals dosed), the difference in *Average %BOD Removal* for the Tests were 29-75% lower than the Control, but were not significant on a 99% confidence interval ($p < 0.01$). However, the differences between ST-1 and ST-4 with the Control were significant on 95% confidence interval ($p < 0.05$), indicating that these pilot-scale septic tanks were not performing equally through the entire experimental run. The performance of ST-3 did not show any significant difference ($p = 0.21$).

The plot in **Figure 3a** also offers evidence that the pilot-scale septic tanks were not operating at "steady-state" in the beginning. During time periods 1 and 3, the effluent BOD concentrations of the Tests and Controls are quite different from each other. Towards the end of the experiment, during time period 5, the effluent BOD concentrations converge showing a more consistent performance in relation to each other. This indicates that all of the systems were performing in a "steady-state" and also shows that the septic tanks recovered rather quickly when the addition of household chemicals was ceased.

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 days after startup. The reason for this anomaly is unknown. A possible explanation for this anomaly is that the BOD for the control at 44 days after startup is very similar to the Raw Sewage BOD concentration. It is plausible that the Control was mistakenly taken from the Raw Sewage during sampling or there could have been a mix up in the laboratory analyses. In either case, these reasons are only speculation and cannot be verified.

Table 2b (Set B- chemicals dosed) shows that the difference in *Average %BOD Removal* between ST-1 (88% poorer removal efficiency) and ST-4 (200% poorer removal efficiency) with the Control was significant on a 95% confidence interval. However, ST#3 actually performed better than the Control (31% higher removal efficiency, p = 0.888) but was not statistically significant. These results indicate that the addition of detergent have significant adverse impacts to the treatment capabilities of septic systems and more pronounced effects are shown when a combination of chemicals are used. The use of sanitary bleach puck (ST-3) shows little or no effect on treatment performance.

There were no significant differences found between the "Tests" and the Control for Set A and Set B, with the exception of ST-1. The addition of laundry detergent actually increased the fecal coliform by 6% and was significant at the 95% confidence interval.

Table 2a. Set A (No Chemicals Dosed) - Summary of Results

Location	**BOD**					**Fecal Coliform**			
	n	**Avg. BOD (mg/L)**	**Avg. % BOD removal**	**% Difference compared to *Control***	**p**	**n**	**Avg. LOG Fecal Coliform (CFU/100mL)**	**% Difference compared to *Control***	**P**
Raw Sewage	8	42 ±22	-	-	-	6	5.43 ±0.52	-	-
ST-2 *(Control)*	8	30 ±12	21 ±25	-	-	6	5.22 ±0.41	-	-
ST-1 (Detergent)	8	33 ±15	12 ±30	75% lower	0.027	6	5.18 ±0.22	<1% lower	0.428
ST-3 (Toilet Puck)	8	33 ±13	15 ±18	29% lower	0.21	6	5.06 ±0.35	3% lower	0.142
ST-4 (BOTH)	8	37 ±17	6 ±26	71% lower	0.034	6	5.09 ±0.25	3% lower	0.287

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 (Detergent)	14	46 ±18	2 ± 27	88% lower	0.018	9	5.18 ±0.22	6% higher	0.999
ST-3 (Toilet Puck)	14	37 ±16	21 ±24	31% higher	0.888	9	5.06 ±0.35	<1% higher	0.778
ST-4 (BOTH)	14	52 ±18	-16 ±41	200% lower	0.003	9	5.09 ±0.25	<1% lower	0.439

Equation 1. Calculation for %BOD Removal

$$\%BOD\ Removal = 1 - \frac{[\mathrm{BOD}]^{\mathrm{TEST}}}{[\mathrm{BOD}]^{\mathrm{Raw\ Sewage}}}$$

Equation 2. Calculation for Average %BOD Removal

$$Average\ \%BOD\ Removal = \frac{\sum_n [\%BOD\ Removal]_n}{n}$$

DIFFICULTIES AND LIMITATIONS WITH EXPERIMENTAL APPROACH

Uncertainties with the Raw Sewage

One of the problems with this study is the composition of the raw sewage used to dose the pilot-scale septic tanks. The raw sewage BOD used in this study ranged from 13-79 mg/L with a mean of 44 mg/L. Normal domestic septic tank effluent BOD was reported to range from 110-400 mg/L (Tchobanoglous and Schroeder, 1985). This indicates that the raw sewage in this study is a very dilute wastewater and may not be representative of the raw sewage found in a typical septic tank. The microbiology in the pilot-scale septic tanks receiving dilute raw sewage (low BOD) may be more susceptible to toxic effects of household chemicals. Chlorine is a very strong oxidizing agent that is not very selective and will readily react with any easily oxidizable substances such as organic matter (BOD). The effects of household chemicals on the microbiology of a septic tank would be more pronounced on a raw sewage with a relatively low BOD, compared to a raw sewage with a higher BOD.

Another important parameter is the ammonia (NH_4) concentration in the raw sewage. Like BOD, ammonia is also a readily oxidizable substance. Chlorine reacts with ammonia, producing chlorides and chloramines. Once chlorides are formed, they no longer function as a disinfectant. Chloramines function as disinfectants, but are much less effective in killing microorganisms (Metcalf and Eddy, 2003). Although not measured during this study, it is expected that the ammonia concentration of the raw sewage in this experiment is lower than normal because of the 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 septic tanks for a longer period of time without chemical addition so that they can reach steady state. Sludge from an existing sewage treatment plant could also be used as a seed to speed up the performance each septic tank. It would also be advantageous to run replicate test septic tanks to determine the reproducibility of the results.

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