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Field tests on a grease trap effluent filter

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ABSTRACT: This study investigates the field performance tests of a commercial grease trap effluent filter for removal of total suspended solids, and oil and grease discharged from the clear zone of full service restaurant grease traps. The grease trap effluent filters were installed on 1,000-gallon, 2,000-gallon and 5,400-gallon full service restaurant grease traps over a period of 8 weeks, and samples were taken at the inlets and outlets. On average, the effluent filters demonstrated to be capable of removing 41% to 57% of TSS, and 43% to 52% of O and G. Field test data also showed that the total amount of TSS removed by the grease trap effluent filter installed on 1,000 gallon, 2,000 gallon and 5,400 gallon grease traps were approximately 2,542 kg, 709 kg, and 2,319 kg, respectively; and the total amount of O and G removed over the same period were approximately 1,104 kg, 271 kg, and 897 kg, respectively.

Key words: *Total suspended solids, oil and grease, grease trap, effluent filter*

INTRODUCTION

Restaurants discharge wastewaters into public sewers have been a problem for many years, but have become a greater problem with the large number of full service and fast food restaurants being built both in large cities and rural communities (Stoll and Gupta, 1993). These restaurants typically discharge large amount of total suspended solids (TSS) and oil and grease (O and G) that would reduce the capacity of public sewers over time (Eddy, 1998). The traditional treatment for this waste prior to discharge into the public sewer is a grease trap that causes separation of the floatable and settleable materials (Stoll and Gupta, 1993). Generally, discharge from a grease trap comes from the clear zone created by this separation process. Even though it is called a clear zone, the water from this zone usually contains a considerable amount of relatively low specific gravity suspended solids and high specific gravity O and G (Fig 1), (Steward, 1997 and Ecotec, 1996). Recently, the application of a number of commercial grease trap effluent filters had been evaluated as a potential tool for the treatment of TSS and O and G in the clear zone wastewaters (Treanor, 1995). A study performed in Sydney, Australia on a 40 seat cafeteria indicated that the discharge from the restaurant cooking area had an average TSS and O and G of approximately 3,024 mg/L and 3,630 mg/L, respectively (Ecotec, 1996). It was demonstrated that Ecotec Grease Extractor effluent filter could improve treatment by reducing TSS level to 84 mg/L, and average effluent O and G to 78 mg/L (Ecotec, 1996). The installation of Ecotec Grease Extractor effluent filter on the grease trap resulted in an average 78% reduction in TSS and 84% reduction in O and G (Ecotec, 1996). Another study performed in Australia concluded that the effect of Taylex Queenland grease trap effluent filter achieved a reduction of the TSS levels by 61%, and O and G by 63% (Taylex, 1997). These studies indicated that there is a need for improved treatment and grease trap effluent filters could be an alternative economical option for the treatment of TSS and O and G (Long, 1997). In tank effluent filter installation (Fig. 2) the grease trap effluent filter is designed to reduce the TSS and O and G components of the tank (grease trap) effluent. The exterior of this filter consists of a cylindrical plastic housing 16 inches (40.64 cm) high and 12 inches (30.48 cm) in diameter with a 4 inch (10.16 cm) polyvinyl chloride (PVC) couplings, and sheets of plastic in the form of plates comprise of removable interior of the filter. There are 27 individual plates stacked on top of each other with built-in spacers that force the wastewater through the 0.8 mm openings (Fig. 2).

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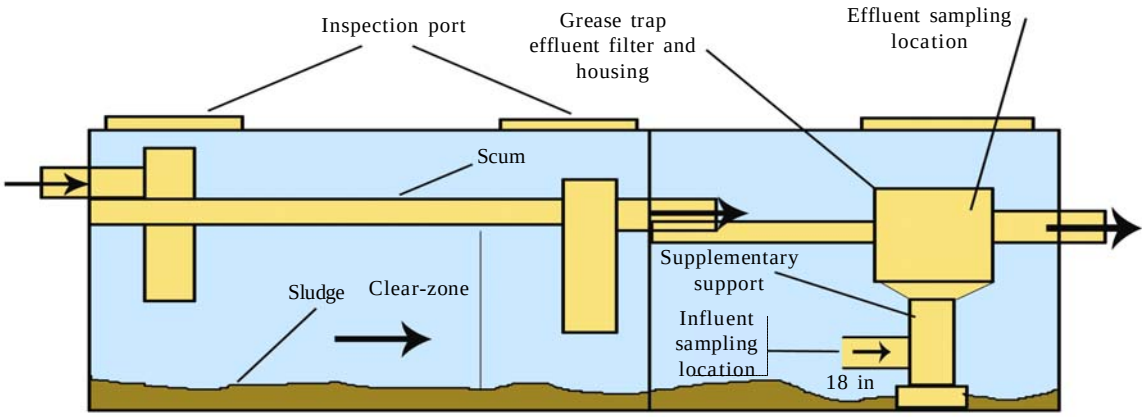

Fig 1: Schematic installation of grease trap effluent filter

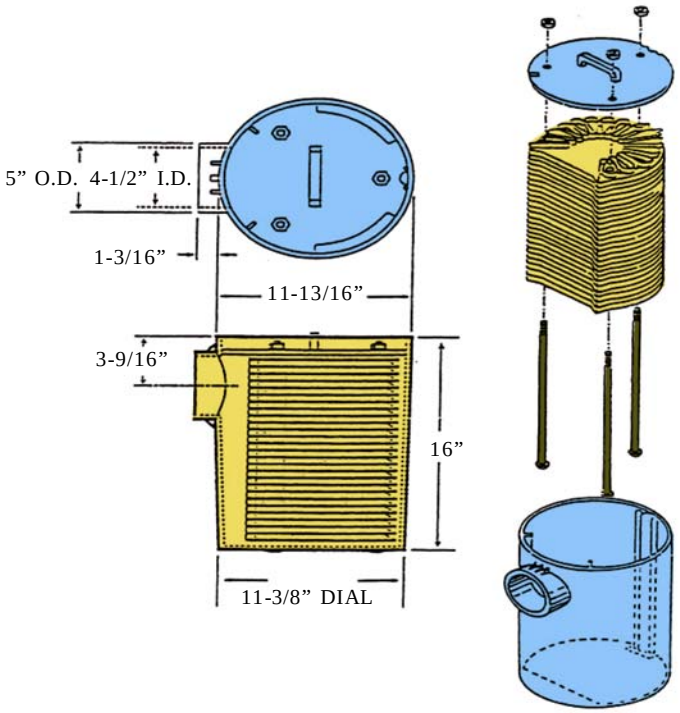

Fig. 2: Details of grease trap effluent filter

MATERIALS AND METHODS

In this study, the sampling sites consisted of four full service restaurants (Cookeville, Tennessee, USA). The grease traps used by the individual restaurants were different in size, dimension, and volume; restaurant # 1 had a 1,000 gallon grease trap with two baffle walls producing a three compartment units; restaurant # 2 had a 2,000 gallon grease trap with baffle for isolating the tank's influent and effluent; restaurant # 3 had a 2,000 gallon grease trap with baffle for isolating tank's influent and effluent; and restaurant # 4 had a 5,400 gallon rectangular grease trap with no compartment or baffle (Fig. 1). Details related to restaurant operation information, activities, frequency of kitchen cleaning and so are shown in Table 1.

Table 1: Restaurant operating information

Site	Grease trap capacity (gallon)	Daily meals	Cooking O and G	Additives to clean drains	Daily water usage (gallon)	Frequency of kitchen cleaning (per day)	Dish washing temperature (°F)	Washing system
1	1,000	400	Vegetable	None	3,600	2	140	Oasis
2	2,000	500	Vegetable	None	2,800	2	175 – 200	Oasis
3	2,000	350	Vegetable	None	2,700	2	160 – 180	Suremix
4	5,400	750	Vegetable	None	6,800	2	160 – 180	Oasis

Two samples were taken from each of the grease traps each day, i.e. one sample from the clear zone at the inlet (influent), and one sample at the outlet from the top of the filter unit (effluent). The locations of the influent and effluent sampling points are indicated in Fig 1. A weekly composite sample was prepared for each site taken over an eight-week period. These composite samples were analyzed for TSS and O and G. Sampling started on May 12, 1997, and ended on July 12, 1997. All samples were taken during the morning hours between 6:30 am. and 10:00 am The samples were collected from each site in the same order during each sampling trip, and the sampling procedure was consistent throughout the study. The samples at the effluent from the filter were first collected followed by the samples at the influent points. The influent samples were collected with a specially constructed sampling device that was put back in place after a day's sampling at each restaurant. This sampling device and procedure would produce a relatively undisturbed sample taken on the following day. The pH values and temperatures of the samples collected were recorded at each of the sampling points and during each sampling trip. An ATI Orion Portable Meter – Model 290A was used to measure the pH and temperature simultaneously, after the sample were placed in the sampling bottle. Laboratory analysis and testing on samples were performed in accordance to the methods set forth in the Standard Methods for the Examination of Water and Wastewater (APHA, 1992). After each sampling trip, a 100 mL volume of each sample was poured into a bottle to prepare the weekly TSS composite sample. The daily TSS composite samples were placed in a refrigerator at 4 °C. After 7 days of composite sample preparation, the composite samples were analyzed for the TSS contents. A 250 mL volume sample from each site was mixed with one gallon bottle and placed in a refrigerator at 4 °C. Approximately 2 to 3 mL of saturated sulfuric acid (H_2SO_4) were added to the samples for preservation. After 7 days, the preserved composite samples were analyzed for O and G. Analysis on O and G was carried out in accordance to standard procedures and methods of determinations found in the Standard Method 5520 (APHA, 1992).

RESULTS

TSS removal efficiencies recorded during the study are presented in Table 2, indicating that TSS removal efficiencies of the filters were approximately 56%, 47%, 57%, and 41% for restaurants # 1, # 2, # 3 and # 4, respectively. Table 3 shows O and G removal efficiencies achieved by the grease trap effluent filter understudy, and the amount of reductions in O and G were approximately 52%, 47%, 50% and 43% for restaurants # 1, # 2, # 3 and # 4, respectively. During monitoring period, in additional to TSS and O and G, the pH values and temperatures were also recorded at effluent sampling points, and the details of field data gathered over a period of 8 weeks are shown in Table 4.

DISCUSSION AND CONCLUSION

The performance of TSS removal efficiencies of the effluent filter installed on 1,000 gallon grease trap (restaurant # 1) indicates that the lowest achievable effluent levels attained by the effluent filter with a detention time of 6.7 h was approximately 679 mg/L, and the highest achievable removal efficiency attained was about 76%. The average detention time on the 2,000 gallon grease trap (restaurants # 2 and # 3) was approximately 17.5 h with the lowest filter achievable TSS removal effluent level of approximately 180 mg/L, and highest removal efficiency recorded at 70%. The effluent filter installed on the 5,400 gallon grease trap (restaurant # 4) with a detention time of 19.1 h indicated relatively less efficient in removing TSS, ranging from 33% to 53%. In this study, it was found that the total amount of TSS (in kg) removed by the filters installed on 1,000 gallon, 2,000 gallon and 5,400 gallon grease traps over a period of 8 weeks were approximately 2,542 kg, 709 kg, and 2,319 kg, respectively.

Table 2: Total suspend solids (TSS) removal efficiencies

Week	Restaurant # 1 Influent, (mg/L)	Restaurant # 1 Effluent (mg/L)	Restaurant # 1 Reduction (%)	Restaurant # 2 Influent (mg/L)	Restaurant # 2 Effluent (mg/L)	Restaurant # 2 Reduction (%)
1	1995	853	57	631	416	50
2	1680	875	48	704	412	41
3	1016	733	28	568	436	23
4	2008	679	66	796	371	53
5	3172	748	76	694	356	49
6	1874	750	60	396	266	33
7	1622	698	57	412	176	57
8	1536	740	52	560	180	68
SD	617	69	14	164	106	14
Average	1863	760	56	620	327	47

Week	Restaurant # 3 Influent (mg/L)	Restaurant # 3 Effluent (mg/L)	Restaurant # 3 Reduction (%)	Restaurant # 4 Influent (mg/L)	Restaurant # 4 Effluent (mg/L)	Restaurant # 4 Reduction (%)
1	613	304	50	559	371	34
2	725	216	70	508	290	43
3	639	200	69	528	325	38
4	539	276	49	856	404	53
5	418	224	46	436	299	31
6	382	195	48	478	320	33
7	614	188	69	962	456	53
8	454	220	52	872	470	46
SD	121	41	11	210	70	9
Average	548	228	57	650	367	41

Table 3: Oil and Grease (O and G) removal efficiencies

Week	Restaurant # 1 Influent (mg/L)	Restaurant # 1 Effluent (mg/L)	Restaurant # 1 Reduction (%)	Restaurant # 2 Influent (mg/L)	Restaurant # 2 Effluent (mg/L)	Restaurant # 2 Reduction %
1	908	418	54	317	191	40
2	1130	698	38	457	290	37
3	431	323	25	284	106	63
4	532	277	48	306	186	39
5	976	215	78	136	76	44
6	777	251	68	212	97	54
7	549	246	55	246	125	49
8	408	214	48	107	55	49
SD	260	159	16	108	75	8
Average	714	330	52	258	141	47

Week	Restaurant # 3 Influent (mg/L)	Restaurant # 3 Effluent (mg/L)	Restaurant # 3 Reduction (%)	Restaurant # 4 Influent (mg/L)	Restaurant # 4 Effluent (mg/L)	Restaurant # 4 Reduction %
1	141	71	49	269	132	51
2	216	105	51	322	189	41
3	148	76	49	345	172	50
4	168	92	45	283	148	48
5	99	47	53	163	131	20
6	123	64	48	210	149	29
7	101	43	57	124	48	41
8	111	58	48	326	170	48
SD	40	21	4	81	43	13
Average	138	70	50	255	142	43

Table 4: Summary of field test data on pH values and temperatures

Site	Grease trap capacity (gallon)	Daily water usage (gallon)	Detention Time (h)	Average pH values	Average temperature (°C)
1	1,000	3,600	6.7	4.00 (SD=0.24)	33.5 (SD=2.00)
2	2,000	2,800	17.1	5.23 (SD=0.29)	28.2 (SD=1.73)
3	2,000	2,700	17.8	4.71 (SD=0.27)	32.8 (SD=2.97)
4	5,400	6,800	19.1	4.12 (SD=2.97)	39.9 (SD=1.38)

In terms of O and G removal efficiencies of the effluent filter installed on 1,000 gallon grease trap of restaurant # 1 showed an achievable effluent levels of O and G of approximately 214 mg/L at 6.7 h detention time and the highest achievable O and G removal efficiency attained was approximately 78%. The average detention time on the 2,000 gallon grease trap (restaurants # 2 and # 3) was approximately 17.5 h with a lowest achievable removal effluent level of 43 mg/L, which is equivalent to 63% removal efficiency. The effluent filter installed on 5,400 gallon grease trap (restaurant # 4) with a detention time of approximately 19.1 h indicated a relatively less efficient in removing O and G that ranged from 20% to 51%. Field tests data showed that the total amount of O and G (in kg) removed or absorbed by the filters installed on 1,000 gallon, 2,000 gallon and 5,400 gallon grease traps over a period of 8 weeks were approximately 1,104 kg, 271 kg, and 897 kg, respectively. Restaurant # 1 samples had an average pH and temperature values of 4.0 (SD = 0.24) and 33.5 °C (SD = 2.0), respectively. Restaurant # 2 samples had an average pH value of 5.23 (SD = 0.29) and temperature of 28.2 °C (SD = 1.73). For restaurant # 3, the mean pH value was 4.71 (SD = 0.27) and mean temperature of 32.8°C (SD = 2.97). The samples of restaurant #4 recorded a mean pH of 4.12 (SD = 0.36) and a temperature of 39.9 °C (SD = 1.38). Even though there were significant differences in grease trap volumes, grease trap detention times and amount of wastewaters generated by the individual restaurants, there were negligible differences in pH values and temperatures among all the four restaurants understudy. The maximum differences in pH values and temperatures were approximately 1.23 and 11.7 °C, respectively.

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