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Studies on the Degradation of Synthetic Detergents by Sewage

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In the last decade, highly polluted domestic detergent wastes have drown attention for their toxicity on aquatic life (Hollis 1976; Bluzat and Seuge 1978; Verma et al 1976; Holman and Macek 1980). Detergents are especially trouble some, because they resisted break down by biological means. However, the use of either slowly degradable branched Alkyl Benzene Sulfonate (ABS) detergent or easily degraded linear Alkyl Benzene Sulfonate (LAS) causes toxic effect to aquatic life and is hazard to stream water (Hollis 1976; Holman and Macek 1980).

Degradation of detergents was studied by several ingestigators (Procter and Gamble 1977; Abe and Kobayashi 1984). Microorganisms play an important role in biodegradation of many organic pollutants (Kotar et al 1971; Atlas and Barth 1972; Moursey and El-Abagy 1981; El-Abagy and Moursey 1982; Abe and Kobayashi 1984). Degradation of these detergents by microorganisms, the rate of their break down, and the intermediate compounds produced are the subject of different studies (Starling et al 1976; Procter and Gamble 1977; Abe and Kobayashi 1984). This degradation depends mainly on the chemical nature of the detergent and on the microbial flora that exist in contact with this detergent waste.

Biodegradation of anionic surfactants was studied using Toma and Nogawa river water in Japan. The results obtained showed that the biodegradation of the isomers of these detergents were influenced by the quality of river water (Abe and Kobayashi 1984).

Biodegradation of alkyl benzene sulfonate (ABS), dodecyl benzene sulfonate (DBS), and linear alkyl sulfonate (LAS) in sewage by spontaneous settling and aeration was detected by Kwon et al 1977. The biodegradation rates of ABS, DBS and LAS by settling at 25°C for five days were 9.8%, 13.7% and 10.4% respectively. When this system was aerated the biodegradation rate was increased to 63.3%, 27.4% and 43.9% for ABS, DBS and LAS respectively.

In most cases, domestic detergent wastes are discharged together

with municipal sewage into the body water ways. Because of this fact the present study was designed to investigate the role of the natural microflora of Ismailia Canal water on the degradation of synthetic detergents. In addition, the effect of aeration or/and the density of sewage microflora on this degradation was also studied. The effect of the bacterial parameters on this degradation was also investigated with special reference to faecal coliform and faecal streptococci groups.

MATERIALS AND METHODS

Three sets of flasks were employed in this study. Each set consists of four 15 L flasks filled with 12 L of Ismailia Canal water. Two detergents and a mixture of these two detergents were the subject of this study. These detergents are alkyl benzene sulfonate (ABS), linear alkyl sulfonate (LAS), and 1:1 mixture of (ABS) and (LAS) provided by Merck, Darmstadt, Germany. The experimental work in this study was designed according to Table (1).

The flasks were aerated with low current of air bubbling to maintain samples in an aerobic conditions. The flasks were kept at room temperature ranged between (24-26°C). Each experiment was conducted for seven days continuously. Samples were taken from each flask every 12 hrs. Detergent concentrations were determined in each sample. The detergent concentration presented here is expressed as methylene blue active substance (MBAS) according to APHA (1978). The initial concentration of each detergent added was 10 mg/L. The reported results are the mean values of seven titrated end points for each sample.

Sewage from Ismailia sewage treatment plant was used in this study as a source for microflora. Two different concentrations of sewage were added to each set. Raw Ismailia Canal water as well as raw Ismailia Canal water that was seeded with two different sewage concentrations were examined for the density of bacterial parameters. The two different sewage concentrations used in this study are 0.5 ml/L and 1.0 ml/L. Total bacterial counts at 22°C was detected by poured plate method to estimate the initial number used as described by APHA (1978). Faecal coliform density and faecal streptococci density were also determined according to APHA (1978). Data indicated in (Fig. 1-4) are the average values that obtained by the statistical evaluation according to Richards and Lacava (1978).

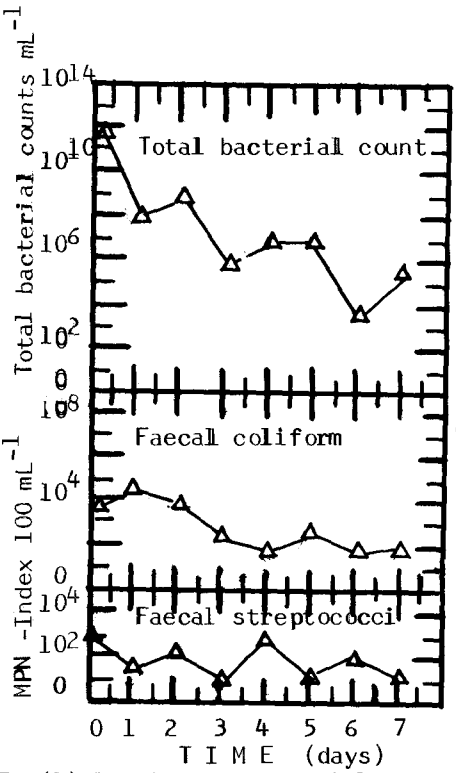
RESULTS AND DISCUSSIONS

The density of bacterial parameters, namely total bacterial count, faecal coliform, and faecal streptococci in Ismailia Canal water is shown in (Fig 1). When this water was seeded with 0.5 ml/L and 1.0 ml/L sewage separately and aerated for seven days, a significant increase in bacterial density were observed (Fig 2). It can be noted from these results that there are relatively high level of bacterial count in the raw Ismailia

Table (1): The experimental design throughout this work, type of detergents used and method of treatment employed in each set.

Flask No.	Set No. 1	Set No. 2	Set No. 3
1*	R. Water	-	-
2**	R. Water + Sewage (0.5 ml/L)	-	-
3**	R. Water + Sewage (1.0 ml/L)	-	-
4***	R. Water + ABS	R. Water + LAS	R. Water + (1:1 Mix.)
5	R. Water + ABS + Aeration	R. Water + LAS + Aeration	R. Water + (1:1 Mix. + Aeration.
6	R. Water + ABS + Aeration + Sewage (0.5 ml/L).	R. Water + LAS + Aeration + Sewage (0.5 ml/L).	R. Water + (1:1 Mix.) + Aeration + Sewage (0.5 ml/L).
7	R. Water + ABS + Aeration + Sewage (1.0 ml/L).	R. Water + LAS + Aeration + Sewage (1.0 ml/L).	R. Water + (1:1 Mix.) + Aeration + Sewage (1.0 ml/L).

R. Water = Raw Ismailia Canal
* To study the density of the Bacterial parameters in Ismailia Canal water.
** To study the density of the Bacterial parameters in Ismailia Canal water after seeding with two different sewage concentrations (0.5 and 1.0 ml/L).
*** This flask was not aerated.
ABS = Alkyl Benzene Sulfonate (10.0 mg/L).
LAS = Linear Alkyl Sulfonate (10.0 mg/L).
(1:1 mix.) = 1:1 mixture of ABS and LAS.



Fig(1) Density of bacterial parameters in raw Ismailia Canal water without aeration.

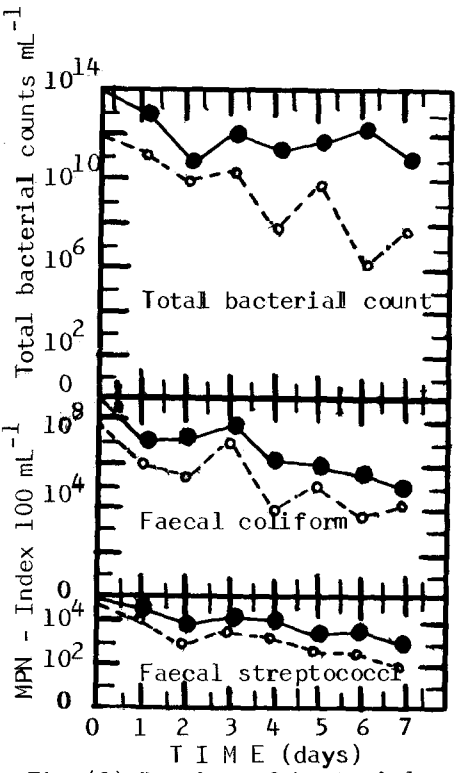


Fig (2) Density of bacterial parameters in Ismailia Canal water seeded by sewage with two different concentrations:

o---o 0.5 mL/L sewage
●——● 1.0 mL/L sewage

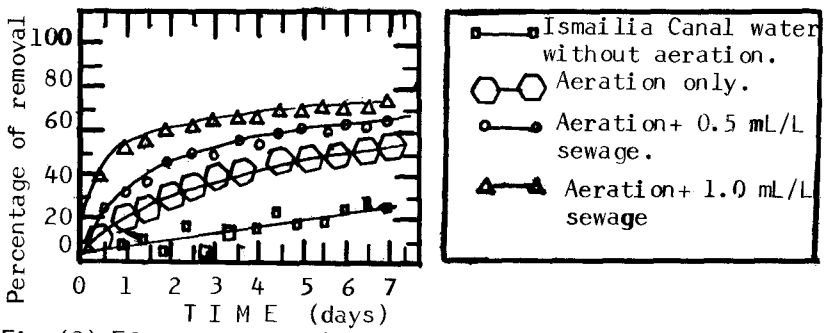


Fig (3) Effect of aeration on the degradation of Alkyl benzene sulfonate (ABS) seeded by different sewage concentrations.

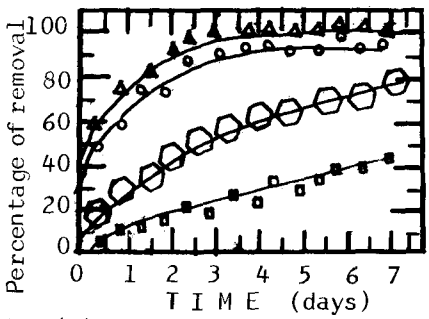


Fig (4) Effect of aeration on the degradation of Linear alkyl sulfonate (LAS) seeded by two different sewage concentrations

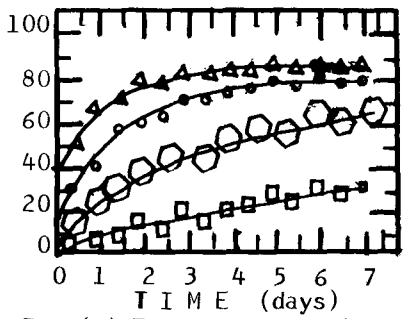


Fig (5) Effect of aeration on the degradation of 1:1 mixture of (ABS) and (LAS) seeded by two different sewage concentrations.

Canal water before the sewage addition. This can be attributed to the low variation in the climate temperature of the Canal that allow the bacterial growth during the period of this study.

The degradation of the hard surfactant ABS in this Canal water without any aeration was only 9.8% within two days (Fig 3). After seven days, this degradation increased to 30.2% within two days and 42.1% within seven days. Further remarkable increase in this degradation was acheived by seeding the system with sewage as a result of increasing the microbial flora. When the sewage was 0.5 ml/L the degradation was 43.5% after two days and 68.7% after seven days. By increasing this sewage dose to 1.0 ml/L further increase in the degradation was reached. At this point the degradation was 60.4% after two days and 74.1% after seven days.

On the other hand, the degradation of the soft anionic LAS was also investigated. The results obtained are illustrated in Figure (4). These results indicated that LAS exhibites a rapid break down. Without aerating the system, the degradation reached 14.9% after two days and 40.7% after seven days. By aerating the system, the degradation was 40.4% after two days, and 74.5% after seven days. By adding 0.5 ml/L sewage, the degradation increased to 78.2% after two days and 89.4% after seven days. Increasing the sewage dose to 1.0 ml/L increased the degradation to 89.7% within two days and almost complete degradation, namely 99.8% within three days only.

When the 1:1 mixture of ABS and LAS was subjected to the same experimental trend, the degradation after two days was 12.3% without aeration, 36.4% after aeration, 60.1% after adding 0.5 ml/L sewage, and 78.3% after adding 1.0 ml/L sewage. The corresponding degradations after seven days increased to 32.5%, 66.0%, 80.7% and 87.3% respectively (Fig 5).

These results showed that the degradation rate of the studied detergents can be enhanced remarkedly by aerating and/or adding sewage as a source of microflora. Increasing density of this microflora increases the degradation rate. In addition, these results showed that the degradation of the hard surfactant ABS can be increased by mixing it with the soft surfactant LAS. The results obtained in this study are in good agreement with that reported by Holman and Macek (1980), Starling et al (1976). It was also reported by Hollis (1976) that the biodegradation of LAS which is accompanied by opening the benzene ring, was enhanced by sewage.

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