

Assessment Of Suitability Of Anionic Synthetic Detergents In Sri Lanka

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Abstract— This research was focused on the understanding of the biodegradability of synthetic anionic detergent powder available in Sri Lankan market. Eight different types of synthetic detergent powders were selected. LAS contents of the selected products were measured according to ASTM: D 3049-89 standard. The biodegradability was measured as the reduction percentage of LAS initially present, within a specific period. The phosphate content in the detergents were measured by SLS: 760, 1986 method and the pH of the media also was obtained to find any relationship between these parameters. The results found that the biodegradability of LAS in detergent powder is ranged between 24%-79%. This study found that the biodegradability of anionic surfactants highly depend on the phosphate content of the product. According to SLS 760:1986, minimum LAS % which has to be maintained in the Sri Lankan synthetic detergent and the existing legislations for the manufacturing, marketing and consuming of detergent products should have modified for the health and safety environment. Therefore further studies need to be conducted to determine the maximum allowable level of phosphates lead to the highest level of biodegradability.

Index Terms— Biodegradability; Synthetic detergent; Surfactants, LAS %; Phosphate content

1. INTRODUCTION

Detergents play an important role in any modern society. They are developed synthetic organic chemicals as cleaning products. Surfactants are the main responsible components of the detergents. They are widely used in household cleaning detergents, personal care products, textiles, paints, polymers, pesticide formulations, pharmaceuticals, mining, oil recovery and pulp and paper industries. Surfactants categorize mainly as anionic, nonionic and cationic depending on their hydrophilic groups. Linear alkylbenzene sulphonates (LAS), alkyl ethoxy sulphates (AES), alkyl sulphates (AS), alkylphenol ethoxylates (APE), alkyl ethoxylates (AE), and quaternary ammonium compounds (QAC) are the commonly used commercial surfactants. Among them Linear alkylbenzene sulphonate (LAS) is a most popular easily biodegraded anionic surfactant in detergents ([1, 2]. Due to their widespread use and higher consumption, surfactants and their degradation products have been detected at various concentrations in surface waters, sediments and sludge-amended soils. The detergents which are easily degradable are used up by microorganisms while other less degradable types bioaccumulate and cause adverse environmental problems [3]. Problems such as destruction of the external mucus layer that protects fish from bacteria and pathogens, severe damages to the gills, lowering of the surface tension of the water, algal blooms that releases toxins and decreases oxygen in waterways and decrease in the breeding ability of aquatic organisms have been reported [4].

Therefore knowledge of the processes involved in distributing these surfactants among ecosystem compartments is essential to an understanding of their behavior in the environment. There have been some detailed research papers and review articles on the occurrence of various [5-8]. This study was mainly focused to find out the suitability of available detergents in Sri Lankan market by investigating the behaviors and fate processes of anionic surfactants with respect to LAS in several detergent products. During the study several standard test methods were applied, to determine the biodegradability of surfactants and ingredients in detergent products.

2 MATERIAL AND METHODS

2.1 Test Method for Synthetic Anionic Ingredient

ASTM: D 3049-89 standard test method was followed to determine synthetic anionic ingredients in the detergent. Biodegradability of LAS and quantity of Methylene blue active substances were measured by ASTM: 2667-95 and ASTM: 2330-02 standard test methods respectively. SLS 760: 1986 test method was applied to measure phosphates content in detergent powder while SLS 760: 1986 standard test method applied to determine pH value in the samples. Eight detergent powders by well-known producers, available in Sri Lankan market have been investigated. The detergents were all labeled and stored in a water free polyethylene bags until they were needed for the study.

3 RESULTS AND DISCUSSION

3.1 Determination of LAS in the Detergent Powder

Collected different branded detergent powders were used to measure major active ingredient percentage (LAS) in the samples. The biodegradability of the LAS in each product is measured as the reduction percentage of LAS during a specific period of time. A reference sample of pure LAS was used for each experiment, in order to ensure accuracy of the test conditions. The LAS % of each detergent powder sample was calculated by using the following formula.

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$$LAS\% = \frac{V_x N_x E W_x D_x 1000}{W_s \times A_x 1000} \quad (1)$$

Where V- Hyamine 1622 solution, mL, N - normality of the Hyamine solution, EW -gram-equivalent weight of anionic-active (350 g – molar weight), D- dilution of sample, mL, A- aliquot of sample dilution, mL, W_s - sample mass, g

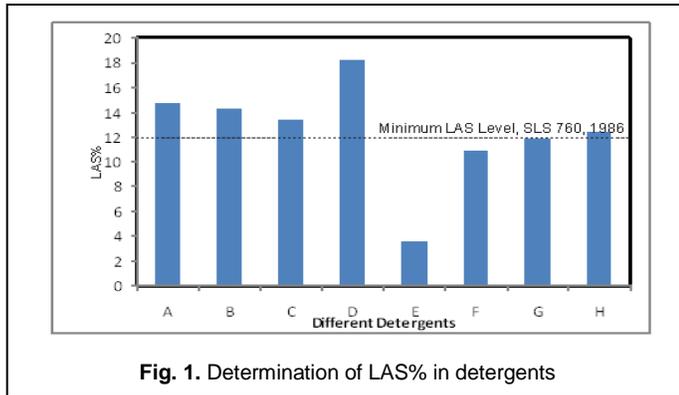


Fig. 1. Determination of LAS% in detergents

It has been recognized that the molecular architecture of a synthetic detergent can influence its biodegradability potential. Linear alkylbenzene sulphonate (LAS) [9, 10]. According to SLS 760:1986, minimum LAS % which has to be maintained in the Sri Lankan synthetic detergent powder is 12% w/w. But in Figure 1 clearly shows that most of products are not deal with the standard.

3.2 Determination of Biodegradability of LAS

ASTM: 2667-95 - standard test method was applied to determine LAS % in the samples. Biodegradability was determined by measuring the reduction in surfactant content during the test period. Based on ASTM: 2330-02, Standard test methods for Methylene blue active substances, LAS in the experimental media at the beginning and at the end were ascertained. Concentration of anionic surfactant in the basal media was about 50 mg/ L instead of 10 mg/ L. The analytical result of the blank sample provided background information and it was used to correct the results. According to the results of ASTM 2667- 95 test, it clearly shows the biodegradability percentages were is lower than the minimum biodegradable level % of 80 and only one product is fully biodegraded. Therefore it can be considered that they may be occurred significant impacts on the environments due to inadequate biodegradability. As the consumption rate of the detergent in Sri Lanka is higher, considerable attention should have paid to aquatic environment since the wastewater is directly discharged to surface water bodies. The products which maintain the minimum LAS% are shown maximum biodegradability % than others. They have reached the minimum biodegradable level (Figure 2). Therefore for healthy and safety environment, it gives a view to produce biodegradable anionic surfactant based on LAS% of the detergent powders. Biodegradability of detergent powder is an essential parameter and it should be a standard level for Sri Lankan synthetic detergent powders. When considering the LAS % and biodegradability of the product there was not a significance relationship between these two parameters, but the graph states that the biodegradability can be optimized by maintain the LAS % in product at the standard level of SLS.

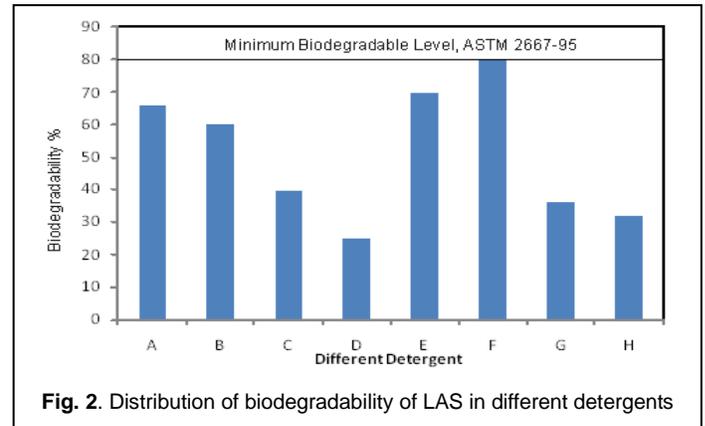


Fig. 2. Distribution of biodegradability of LAS in different detergents

3.3 Determination of Phosphates and pH in Detergents

Phosphate is an important ingredient and correlated with performance of the detergent. Therefore phosphates are added as sodium tri-polyphosphates (STPP). The Phosphate levels in the samples were determined according to the Sri Lankan standard test method for phosphate; SLS 760: 1986. Phosphate amounts in the samples were measured as average STPP%.

$$Total\ Phosphate = \frac{V_x N_x 0.001349 \times 250 \times 100 \times 360}{M \times 50 \times 93}$$

Where V - volume in mL of NaOH solution required to react with the precipitate, N - normality of NaOH solution and M - mass in grams of sample taken for the test. According to the Figure 3, except one sample others are lower than the minimum phosphate level. According to the SLS 760: 1986, 20% of phosphate percentages have to be maintained for the synthetic detergent powder. The product which phosphate level is exceeded the minimum level has the higher selling market value. The people use it regularly for removing all marks and patches in the cloths. According the Figure 4, it clearly can be concluded phosphate % in the detergents limit the biodegradability of the detergent. The product with low phosphate % show higher degradable level. Also standards of SLS 760: 1986, shows 20% of phosphate% is needed this study showed that the maximum biodegradability of detergent 5-10% percent of phosphate % is well enough. Therefore the standard level of the phosphate in the product should be reduced for safe environment.

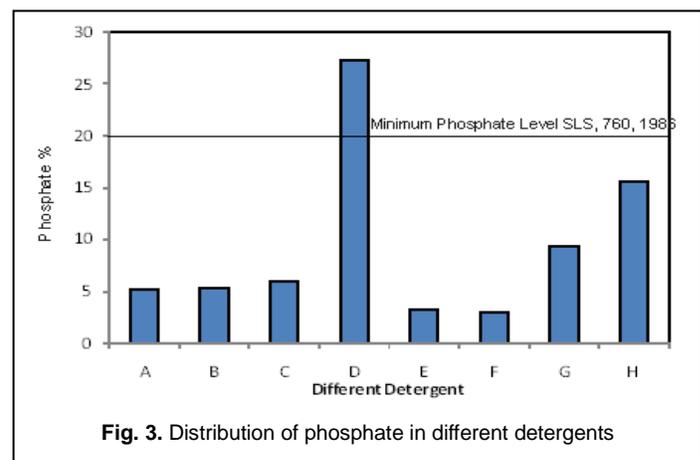


Fig. 3. Distribution of phosphate in different detergents

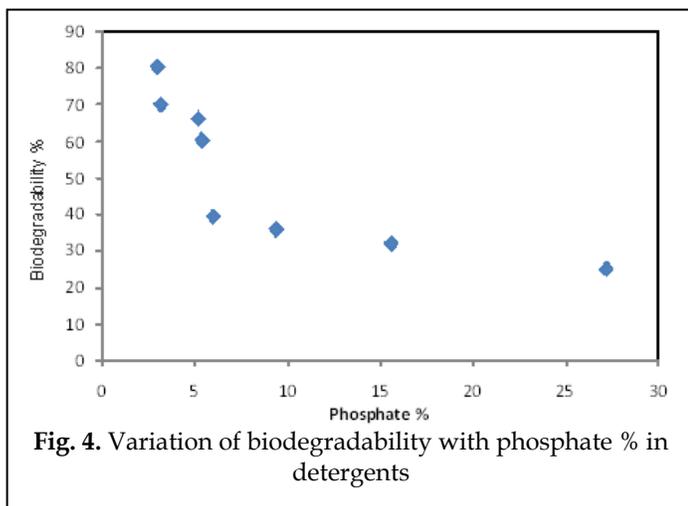


Fig. 4. Variation of biodegradability with phosphate % in detergents

As the biodegradation of LAS is highly affected by the pH of the product, pH levels were measured in the samples. The efficiency of microbial activities in the detergent products was varying with pH value.

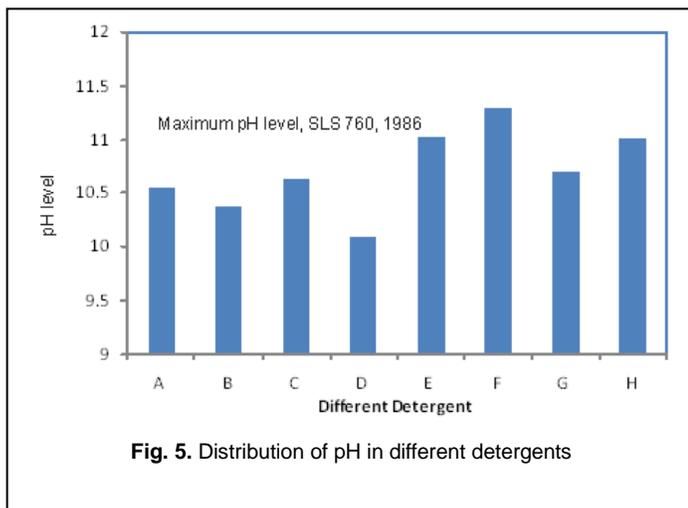


Fig. 5. Distribution of pH in different detergents

According to the Sri Lankan standard, the pH range need to be maintained in a laundry detergent is 9 to 11. The pH measurements of each detergent specimen were in range of standard; SLS: 760, 1986 (Figure 5). The above results show that the pH of the each product is maintained as per the SLS standard. For proper washings the detergent products need to be in basic nature in the aqueous solution.

CONCLUSION

Minimum LAS % in the Sri Lankan synthetic detergent powder is not maintained. The products which maintain the minimum LAS% are shown maximum biodegradability % than others. Biodegradability of detergent powder is an essential parameter. Phosphate % in the detergents limits the biodegradability of the detergent. The low phosphate % shows higher degradable level and this percentage should be maintained at standard level for Sri Lankan synthetic detergent powders. When considering the LAS % , phosphate % and biodegradability of the product there is not a significance relationship between these parameters. But the biodegradability can be optimized by maintaining the LAS %

and phosphate % in product at the standard levels of SLS.

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