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BIODEGRADATION OF LAUNDRY WASTEWATER

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Abstract - *Wastewater is the term used for discarded or previously used water. Laundry waste accounts for about 20% of the total wastewater of which surfactants are the main component. Surfactants if discharged into the water bodies, hinder aeration and treatment facilities due to their high foaming and low oxygenation capacity. Biodegradation of laundry wastewater is adversely affected by the presence of anionic surfactants. The main objective of the present study is to determine the efficiency of Bacillus cereus sp. in degrading synthetic laundry wastewater sample. Optimization studies of various parameters influencing biodegradation were done in batch reactors and the rate of biodegradation noted. A maximum of 95% removal of surfactants was observed under optimum conditions.*

Key Words: *Surfactants, Optimization, Bacillus cereus*

1. INTRODUCTION

Water is a common chemical substance that is essential for the survival of all known forms of life .Water pollution is the contamination of water bodies such as lakes, rivers, pond, oceans, and groundwater caused by human activities, which are harmful to organisms and plants that live in these water bodies. Detergents are various surface-active agents (surfactants) particularly effective in dislodging foreign matter from solid surfaces and retaining it in suspension.

Large concentrations of surfactants cause skin irritation. The threshold value that can impair aquatic life is 3-12 mg/L. Bacterial detergent-degraders such as *Pseudomonas aeruginosa*, *Escherichia coli*, *Enterococcus majodoratus*, *Klebsiella liquefasciens*, *Enterobacter liquefasciens*, *Klebsiella aerogenes*, *Enterobacter agglomerans*, *Staphylococcus albus*, *Proteus* sp., *Klebsiella oxytoca* and *Brevibacterium* sp., were isolated and tested them for degradation by Methylene Blue Active Substance (MBAS) Assay and were found to be positive for degradation. Biodegradation can be performed by soil or aquatic microorganisms leading to generation of water and carbon dioxide gas. Rate of biodegradation is dependent on temperature and oxygen such that aerobic conditions and a high temperature are beneficial for the process.

Sushma Patrao [4] focused on degradation of anionic surfactants by *Bacillus subtilis* and *Bacillus cereus.Bacillus subtilis and Bacillus cereus* were analysed for their capacity to degrade surfactants in laundry and dish washing detergents. Bacteria were isolated from soil at the outlet of these detergents and identified by biochemical tests. Methylene Blue Photometric Assay and Methylene Blue Active Substance Test were used to determine the amount of degradation by the bacteria. *Bacillus subtilis* showed better degradation for both dish and cloth washing detergent. Degradation was highest during the first 24 hours of incubation. Increase in surfactant concentration after 24 hours is attributed to the production of biosurfactant by both bacteria.

Amiy Dutt Chaturvedi [1] investigated the effect of household detergents (Surfactants) degraded through aquatic fungi. In general most of commercial household (Surfactants) detergents are biodegradable and amount of can be commercially reduced by secondary treatment of Municipal sewage wastewater plants.Future studies on commercial surfactant toxicities and biodegradation are necessary to

withdraw high toxic & non-biodegradable heavy metal from the environment.

Erich Jelen [5] studied the anaerobic biodegradation of detergent surfactants. This study focusses on the anaerobic degradation of detergent and in turn produces gases like methane used up for cooking and also as biofuel.

The present study is focussed on the biodegradation efficiency of *Bacillus cereus* in the removal of synthetic surfactant sample under varying conditions of temperature, pH and sulphate concentration.

2. METHODOLOGY

Synthetic surfactant wastewater samples were prepared with the help of sodium dodecyl sulfate (SDS). Analysis of anionic surfactants was done using methylene blue active substance test (MBAS) and spectrophotometrically analysed at 652nm using uv-visible spectrophotometer. Other analysis were conducted by the procedure in standard methods for the examination of water and wastewater (APHA 2005)

Bacterial culture, *Bacillus cereus* for degradation of anionic surfactants was procured from microbial type culture collection center, Chandigarh. Nutrient broth was the media used for bacterial culture. The culture is incubated at 37°C for 24hrs and is stored in the refrigerator for further experiments.

Optimization of the various parameters such as pH, temperature, time and sulfate was done. pH was measured with the help of pH meter. Temperature was measured with the help of temperature rod (water quality analyzer). For sulfate measurements, 100ml of the sample was taken, 5ml of conditioning reagent and barium chloride was added and the sample was spectrophotometrically analyzed at 420nm.

pH was adjusted from 5 to 9 and the optimum value at which the maximum degradation obtained was noted. Temperature was adjusted from 25˚C to 35˚C and the temperature at which maximum degradation for anionic surfactants obtained is noted. Sulfate was adjusted to 10mg/L, 50mg/L, and 100mg/L. The sulfate value was adjusted with the help of standard sulfate solution and the optimum value of sulfate is noted.

The samples are incubated for 6hrs, 12hrs, 18hrs, 24hrs and so on in an orbital shaker incubator and is taken and centrifuged at 5000rpm for 30minutes in a centrifuge. Thes supernatant is taken and analyzed by MBAS method. Equal quantities of methylene blue and chloroform solution were added and the color from the chloroform layer is extracted and spectrophotometrically analyzed at 652nm

The biodegradation of synthetic surfactant sample is then done with these optimum parameters and the percentage removal efficiency is noted.

3. RESULTS AND DISCUSSION

3.1 Optimization of pH

The pH of the anionic surfactant sample was varied from 5-9.The maximum efficiency of biodegradation was obtained at pH 8. The percentage efficiency of removal of surfactants of concentrations 5mg/L and 10mg/L concentration were found to be 70% and 50% respectively. The least efficiency of biodegradation was obtained at a pH of 5. This shows that the bacteria are uncapable of degrading the anionic surfactant in an acidic pH. The bacterial degradation is showing a decreasing pattern after pH 8. So a pH value of 8 was adopted for further studies

The variation of pH versus concentration of anionic surfactant 5 mg/L is shown in figure (1) and for the concentration of 10 mg/L is shown in figure (2).

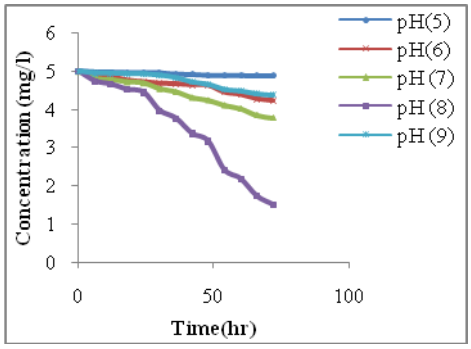

Fig 1: Variation of pH versus time for removal of anionic surfactant at concentration 5mg/L

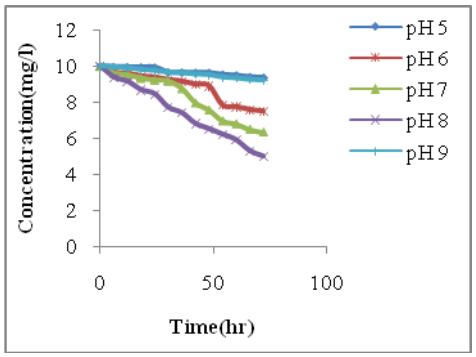

Fig 2: Variation of pH versus time for removal of anionic surfactant at concentration 10mg/L

3.2 Optimization of temperature

The incubation temperature is varied from 25°C to 35°C. The maximum biodegradation efficiency was observed at a temperature of 30°C.

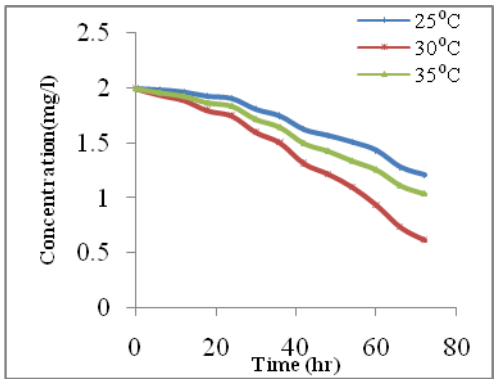

Fig 3: Variation of temperature versus time for removal of anionic surfactant at concentration 2mg/L

The biodegradation efficiency for varying temperature was checked for different concentrations. The percentage biodegradation efficiency at 30°C for 2mg/L , 20mg/L and 40mg/L are 69% , 68% and 50% respectively. The bacteria are capable of degrading more than 50% of the anionic surfactant within 72 hrs at optimum temperature The least efficiency of removal was shown at a temperature of 25°C.Variation of temperature at different concentrations is shown in figure (3), (4),(5) respectively.

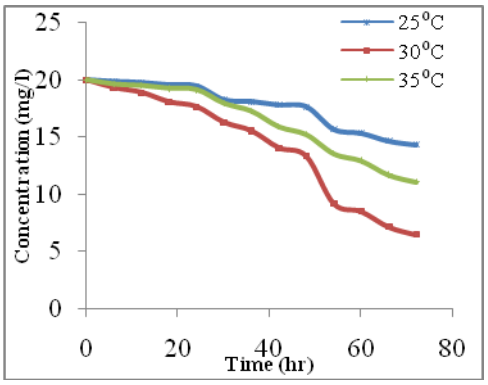

Fig 4: Variation of temperature versus time for removal of anionic surfactant at concentration 20mg/L

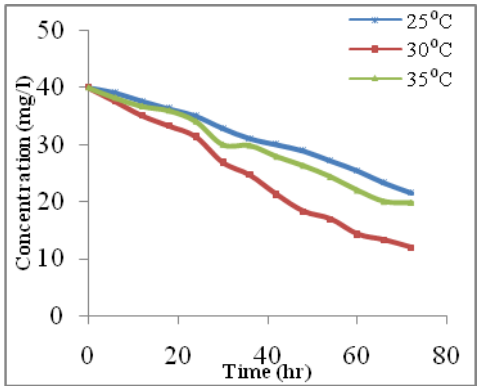

Fig 5: Variation of temperature versus time for removal of anionic surfactant at concentration 40mg/L

3.3 Optimization of Sulfate

The sulfate concentration is varied to 10mg/L, 50mg/L and 100mg/L respectively. The sulfate value of anionic surfactant was adjusted with the help of standard sulfate solution. The value of sulfate

at which the biodegradation efficiency is maximum is at 10mg/L. The percentage biodegradation efficiency at 10mg/L, 50mg/L and 100mg/L sulfate concentrations are 85%, 34% and 35.42% respectively. This means that the bacteria is able to degrade the anionic surfactant at a low concentration of sulfate .Variation of surfactant concentration at adjusted sulfate concentration versus time is shown in figure(6).

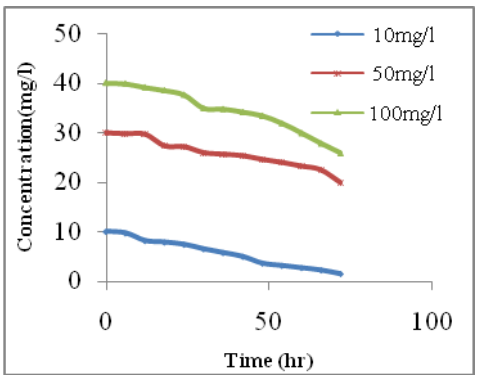

Fig 6:Variation of sulfate versus time for removal of anionic surfactant by *Bacillus cereus*

3.4 Biodegradation of synthetic surfactant sample with optimum parameters

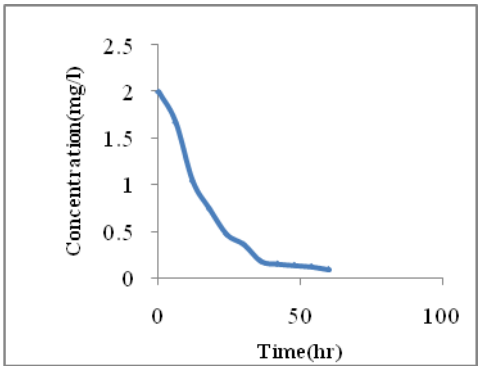

Fig 7: Variation of anionic surfactant concentration versus time. for *Bacillus cereus*

The best percentage removal efficiency of anionic surfactant was observed after an incubation time of 6hrs.

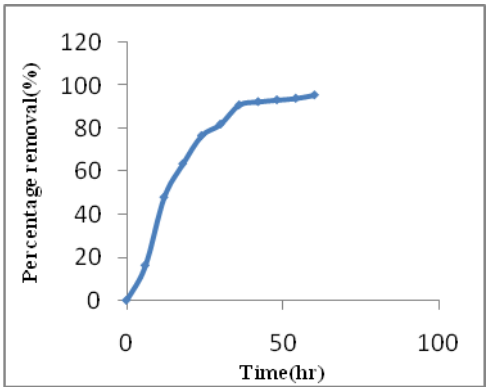

Fig 8 : Variation of percentage removal efficiency versus time for *Bacillus cereus*

The synthetic surfactant sample of 2mg/L concentration is taken for analysis and is adjusted to optimum pH of 8, optimum sulphate concentration of 10mg/L and incubated at optimum temperature of 30°C.After 60hrs, 95.47% degradation was observed. Variation of concentration of anionic surfactant with time is shown in figure (7) and the variation of percentage degradation efficiency with time is shown in figure (8).

4.CONCLUSION

Synthetic surfactants discharged into the water bodies hinder aeration due to its high foaming and low oxygenation capacity. Microbes are shown to be an efficient degrader of anionic surfactants. *Bacillus cereus* showed a maximum degradation within 72hrs of incubation.

The optimum temperature for *Bacillus cereus* was found to be 30°C and pH was found to be 8.The optimum sulfate concentration was found to be 10mg/L. Biodegradation efficiency for the removal of synthetic surfactants under these optimum parameters was found to be 95% within 60hrs.

REFERENCES

1.Amiy,Chaturvedi., K.L.Tiwari (2013)"Effect of household detergent degraded through aquatic fungi" *Recent research in science & technology(5) 12-16*

2.Chan,H., (2012) "High performance achieved by microbes to separate laundry effluents resulting in producing high water quality in a compact area" *Separation and Purification Technology (*90)101–108

3.Delforno,T., Moura,A., Okada,L., (2014) "Effect of biomass adaptation to the degradation of anionic surfactants in laundry wastewater using EGSB reactors" *Bioresource Technology(154) 114-121*

4.Sushma, Patrao., Nishmitha, Suvarna., and Melwyn, Sequiera.,"Degradation of anionic surfactants by *Bacillus subtilis* & *Bacillus cereus" Pharmacy & biological science 42-45*

5.Ute, Merrettig, Bruns., and Erich, Jelen.,(2009) "Anaerobic Biodegradation of Detergent Surfactants *Materials 181-206*