ISSN XXXX XXXX © 2018 IJESC

Research Article Volume 8 Issue No.12

Removal of Surfactant from Waste Soap Solution by using Membrane Bio-Reactor

Vishal R.Yadav[1], Sachin A. Dawale[2]
Lecturer in Chemical Engineering[1], Lecturer in Polymer and Plastic Engineering[2]
Institute of Petrochemical Engineering, Dr.Babasaheb Ambedkar Technological University, Lonere, Raigad, India

Abstract:
A membrane bioreactor (MBR) was used to investigate the aerobic degradation of foam active substance(surfactant).The surface aeration using membrane bioreactor(MBR) guaranteed sufficient O2 for substrate removal and bacteria growth and avoided foam development. Moreover, the membrane filtration enabled the separation of the bacteria still loaded with surfactant in the collecting container. The biological degradation of the surfactant with varying hydraulic retention time (HRT) and influent concentration showed high substrate removal of nearly 95 %.surfactant used worldwide in detergent and household cleaning product formulations. Its biodegradation and removal has been extensively studied in wastewater treatment facilities at low concentrations (<10 mg/L).however, has been expended investigating degradation of higher concentrations of surfactant representative of those expected in wastewater generated at surfactant manufacturing operations. This work was conducted to investigate biological processes for treating wastewaters containing high concentrations (e.g., 400 mg/L) of surfactant.

I. INTRODUCTION:

The MBR process was introduced by the late 1960s, as soon as commercial scale ultrafiltration (UF) and microfiltration (MF) membranes were available. The original process was introduced by Dorr-Olivier Inc. and combined the use of an activated sludge bioreactor with a cross flow membrane filtration loop. The flat sheet membranes used in this process were polymeric and featured pore size ranging from 0.003 to 0.01_m. Although the idea of replacing the settling tank of the conventional activated sludge process was attractive, it was difficult to justify the use of such a process because of the high cost of membranes, low economic value of the product(tertiary effluent) and the potential rapid loss of performance due to fouling. As a result, the focus was on the attainment of high fluxes, and it was therefore necessary to pump the mixed liquor suspended solids (MLSS) at high cross flow velocity at significant energy penalty (of the order 10 kWh/m3 product) to reduce fouling. Due to the poor economics of the first generation MBRs, they only found applications in niche areas with special needs like isolated trailer parks or ski resorts for example. The breakthrough for the MBR came in 1989 with the idea of to submerge the membranes in the bioreactor. Until then, MBRs were designed with the separation device located external to the reactor and relied on high trans-membrane pressure (TMP) to maintain filtration. The other key steps in the recent MBR development were the acceptance of modest fluxes (25% or less of those in the first bubbly generation), and the idea to use two-phase flow to control fouling. The lower operating cost obtained with the submerged configuration along with the steady decrease in the membrane cost encouraged an exponential increase in MBR plant installations from the mid 1990s. Since then, further improvements in the MBR design and operation have been introduced and incorporated into larger plants. While early MBRs were operated at solid retention times (SRT) as high as 100 days with mixed liquor suspended solids up to 30 g/l, the recent trend is to apply a lower SRT (around 10–20 days), resulting in more manageable mixed liquor suspended solids (MLSS) levels (10–15 g/l). the fouling propensity in the MBR has tended to decrease and overall maintenance has been simplified as less frequent membrane cleaning is necessary.

Table.1. Characteristics of feed

Temp	Ph	TS	TDS	TSS	COD	Surfactant
25-30 c	.2	1600 mg/l	1100 mg/l	500mg/l	2880 mg/l	432 mg/l

II. MATERIALS AND METHODS:

The MBR used for treatment of waste water containing surfactant is of 20 lit capacity but its working capacity is 15 lit. Membrane unit is submerged in the bioreactor. MBR has two membrane pouches of pore size 0.5-3μ fabric backed membrane and size of 8*8 inch, it is made up of polyether sulphone .The surface area of each membrane is 0.06 m². The MBR body is made up of stainless steel (SS-304) equipped with drain valve at the bottom and air purging system for supply of air for biodegradation. Air flow meter of range 0.5-5 LPM also attached to measure the air flow rate to the membrane bioreactor. The MBR system consist of compressor with discharge valve, vacuum guage of range 0-1kg/cm2 ,temp indicator and water flow meter of range 0.5-5LPM and diaphragm pump for drawing the permeate. The MBR system arrangement are as shown in fig. In order to avoid bacterial growth in the mixing flask, the nutrients were added to the influent after the mixing flask. In order to supply the growing bacteria with nutrients, inorganic substances were added to the feed (waste water containing surfactant obtained from Hindustan Lever Ltd).Their compositions are given in Table 1.For the membrane filtration system the membrane material was composed of polyether sulphone. The membrane had a mean pore size of 0.5-3μ .Total surface area of a module was 0.06 m². Fill the reactor with feed solution enough to completely submerge the membrane pouches preferably level should be 2 inch above the pouch. Start the compressor keeping the compressor outlet valve crack open. Slowly increase the flow to the desired level. To draw a permeate start the diaphragm pump. Recycle permeate until the system is stabilized. Clarity will depend upon the biological system &particle size of the colloidal matter. The permeate will become clear after 15 min of recycling.

Table.2. Composition of nutrients & minerals in waste water containing surfactant

Items	components	concentration
Inorganic salts	(NH4)2SO4	3.2g/L
	KH2PO4	1.6g/L
	K2HPO4	1.8g/L
Mineral element	Mgso4.7H2O	1.9 gL-1
	MnCl2.4H2O	2.9 gL-1
	Cu SO4.5H2O	1.4gL-1
	ZnSO4	1.1gL-1
	Feso4.7H2O	1.2 gL-1
	NH4cl	2.5 gL-1

Operating Conditions: The MBR operated at different HRT (Hydralauic retention time)at 3-12 days at about temperature 25-30c.The v Ph alue maintained in the range of 6-9. Its value is adjusted by adding NaoH.Besides changing HRT, the solid retention times (SRT) was stepwise increased by using membrane filtration in order to determine the effect of various biomass concentrations, on the biological degradation of surfactant in the membrane process. The effect of various HRT on biodegration are investigated. The ability of MBR for surfactant removal for different HRT also analyzed.

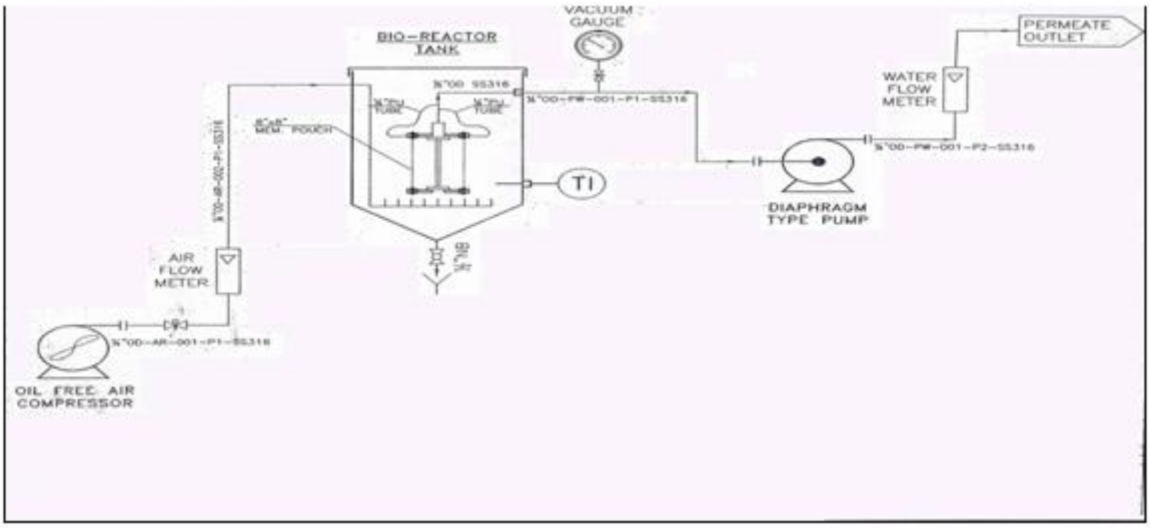

Figure.1. Flow chart for membrane bio-reactor process

III.ANALYTICAL METHODS

The biomass concentration was evaluated by measuring total suspended solids (TSS) and volatile suspended solids (VSS). Its measurement follows. The sample taken was clarified by centrifugation for 20 min at 4000 rpm. After centrifugation the solid part found near the bottom of the centrifugation glass was carefully put into a porcelain cup and dried for 24 h at 105°C for TSS. The dried matter was cooled in a desiccator for 2 h, and weighed. Further the sample in the porcelain cup was burnt for 2 h at 550°C in order to oxidize all organic matter completely for measuring VSS. The measurement of the pH was performed online by a pH electrode which enabled the pH value to control by a dosage of soda solution(NaOH) The pH fluctuation ranged ± 0.02.Total solids are determined as the residue left after evaporation of the unfiltered sample and total dissolved solids are determined as the residue left after evaporation of filtered sample and total suspended solids are taken as the difference between total solid and total dissolved solids.COD (chemical oxygen demand) is the measure of oxygen consumed during oxidation of organic matter.it is measured by using standard method of determination of COD. Surfactant concentration is measured by using standard method of spectrophotometric analysis.

IV. RESULTS AND DISCUSSION

Effect Of Hydraulic Retention Times (HRT)

The wastewater with the foaming active surfactant was successfully treated in an aerobic membrane bioreactor with surface aeration for different hydraulic retention times, Hydraulic retention time (HRT) ranges from 3 to 12 days The experiment consisted of 4 experimental periods.

Overall performance of the MBR: Results show the development of the TSS profiles in submerged MBRs at different HRT. It can be seen that the biomass was strictly developed from the microorganisms coming in with the activated sludge. The TSS built up rapidly at the beginning of each run and more slowly as the time elapsed and finally reached a stabilization state. At the initial stage, the bacteria could be subjected to unlimited supply of food and oxygen, which promoted bacteria to stay in the exponential growth phase. As the TSS increased, the substrate became limiting and the bacteria may enter the endogenous phase. This was depicted in the plot, which showed the TSS increased until day 6, thereafter, it was not absolutely constant but fluctuating around a mean value and apparently reached a steady state towards the end of experiments. In reactor 1, the stabilization value of TSS was found to be. The biomass concentrations obtained in MBR were considerably higher than the conventional activated sludge process. The intensification in biomass concentrations revealed the potential capability of submerged MBR to operate in a smaller reactor volume.

Carbonaceous removal: Result shows the performance of COD in submerged MBRs during the 12 d experimental runs. The results obtained from the studies clear indicate that the biological removal efficiency of COD in MBR was observed to fluctuate around 78– 90%. Biological removal efficiency of the submerged MBR was determined from the supernatant of the samples collected after it was allowed to settle for approximately 30 min. This corresponds to the reduction in conventional treatment plants, which can achieve a COD degradation rate of 75–85%. The findings demonstrated that the biological treatment, which relied on the microorganisms present in the mixed liquor to metabolize and remove the dissolved organic matter, has limited capability in improving the COD removal efficiency. In submerged MBRs, the membrane separation plays a significant role in maintaining high and stable COD removal. It serves as an addition purification phase to retain the remaining particulate COD and produced an improved effluent quality. As shown in Table 3, the coupling of the membrane filtration process in a bioreactor could increase the overall efficiency to as high as 96%. In other words, 10–20% of the COD present in the wastewater has been effectively removed by submerged membrane separation. This shows that the submerged membrane filtration unit provides a second defense frontier in wastewater treatment in obtaining an effluent that is low in biodegradable organics. High removal efficiencies of more than 90% have been commonly by various researchers. This remarkable COD removal efficiency seemed to be one of the major advantages of submerged MBR that made it a promising alternative to the conventional process. The improved COD removal to the combination of complete particulate retention by the membrane, including suspended COD and high molecular weight organics, as well as the avoidance of biomass washout commonly encountered in activated sludge. It has reported that the membrane in MBR contributed approximately to 30% of the removal of organic matter, this roughly equating to the insoluble fraction with the solutes being removed via active biomass. These reports were in agreement to our experimental findings that improved efficiency of submerged MBRs was enhanced by the use of membranes.

Surfactant Removal: Fig shows the Effect of Variation in Hydraulic Retention Time (HRT) on surfactant Degradation High degrees of biodegradation of the surfactant of nearly 95% were obtained at high volumetric loading rates. surfactant concentration from feed decreases proportionally with HRT as shown fig Initially feed contain more amount of surfactants, it is decreases with increase in HRT. Result shows the concentration of surfactant inversely proportional to HRT. The additional removal of substrate results from a physical separation of rest substrate by the membrane filtration. The rest substrate is difficult to biodegrade and has a larger molecular size than the membrane pore size used in this work. During long term filtration runs, a rapid decrease in permeate flux by layering and clogging of the membrane was observed. In order to avoid the rapid decrease in permeate flux, one of the both membrane modules was separated and cleaned chemically. The chemical cleaning consisted of alkaline, chloric, acidic and enzymatic steps. Each step took about 20-30 minutes.

V. CONCLUSIONS

A membrane bioreactor has been used to investigate the aerobic biodegradation of the surfactant. The following results were obtained:·An aerobic treatment of wastewater containing foam active substances (surfactant) was successfully carried out. The membrane filtration improved the separation of the bacteria still loaded with surfactant in the collecting container. The waste water released from various industry like surfactant manufacturing industry, soap and detergent industry and many other industry which uses surfactant in their product, contain higher percentage of surfactant concentration which affects adversely on the environment. It can be treated successfully in MBR. The effluent quality can be controlled below the standard limit, besides this MBR has many advantages as compared to other techniques. The MBR is investigated for treatment of wastewater containing foam active substances (surfactant) was successfully carried out. And effect of HRT on various parameters like flux, permeability, TMP, COD, and surfactant removal efficiency are analysed. Result shows that surfactant concentration decreases as the HRT increases. Surfactant concentration can be decreased below standard limit by using MBR. Transmembrane pressure (TMP) increases with increases in HRT, permeability and flux of the membrane decreases with increases in HRT. High degrees of biodegradation of the surfactant of nearly 95% were obtained at high volumetric loading rates The special characteristic of membrane filtration, the complete retaining of bacteria, enables high biomass concentrations resulting in very high SRT. The excess sludge can be reduced This is only about 5% of the sludge obtained at low SRT. In contrast to these advantages due to the reduced excess sludge production, the disadvantages of increased energy consumption at higher concentration due to the extremely high O2 requirement have to be taken into account. High strength wastewater was treated by submerged MBR at SRT 200 d. It was found that the submerged MBRs could remove up to 98% of the suspended solids and achieve a remarkable COD overall removal efficiency of 96% in all the 4 experimental runs. Membrane bioreactor that use membrane unit to separate treated water and mixed liquor can be replace for the sedimentation/ clarification techniques. So higher strength wastewater can be treated and lower biomass yields are realized.

VI. REFERENCES:

[1]. J.A. Scott, D.J. Neilson, W. Liu and P.N. Boon, A dual function membrane bioreactor system for enhanced aerobic

remediation of high strength industrial waste, Water Sci. Technol., 38(4–5) (1998) 413–420.

[2]. E.B. Muller, A.H. Stouthamber, H.W. Verseveld and D.H. Eikelboom, Aerobic domestic wastewater treatment in a pilot plant with complete sludge retention by cross flow filtration, Wat. Res., 29 (1995) 1179– 1189.

[3]. E. Egemen, J. Corpening and N. Nirmalakhandan, Evaluation of an ozonation system for reduced waste sludge generation, Water Sci. Technol., 44 (2–3) (2001) 445–452.

[4]. R.M. Ben and J.S. Michael, Membrane bioreactors for wastewater treatment and reuse: a success story, Water Sci. Technol., 47 (1) (2003) 1–6.

[5]. X. Huang, P. Gui and Y. Qing, Effect of sludge retention time on microbial behaviour in a submerged membrane bioreactor, Process Biochem., 36 (2001) 1001–1006.

[6]. N. Engelhardt,W. Firk and W. Warnken, Integration of membrane filtration into the activated sludge process in municipal wastewater treatment, Water Sci. Technol., 38(4–5) (1998) 429–436

[7]. Al-Jayyousi,O.R.,“Greywater reuse: towards sustainable water management,” *Desalination*,**156**(1-3), 181-192 (2003).

[8]. Marcucci, M., and Tognotti, L., “Reuse of wastewater for industrial needs: the Pontederacase,” *Resources, Conservation and Recycling*,34(4), 249-259 (2002).

[9]. Jefferson, B., Laine, A. L., Stephenson, T.,and Judd, S. J., “Advanced biological unit processes for domestic water recycling ,” *WaterSci. Tech.*, 43(10), 211-218 (2001).

About Author:

Vishal R. **Yadav** received Diploma in chemical Engg. from Govt. Polytechnic, Jalna. He graduated in chemical Engineering from the Amravati university (M. S.), India. & post graduated from UDCT Amravati Presently; he is working as lecturer in chemical engg in Dr.Babasaheb Ambedkar Technological university (M.S.), India.