II-445 EFFECT OF MIXING ON ORGANIC SUBSTRATE REMOVAL IN MICROAEROPHILIC UPFLOW SLUDGE BED REACTOR (MUSB)

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INTRODUCTION

High energy consumption in conventional aerobic processes and low treatment effeciency in anaerobic processes, has highlighted the necessity of developing a process with low energy consumption without sacrificing the effluent quality. Microaerophilic upflow sludge bed reactor (MUSB) is a process in which wastewater is aerated for a short detention time in aeration vessel (AV) and then is allowed to flow in upflow fashion in biological vessel (BV). Limited Oxygen conditions in upflow vessel result in the development of sulfur microorganisms. Sulfate reducing and sulfide oxidising microorganisms act in a symbiotic way to degrade organic substances and result in highly settelable sludge. However organic substrate removal in MUSB is sensetive to hydraulic, microbiological and other operating conditions. This research paper investigates the effect of mixing on organic substrate removal in MUSB reactor.

MATERIAL AND METHODS

The experimental study was carried out on two MUSB reactors, each having two columns; AV and BV as shown in Fig 1. In one reactor mixer with speed varying from 0.5-2.0 rpm has been installed in BV. The other reactor was operated without any mixer. The total volume of each reactor was 60L. Sludge from anaerobic digester was used as a seed sludge. About 5-10 % of total volume of BV was fed with the digested sludge having MLVSS as 8750 mg/l. Synthetic wastewater with Lactic acid as an organic substance was used. Table 1 shows composition of concentrated synthetic wastewater. Influent concent-ration was maintained between 50-80 mg/l by diluting with tapwater. In this study only one stage MUSB was operated with total detention time of about 35 minutes, however in actual practice number of stages are to be

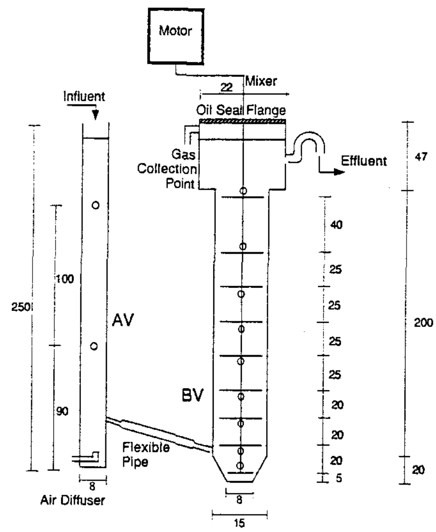

Fig 1 Microaerophilic Upflow Sludge Bed Reactor (MUSB)

Table 1 Composition of synthetic wastewater.

Substance	Concentration
Lactic acid	10.0 g/l
NH_4SO_4	8.0 g/l
K_2HPO_4	1.0 g/l
$NaHCO_3$	10.0 g/l
$MgSO_4$	1.0 g/l
$CaCl_2$	1.2 g/l
KCl	4.0 g/l
Yeast extract	1.0 g/l

Table 2 Operating conditions maintained in MUSB reactor

Flow rate	=	100 l/hr
Upflow velocity in BV		
(Blanket part)	=	9.4 cm/min
(Solid liquid separation part)	=	4.4 cm/min
Upflow velocity in AV	=	33.0 cm/min
Detention time in BV		
(Blanket part)	=	21.0 min
(Solid liquid separation part)	=	9.0 min
Detention time in AV	=	7.0 min
Mixing speed	=	1.5 rpm
Temperature	=	25^{0}C

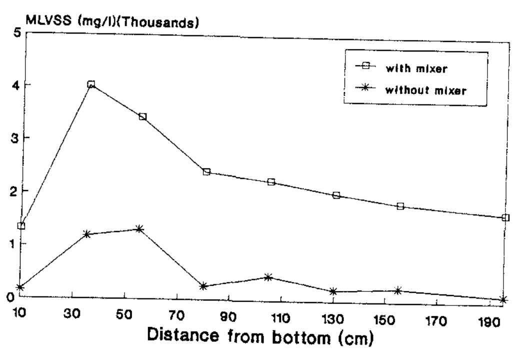

Fig 2 Biomass profile in a MUSB reactor with and without mixer

connected in series, depending on the type and strength of wastewater. Table 2 shows the operating conditions maintained in the reactor.

RESULTS AND DISCUSSION

Initially in both MUSB reactors, granules of about 8-10 mm size, having inner dense anaerobic nuclei surrounded by fragile floc, were formed. Grenules disappeared in MUSB without mixer very soon, however ganules could be maintained for about two weeks in MUSB with mixer. Although granules were disappeared but still sludge was found to be very dense with high settelability. And SS in effluent was as low as 8-10 mg/l for both the reactors. In MUSB with mixer, biomass concentration was uniformly distributed through out the depth. Larger variation along the depth was observed in a reactor without mixer. Fig 2 compares the biomass concentraton observed in MUSB with and without mixer. Larger proportion of biomass was attached on the walls of BV and hence less biomass concentration was observed in case of a reactor without mixer.

Fig 3 and Fig 4 show the COD removal achieved in MUSB reactor with and without mixer respectively. In MUSB with mixer about 50 % of COD removal effeciency was achieved at influent concentration of 50-80 mg/l at detention time of 35 min. However reactor without mixer showed unstable performance in terms of COD removal. As sulfur metabolism is considered to be the main metabolism responsible for COD removal, sulfate reducing activity was examined in both the reactors under batch conditions. Fig 5 shows no sulfate reducing activity in MUSB without mixer, as most of the sulfate reducing activity was taking place in the dense biomass attached to the walls of BV.

Fig 6 compares the COD removal effeciency in both the reactors. In case of MUSB with mixer about 50 % of COD removal effeciency was achieved, however reactor without mixer showed large variation in COD removal effeciency ranging from 10-40 %. The main reason of poor performance was short circuiting of wastewater. Possibility of short circuiting was further confirmed by DO data. DO in case of BV of MUSB with mixer was found to be 0 mg/l but DO in BV of MUSB without mixer was still about 3-4 mg/l. Hence in MUSB reactor where, dense sludge is produced, mixer is necessary to distribute the sludge uniformly and to provide sufficient contact between biomass and substrate.

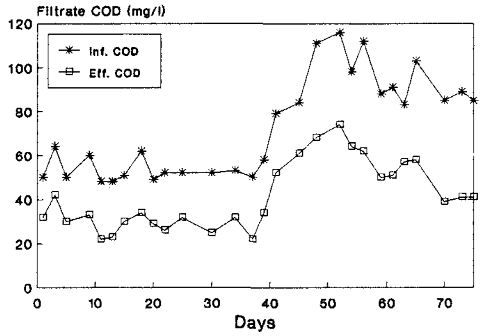

Fig 3 COD removal in MUSB reactor with mixer

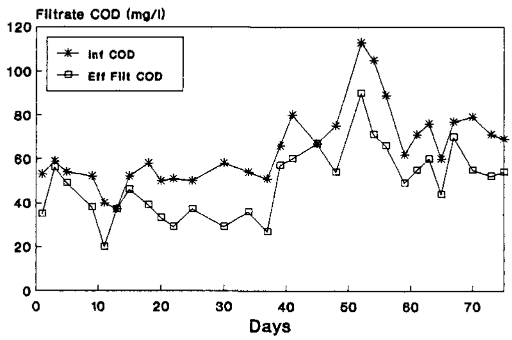

Fig 4 COD removal in a MUSB reactor without mixer

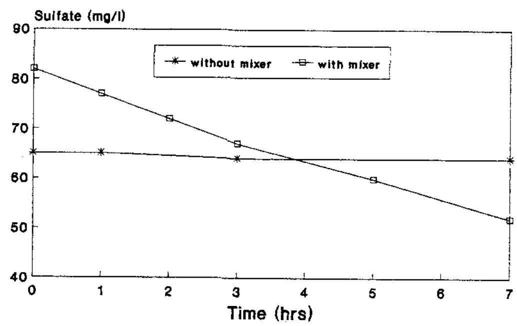

Fig 5 Sulfate reducing activity obtained in batch experiment for MUSB reactor with and without mixer

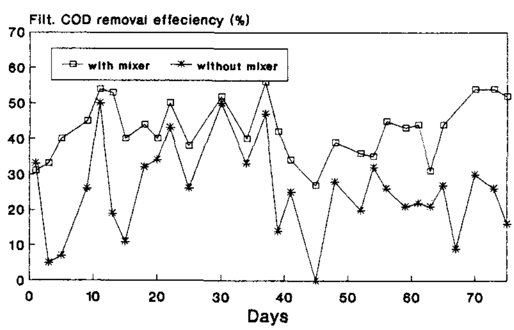

Fig 6 Comparison of COD removal effeciency for reactor with and without mixer