EFFECT OF HYDRAULIC RETENTION TIME ON THE ACTIVATED SLUDGE SYSTEM

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ABSTRACT

A bench scale of activated sludge reactor was operated, as extended aeration system to treat actual wastewater was daily collected from Eastern Treatment Plant at south east of Alexandria and to study the effect of hydraulic retention time. Samples were taken daily (Grab & composite) at different hydraulic retention time (modes) of 18, 12, 6.18, and 3.37 hours respectively with fixed recycle ratio (100%). COD, BOD, SS, SVI and F/M ratio were determined during the experimental work. The experimental results showed that increasing the HRT caused slight increasing in the removal efficiency of COD and BOD. {the C.O.D removal efficiency decreased from 88 % (at mode 1 = 18 hrs) to 84 % (at mode 4 = 3.37 hrs) and the B.O.D removal efficiency decreased from 91 % (at mode 1) to 85% (at mode 4)}. The quality of the effluent from bench scale activated sludge with extended aeration is within the limits reported in the Egyptian Environmental Requirements.

Keywords: Activated sludge, Extended aeration, Hydraulic retention time, Sludge volume index, Wastewater treatment

INTRODUCTION

Greater attention is now being focused on the wastewater treatment of small communities and recreational areas to protect environmental quality. The objectives of the treatment of wastewater are removal of suspended solids, reduction in the concentration of oxidizable organic matter and removing the highly toxic metal. Small-activated sludge treatment plants are available in many places, such as small communities, industrial plants and resorts [1]. Those plants are operated as extended aeration activated sludge treatment plants for domestic or industrial wastewater or both [2], [3].

The aim of this research is studying the effect of hydraulic retention time on the efficiency of plant through COD removal efficiency, BOD removal efficiency, the concentration of mixed liquor suspended solid (MLSS), the effluent concentration of COD (Xe), and food to microorganisms ratio (F/M).

EXPERIMENTAL SYSTEM

Bench scale activated sludge reactor was fed with actual wastewater from the influent of ***Eastern Treatment Plant*** at south east of Alexandria. The reactor tanks were fabricated to simulate an extended aeration system. The volume of aeration tank and settling tank is 41.0and 72 liters respectively. First tank was operated as activated sludge extended aeration unit and second was operated as a settler. An arrangement of sludge recycling was considered. Figure (1) shows layout of activated sludge bench scale reactor. The reactor was operated with hydraulic retention times of 18, 12, 6.18, 3.37 hours. Aeration was adjusted at suitable rate from air compressor to submerged air diffusers in the bottom of aeration tank.

The reactor was operated hydraulically with flow rate of 0.11, 0.166, 0.316 and 0.59 m^3/d at hydraulic retention time (HRT)(modes) of 18, 12, 6.18 and 3.37 hours respectively.

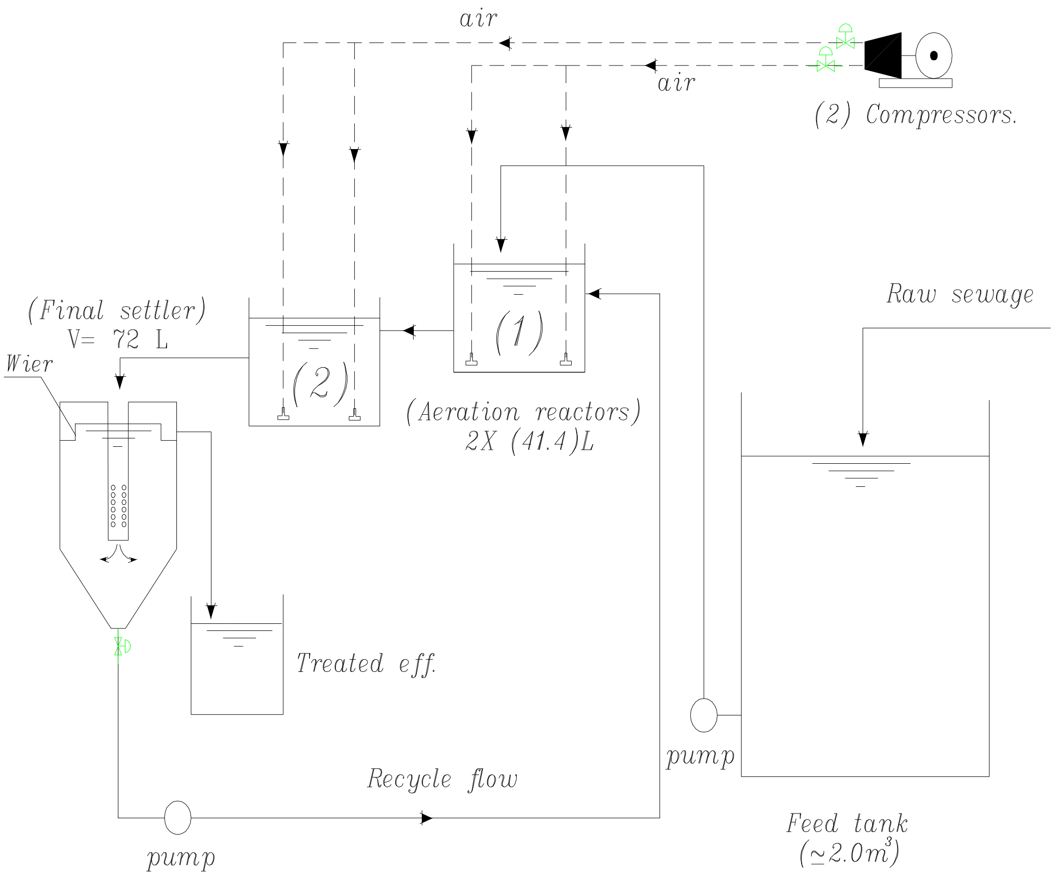

Figure (1) layout of activated sludge bench scale reactor

ANALYTICAL METHODS

The performance of the reactor was monitored by COD, SS, and by BOD. Using the procedure described in "standard Methods" [4] carried out all determinations. Mixed liquor suspended solids (MLSS) were determined gravimetrically using a 0.45 μ m filter. The settling properties were evaluated using the sludge volume index (SVI). F/M ratio was calculated as explained in "Metcall and Eddy".

RESULTS AND DISCUSSION

The data depicting the performance of the laboratory scale system for the four HRTs (modes) were figured, averaged, summarized, and collected in Table (1). The ambient temperature of modes was in the range of 18.63 - 23.75°C during those periods.

At mode (1) (HRT = 18 hr. Qin = Qr = 0.11 m^3/d) the influent C.O.D concentration {(COD)(IN)(T)} was found in the range of (100 - 300) mg/l as total and soluble C.O.D concentration {(COD)(IN)(F)} was in the range of (70 - 140) mg/l. The effluent soluble C.O.D concentration (E) from the reactor was in the range of (10 - 30) mg/l. The concentration of MLSS ranged between (1169 - 3451) mg/l and suspended solids in the range of (35 -363) mg/l. The effluent suspended solids (Xe) range between (49 -154) mg/l.

At mode (2) (HRT = 12 hr. Qin = Qr = 0.166 m^3/d) the {(COD)(IN)(T)} was found in the range of (110 - 300) mg/l, {(COD)(IN)(F)} in the range of (70 - 110) mg/l and (E) was in the range of (10 - 50) mg/l. The concentration of MLSS in the influent ranged between (2253 – 4919.5) mg/l, suspended solids in the range of (7- 404) mg/L and (Xe) range between (11 -122) mg/l.

At mode (3) (HRT = 6.18 hr. Qin = Qr = 0.3168 m^3/d) the {(COD)(IN)(T)} was found in the range of (100 - 290) mg/l, {(COD)(IN)(F)} in the range of (70 - 140) mg/l and (E) in the range of (20 - 40) mg/l. The concentration of MLSS was ranging between (1301.5 - 5120) mg/l, suspended solids in the range of (50-632) mg/L and (Xe) range between (44 -151) mg/l.

At mode (4) (HRT =3.37 hr. Qin = Qr = 0.59 m3/d) the {(COD)(IN)(T)} was found in the range of (100 - 250) mg/l, {(COD)(IN)(F)} in the range of (40 - 80) mg/l and (E) was in the range of (10 - 50) mg/l. The concentration of MLSS ranging between (1340.5 - 3306) mg/l and suspended solids in the range of (15 - 860) mg/L and (Xe) range between (52 - 185) mg/l.

Table (1). The effect of (HRTs) on different parameters

Modes (HRTs)	Ave. C.O.D mg/l			Ave. MLSS mg/l		Ave. S.V.I ml/g	Ave. F/M	Ave. Xe mg/l
	IN (T)	IN (F)	Eff. (E)	(IN)	(R)			
Mode (1) 18 hrs.	175.45	85.45	21.81	167.545	2447	33.168	0.128	99.454
Mode (2) 12 hrs.	190	76.66	27.5	171.727	3591.69	40.097	0.146	56.18
Mode (3) 6.18 hrs.	181.66	98.33	25.89	919.583	2401	27.960	0.353	83.58
Mode (4) 3.37 hrs.	160	63.88	25.55	339.77	2282	28.92	0.616	110.44

Figure (2), (3), (4) and (5) presents the relation between HRT and different parameters at each mode.

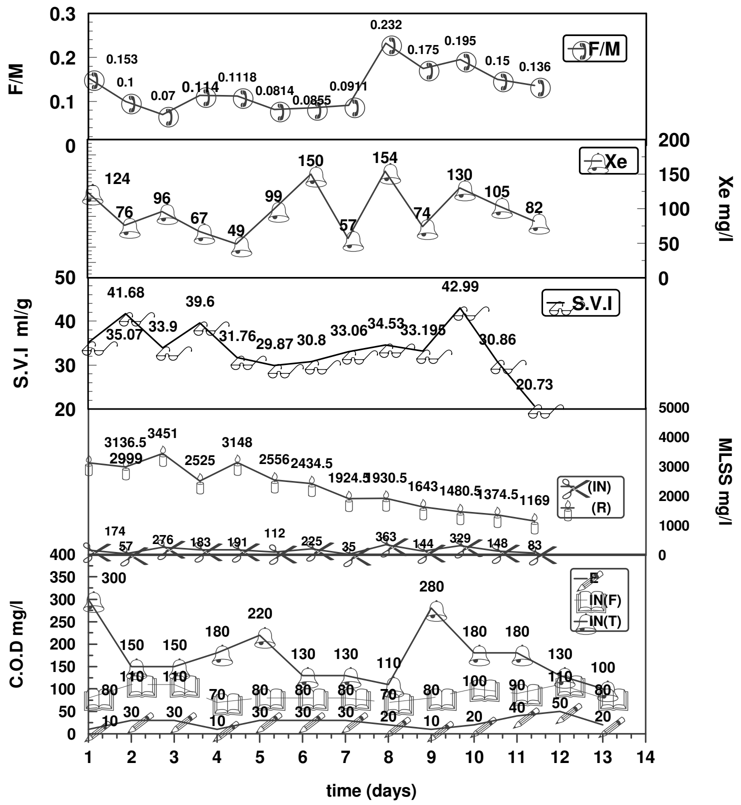

Fig. (2) The relation between HRT and different parameters at (MODE 1) $Q_{IN}=Q_R$= 110 L/d =0.11 m^3/d <u>**D.T = 18 hrs.**</u>

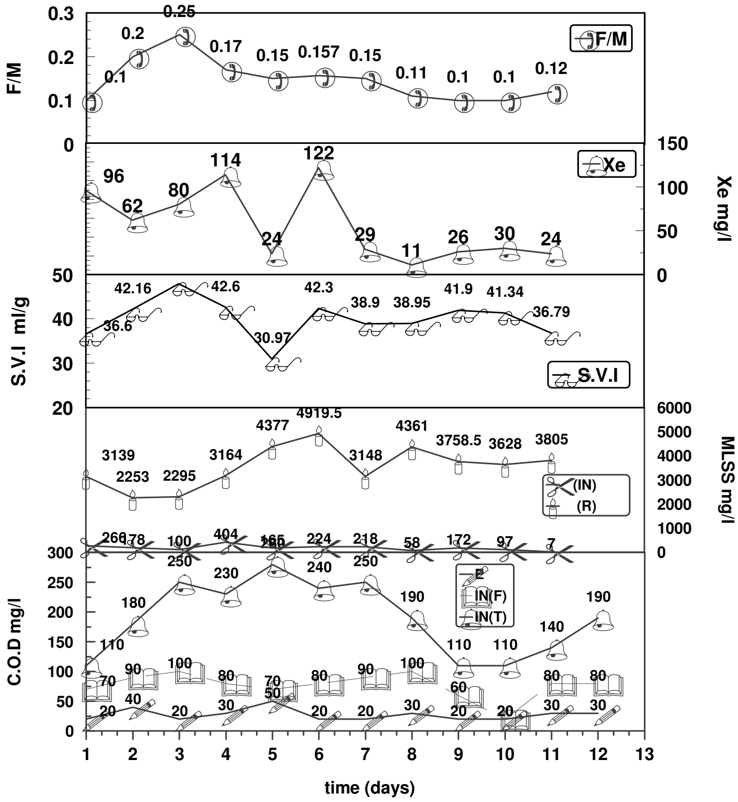

Fig. (3) The relation between HRT and different parameters at (MODE 2)Q_{IN}=Q_R= 165.6 L/d =0.166 m^3/d D.T = 12 hrs.

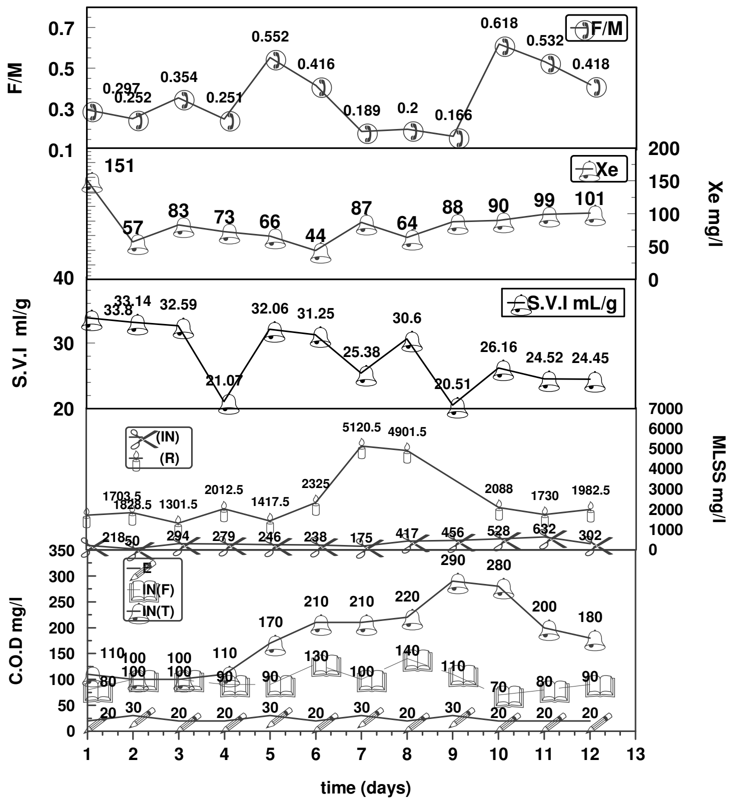

Fig.(4)The relation between HRT and different parameters at (MODE 3) Q_{IN}=Q_R= 316.8 L/d =0.3168m^3/d D.T = 6.18 hrs.

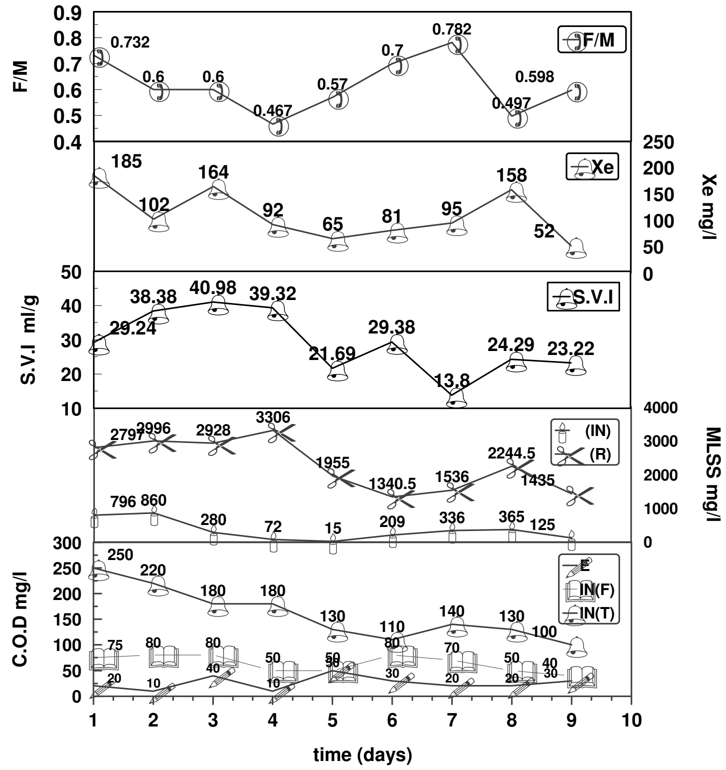

Fig. (5)The relation between HRT and different prameters at (MODE 4) $Q_{IN}=Q_R$**=24.6 L/hr =590.4 L/d =0.59m^3/d** **D.T = 3.37 hrs.**

Removal efficiencies of total COD and BOD are calculated, averaged, summarized, and collected in table (2) for the four HRTs (modes). Figures (6) and (7) present the relation between removal percentage of COD, BOD and HRTs (modes).

Table (2). The effect of C.O.D & B.O.D removal percentages at different modes (HRTs)

Modes (HRTs)	Ave. C.O.D mg/l				Ave. B.O.D mg/l		
	IN(T)	IN(F)	Eff. (E)	Removal %	Inf.	Eff.	Removal %
Mode (1) 18 hrs.	175.45	85.45	21.81	88	126.58	11	91
Mode (2) 12 hrs.	190	76.66	27.5	86	130.66	12.84	90
Mode (3) 6.18 hrs.	181.66	98.33	25.89	85.78	151.25	17	89
Mode (4) 3.37 hrs.	160	63.88	25.55	84	105.10	15.45	85

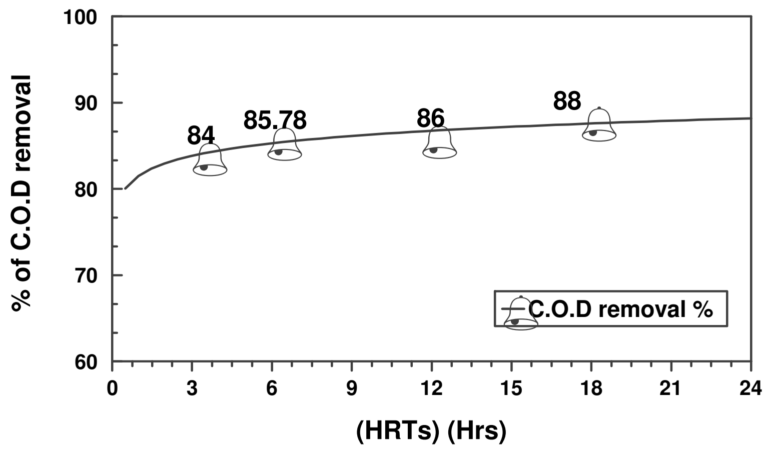

Fig. (6)The relationship between % of COD removal and (HRTs)

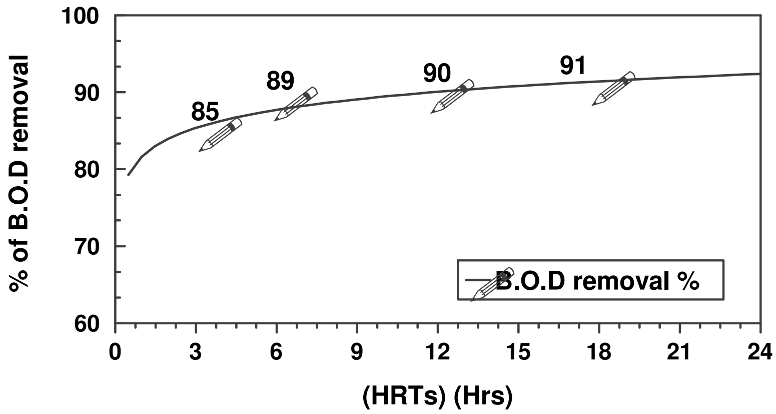

Fig. (7)The relationship between % of BOD removal and (HRTs)

Comparing with results obtained by Batchelor et al. and Hadjivassilis [5, 6] we find that the results in the research are fairly good.

The study in laboratory scale has demonstrated that the C.O.D removal efficiency decreased from 88 % (at mode 1) to 84 % (at mode 4). The B.O.D removal efficiency decreased from 91 % (at mode 1) to 85% (at mode 4). From the results in Figures (6), (7) its can be concluded that increasing the HRT caused slight increasing in the removal efficiency of COD. Also increasing the HRT caused increasing in the removal efficiency of BOD. The actual wastewater was kept at ambient temperature with suitable aeration during feeding the reactor for 24 hours. The feed tank in fact was a very effective unit in this work. So the effect of influents throughout the HRT duration is significant. Figures (2), (3), (4) and (5) show that in spite of inconsistent values of C.O.D in the influent the steady of C.O.D in the effluent was noted.

The quality of the effluent from Bench scale activated sludge with extended aeration is within the limits reported in the Egyptian Environmental Requirements (EER). (BOD was in range of 11 - 15.45 < 20 mg/l and COD was in range of 21.81 - 25.55 < 30 mg/l)

CONCLUSION

The experimental results showed that increasing the HRT caused slight increasing in the removal efficiency of COD where C.O.D removal efficiency decreased from 88 % (at mode 1) to 84 % (at mode 4). Also increasing the HRT caused increasing in the removal efficiency of BOD where B.O.D removal efficiency decreased from 91 % (at mode 1) to 85% (at mode 4). The quality of the effluent from Bench scale activated sludge with extended aeration is within the limits reported in the Egyptian Environmental Requirements.

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