Additional Processes in Prearation Tank and Primary Settling Tank for Wastewater Treatment Using Laboratory Unit

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ABSTRACT

Laboratory unit was designed to simulate (T2) line in Alrustamyia station for sewage treatment southern part of Baghdad city . The work involved two stages, before and after prearation tank and primary settling tank. Storage wastewater samples problem was overcome through using rotary cooling system at 2 C. The encouraging results obtained from previous work (new chemical treatment of prearated wastewater) were employed for the completion of our continuous feeding experiments on a laboratory unit scale. The flow rate was used as a control factor for monitoring the concentration of pollutants in the treated wastewater treated. The selected flow rate included the basic design flow rate of the T2 line (1X) and new flow rates (2X and 4X). The our new techniques involved the continuous feeding were reduced the concentrations of Biological Oxygen Demand (BOD), Total Suspended Solid (TSS), liberated the entrapped oil and greases as well as reducing other pollutants. It was found that 2X flow rate was the best flow rate which doubled the quantity of wastewater treated and reduced the resident time of treatment to the half.

Key words: sewage; Prearation tank; Primary settling tank, Modified Chemical treatment; Laboratory system.

عمليات اضافية في خزاني التهوية الاولية والتركيد الاولي لمعالجة العوادم السائلة باستخدام الوحدة المختبرية

الخلاصة

تم تصميم وحدة مختبرية لمحاكات الخط (T2) في محطة الرستمية لمعالجة العوادم الثقيلة الواقعة في الجزء الجنوبي من بغداد . تضمن العمل مرحلتين ، قبل وبعد خزان التهوية الاولية وخزان التركيد الاولي . تم تجاوز مشكلة خزن عينات العوادم المصرفة من خلال استخدام نظام تبريد دوار بدرجة حرارة 2 م . تم استخدام النتائج المشجعة التي تم الحصول عليها من العمل السابق (معالجة كيميائية جديدة للعوادم في مرحلة التهوية الاولية) لاكمال تجاربنا في التغذية المستمرة على مستوى الوحدة المختبرية . تم استخدام سرعة الجريات كعامل سيطرة لمراقبة تركيز الملوثات في العوادم المعالجة . تضمن سرعة الجريان اختيار الجريان التصميمي الاساس (1X) للخط T2 وسرع

جريان جديدة (2X و 4X) . ادت تقنياتنا الجديدة للتغذية المستمرة الى خفض تراكيز الطلب الحياتي للاوكسجين (BOD_5)، المواد العالقة الكلية (TSS) ، تحرير الزيوت والشحوم المحتجزة بالاضافة الى خفض الملوثات الاخرى . لقد وجد ان افضل سرعة جريان هي (2X) والتي تضاعفت فيها كميات العاودم المعالجة وخفض وقت احتباس المعالجات الى النصف .

INTRODUCTION

Sewage treatment, or domestic wastewater treatment, is the process of removing contaminants from wastewater and household sewage, both runoff (effluents) and domestic. It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants. This wastewater is often inadvertently contaminated with many toxic organic and inorganic compounds [1] . Primary treatment involves screening , grinding , sedimentation and clarification, to remove the floating and settleable solids found in raw wastewater. When raw wastewater enters the treatment plant it is typically coarse, so it screened to remove large objects, grounds to reduce the size of the remaining solids, and then flows to primary sedimentation tanks .The sedimentation tanks provide sufficient capacity to establish quiescence in the wastewater, allowing solids with a higher specific gravity than water to settle and those with a lower specific gravity to float. Well-designed and well-operated primary treatment should remove 50 to 70% of the suspended solids and 25 to 40% of the BOD. Free oil, grease and other floating material are removed by skimmers from the surface of the primary sedimentation tanks. Typical detention time in the primary sedimentation tanks is 1.5 to 2.5 hours. Chemical flocculants/polymers are frequently added to the primary sedimentation tanks to increase solids removal. Solids removed during primary treatment are dewatered and disposed off as part of the sludge treatment [2]. There is a conventional treatments followed in wastewater treatment plants include a Physical processes which regards the first operations to remove solids materials from the wastewater where it passes through scrubbers to remove the heavy solids and floating materials . After that the wastewater is turned by air to float the debris with the air and gate removed , where the process is called primary treatment or prearation. There is also conventional chemical treatment which may be used like adding alum and iron salts to the wastewater to accelerate the separation processes [3] . The small air bubbles associated with particles reduce their intensity leading to float. The process of bubble generating is conducted by mechanical mixing of the air with water withdrawn by vacuum or air pumping strongly in the water under high pressure. This technology called air flotation and is a technique used in most of the wastewater stations. It is removed oils and suspended interface particles. These particles wetted with oils with oils that it cannot be removed by gravity and it needs to be a very long time .The primary Settling is an important process for the removal of some organic loading and non-organic ingredients along with the total suspended solids (TSS). Suspended solids are particles that can be removed from wastewater with additional treatments such as chemical treatments using the coagulants or filtration or sedimentation due to gravity [4]. DAF with the acidification and coagulation is suggested for biodiesel wastewater treatment. Biodiesel wastewater treatment by acidification before alum

coagulation allowed the alum concentration to be reduced by 60–90% compared to treating without acidification. In addition, the efficiency of Grease & Oil removal from biodiesel wastewater by DAF with alum and acidification was 85–95%. It can be concluded that the efficiency of Grease & Oil removal from biodiesel wastewater using DAF with acidification and coagulation was 10% greater compared to other processes [5].

MATERIAL AND METHODS

Laboratory unit

We selected line (T2) in the Rustumiya station to be our model for the implementation of laboratory tests on subsequent modified treatments. So we made thefollowingcalculationforsimulatedthelineT2:

1-Thevolumetricscaleselectedwas1:1000000.

2- Flow rate (m^3 / min, or ml /min) = Volume of tank ($m3^{,}$ $ml^{)}$ / Time (min)

3- The flow rate of Line T2 = 45000 m^3 / 24 h (day) X 60 min (hr) for one branch = 31.3 m^3 / min or 31.3 ml / min.

4- This flow (31.3 m^3 / min or 31.3 ml / min) after prearation was divided into four settling tanks , So , The flow rate (ml / min) into each primary settling tank = 7.8 ($m3^{,}$ ml / min).

5- Based on the scale, the volume of the primary settling tank = 2.4532 liter ($2453m^3$).

6- The retention time in prearation tank is neglected.

7- Hydraulic resident Time (HRT) in settling tank = Volume of tank / flow rate X 60 (min) = 5.2 h.

a-The hierarchy was used to maintain the continuation of flow by gravity as is the case in real line. Figure (1) and Table (1) illustrate the stages of building the laboratory system.

Table (1) the parameters of T2 line design in Alrustamyia station For wastewater treatment.

Parameter	Preaeration	Primary settling tank
Dimensions	**NA**	**25m Diameter x 5m height**
Volume (V-1)	**"**	**2453 (m^3 / tank) (2.453 L)**
Number of tanks	**-**	**4 (T2)**
Total Volume (V) treated / day	**(45000 m^3 / day line T2)**	
(Flow rate) (volume / time)	**1872 m^3 / hr (31.1m^3 / min) (31.1 ml / min)**	**7.8 m^3 (ml) for each settling tank**
Hydraulic Retention Time (θ)	**-**	**5.2 hr.**

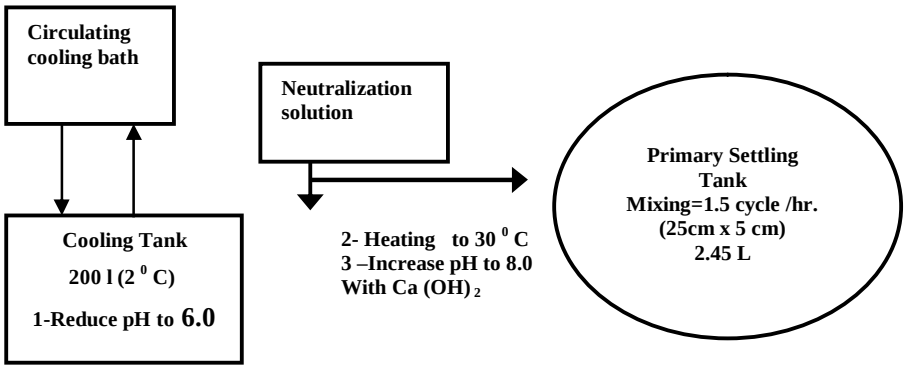

Figure (1) the diagram of laboratory scale construction of T2 line in Alrustamyia station for wastewater treatment.

Operation of laboratory system

1- Prearation tank: Since the flow rate in the laboratory system is 31.1 ml / min, so a large 200-liter preserved tank has been developed to receive untreated wastewater coming from the station. The reservoir system has been linked to circulating cooling bath (Chiller capacity of 30 liters through a Coil of aluminum of 10 meters length which erected inside the reservoir to keep a lower temperature of about 2 C to prevent any biological activity as well as to stop the chemical reactions . The flow was controlled by an flowmeter . The tank was equipped with air Compressor to pump air into the water through a distributor installed in the bottom for the purpose of mixing before pumping to increase efficiency of flotation of oils and oxidation and precipitation of minerals and dispersed the suspended matter containing fat . This step was processed as conventional method of operating the station by ideal design and new modified treatments . The modified processes in this reservoir includes the reducing the pH to 6 and return to 8 [6] .

2 – Primary settling tank : the water from the reservoir go beyond through a short tube to the primary settling. This tank was constructed from aluminum and coated by epoxy to prevent any reactions that may occur. The tank Settles on the hot plate stirrer to raise the temperature to 25 ° C with very slow mixing (2round / min) as it a case in Alrustamyia station . The water after prearation tank was mixed with the stream of calcium hydroxide (5 %) through a peristaltic pump of flow rate whose calculated to raise the water to the pH 8.0 [6] . Then the water is influent to the bottom of the settling tank in the beginning .The Resident time is 5.2 hours as in the basic design of the line and the flow rate is of 7.8 ml / min .The effluent was collected at interval time of 5.2 hr and the required tests was conduct . The settling tank Was filled first with water treated according to the traditional method of treatment or modified one . The tests cover all pollutants using photplabspectral S12 instrument supplied from WTW company with the kits .BOD was measured using BOD instrument supplied from WTW company . Anther required tests were conducted according to the APHA [7] .The BOD also measured using modified sludge [8].

The flow rate was changed to become 2X and 4X under modified treatment .The same tests were done.

Results and Discussion

Table (2), shows the average values of wastewater characteristics after prearation and primary settling tank that collected during six months from line T2.

Table (2) the range of pollutants values of line T2 in Alrustamyia station for wastewater treatment during the six months.

No.	Test (mg / l)	Location of Sampling*	
		After Prearation	After Primary Settling tank
1	pH	6.6 -7.4	6.6 -7.4
2	DO	5 -6	3 - 4
3	BOD_5 Natural Sludge	180 -300	170 -120
	BOD_5 Modified Sludge	500 -600	300 -400
4	TS	1801600	800 -1000
5	TSS	550 -600	350 -400
6	TVSS	350 -300	150 -200
7	TDS	1000 -1100	980-1060
8	Oil & Greases	210 -300	100- 120
9	Fe total	2.6 – 3.1	0.9 -1.1
10	TH($CaCO_3$)	> 450	> 450
11	NH_4	3 -7	6 - 8
12	SO_4	317 -400	360 -380
13	NO_3	6	1.32
14	PO_4	9.8-10	11.5 -13
15	TOC	350 - 250	250 – 200
16	COD	00 - 9508	600 -700
17	Alkalinity ($CaCO_3$)	140-120	140-120
18	Cl^-	207	225
19	Zn	0.15 - 0.17	0.09 -1.12
20	Pb	0.8 -1.3	0.5 – 0.9

*** Range of values.**

The colored section and values indicate the high levels of pollution. The colored values of BOD by using modified inoclum show the real values.

OPERATION OF LABORATORY SYSTEM

The system operated continuously after filling the prearation and settling tank with required quantities of treated wastewater according to the selected method of

treatment (treated wastewater from station, optimum treatment and modified treatment). The two last treatments were achieved in laboratory. All treatments performed in the same batch of wastewater which stored in suitable condition (bellow 2 C in isolated and protected containers).

a- Prearation tank

Table (3) shows all treatments and tests achieved in our laboratory system on the prearation tank comparison with the results of tests conducted on water samples collected from the untreated samples taken from untreated wastewater and after prearationfromlineT2ofAlrustamyiastation.

The results of station treatment and optimum lab treatment showed no real change was made in the specification of outlet wastewater from prearation tank with only the except for some pollutants such as BOD and TSS. Reason for this is to do benthic aeration in the optimum treatment lNo (3) in the Table (3) but there remains the problem of design and operations in the prearation tank. The introduction of chemical treatment to reduce the pH to 6 with high benthic aeration benthic had an effect in causing the release of the pollutants associated with and coated with suspended materials which led to increased concentrations significantly and therefore the possibility of reduction in post-treatments and not passed to other subsequent tanks. The results can be seen clearly in the shadow of the Table which shows the best treatment.

b – Primary settling tank

Table (4) shows the results of treatments in a primary settling tank in the laboratory system .These results represent tests of water emerging from the tank. The Table shows the use of volumetric flow and its changes with the change of Hydraulic retention time of water in the tank according to the modified treatment elected in Figure (1) above. The flow rate 2X (15.6 ml / min) was selected which reduced the retention time to the half (2.65 h). The other accelerated flow rate (4X) did not enhance the efficiently process and wastewater processing is not complete and the pollutants remain at high concentrations.

The modified new treatment in the primary settling tank characterized by reducing the most of pollutants concentrations through reducing the pH number and addition of calcium hydroxide and bottom aeration which helped metal deposition (Iron, Zn, Pb) as well as phosphate, ammonia and eventually reducing the BOD. The modified treatment allows duplicating the flow rate of wastewater treatment and occupied the new quantities entered to the station which is disposed ithouttreatment.

Table (3) Characteristics of wastewater after prearation treatments.

Test (mg / l)	Raw water[1]	After Prearation [2]	After Prearation [3]	After Prearation[4]
pH	6.9 -7.2	6.6 -7.4	6.9 -7.2	**7.8**
DO	5.5 – 6.4	5 -6	8 – 9	**10 - 12**
BOD_5 (Natural sludge Inoculums)	200 - 300	**180 -300**	250 - 300	**200 -50**
BOD (With modified Inoculums)	600 - > 800	**500 -600**	350 - 400	**350 - 400**
TS	1500 - 1800	1801600	1100 - 1200	**1100 -1200**
TSS	500 - 700	550 -600	450 -500	**450 – 500**
TVSS	400 - 600	500 -550	350 - 400	**450- 400**
TDS	1000 -1200	1000 -1100	950 - 1000	**850 - 950**
Oil&Grease	300 - 400	210 -300	320 - 400	**350 -450**
S^{-2}	4.5 – 5	4.5 -4.4	2- 3	**0.8 – 1.2**
NH_4^+	1.9	3 -7	1.3	**1.1**
SO_4^{-2}	<580	317 -400	650700 –	**70 - 700**
NO_3	6	1.7	6.0	**7.0**
PO_4^{-3}	9.5	9.8-10	11 -10	**11.5**
TOC	300 -350	300 -350	300 – 250	**275 - 300**
COD	800 -1000	00 - 9508	920 – 750	**755 - 930**
Pb	0.6 -0.8	0.51 – 0.65	0.52 – 0.68	**0.69 – 0.85**
Total Fe	0.85 -0.9	2.6 – 3.1	0.778 - 0.8	**0.9 - 1.2**
Zn	0.14 – 0.15	0.10 – 0.12	0.11 – 0.13	**0.14 - 0.16**

1- Sewage introduce at prearation tank.
2- Sewage treated after prearation in Alrustamyia station (T 2 Line).
3- Slandered prearation treatment of sewage water in lab.scale according to the plant design.
4-Modified lab. Prearation treatment of sewage water (pH reducing, submerged aeration), Sample had been taken after the praearation.

Table (4) Characteristics of wastewater after primary settling Tank and modified treatment.

Test (mg/ l)	**Modified prearation treatment**	**1 * (1X)**	**2 (2X)**	**3 (4 X)**
Flow rate Q(ml / min)		7.8 m^3 / min	**15.6**	31.12
Hydraulic Retention Time θ (hr.)		5.3	**2.65**	1.33
pH **	7.8	7.6 – 7.7	**7.8 – 8.0**	7.8 – 8.0
DO mg/l	10 - 12	9 –10	**10 - 12**	10 -12
BOD_5 a–Natural sludge Inoculums b- Modified Inoculums (3 %)	200 -250	165 – 180	**170 - 190**	180 -200
	350 - 400	190- 200	**200 – 210**	280 -300
Settling Volume (%) * **		7	**7**	5
TS "	1100 -1200	700 -800	**720- 800**	1000 -100
TSS "	450 – 500	180- 200	**190-200**	300 -350
TVSS "	450 400 -	110 -150	**100 -120**	210 -250
TDS "	850 - 950	900 -1000	**900 -1000**	900 -1000
Oil&Grease"	350 -450	25 – 30	**28 – 32**	70 – 80
S^{-2}	**0.8 – 1.2**	0.34 – 0.5	**0.15 -0.18**	0.2 -0.3
NH_4^+ "	1.1	10	**0.85 -0.96**	0.9 – 1.0
SO_4^{-2} "	670 - 700	680 -710	**650 -660**	650 -660
NO_3^-	7.0	0	**0.3 – 0.6**	0.2 -0.3
PO_4^{-3}"	11.5	7- 8	**6.6 – 7.8**	8.4 – 8.8
COD"	755 - 930	300 -320	**295 – 300**	340 -380
Pb "	0.69 – 0.85	02.6 - 0.28	**0.24 – 0.26**	0.32 – 0.38
Total Fe	0.9 - 1.2	0.18 – 0.20	**0.2- 0.21**	0.38 -0.42
Zn "	0.14 - 0.16	0.15 - 0.16	**0.12 –o.13**	0.15 -0.16

*1-: Modified prearation wastewater treatment) .

1X: Flow rate treatment according to the modified treatment ; 2 X flow rate; 4 X flow rate.

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