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Effect of Using Local Sand Filter on Increasing Efficiency of Treatment Wastewater in Iraq

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Abstract

Sand filtration has been an effective wastewater treatment process for control of contaminates. Sand filters are very economic treatment and do not need constant operator attention, making them an appropriate technology for wastewater systems either they are big or small. Iraq has combined wastewater systems (domestic and storm) water, old treatment plants with very determinate characteristics of influent (suspended solids S.S equal to 350 mg/L), increasing population and absence of industrial water treatment units; all these conditions lead to problems of overflow, by-pass wastewater and effluent which have characteristics under what are required.

The results of this paper demonstrate that 76% removal efficiency (R.E) for S.S. can be achieved by using sand filtration technique.

The best position of sand filter is in 2nd stage (pretreatment) because of the highest R.E of S.S. High possibility to contaminate filter in 1st because of oils and floating materials makes this position not good in spite of high R.E. As a result of this position, effluent will be very low contaminate (s.s reaches 5-10 ppm). In oppose to ordinary effluent which has 69 ppm of s.s (according to international environmental standards , effluent's s.s should be 35 ppm or less and according to Iraq E.S effluent's s.s should be 60 ppm or less) .No desirable change in s.s concentration Is noticed with different sand thickness.

Sand filtration appears unexpectable ability (approximately 50%) to remove iron and toxic cadmium.

Keywords: wastewater treatment, sewage system, suspended solids.

تأثير استعمال فلتر الرمل المحلي في زيادة كفاءة المعالجة لمياه الفضلات في العراق

الخلاصة

تقنية فلتره الرمل تمتلك كفاءة جيدة في السيطرة والحد من ملوثات مياه الفضلات . وأذا ما أضفنا لذلك أنها تقنية أقتصادية من حيث وفرة الرمل وعدم الحاجة الى مراقبة مستمرة أثناء أستعمال هذه التقنية ,فأنها تعد تكنلوجيا معالجة جد ملائمة في مشاريع التصفية الكبيرة منها والصغيرة.

العراق يمتلك أنظمة مجاري مزدوجة (مياه الامطار والمياه المنزلية) , فضلا عن مشاريعا المعالجة القديمة وبمواصفات تصميمية للمياه الواجب معالجتها محدودة (تركيز المواد الصلبة العالقة حوالي 350 جزء بالمليون) ومقدار أستهلاك من الماء للفرد الواحد منخفض 150 لتر يوميا (عالميا 300-400 لتر) ونسبة سكان متزايدة وغياب العديد من وحدات معالجة المياه الصناعية و كل ذلك يؤدي بشكل مستمر الى مشاكل طفح المجاري في الشوارع خصوصا بالشتاء وطرح جزء من مياه الفضلات دون معالجة أو مياه معالجة دون المواصفات المطلوبة.

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نتائج هذا البحث أثبتت أن كفاءة الازالة للمواد الصلبة بأستخدام فلاتر الرمل في معالجة مياه الفضلات تصل الى 76%.
وأن أفضل موقع لفلاتر الرمل هي مرحلة ماقبل المعالجة أذا ماقورنت بالأمكانية العالية لتلوث الفلتر وأنسداده بالدهون والملوثات الأخرى في المرحلة الأولى من دخول مياه المجاري الى مشاريع المعالجة.
من هنا ممكن أن يصل تركيز المواد الصلبة العالقة في المياه المعالجة كليا الى 5-10 ملغم / لتر أذا مامرت المياه الداخلة على فلاتر الرمل أولا . مقارنة بتركيز لهذه المواد يصل الى 69 % عند عدم المعالجة بفلتر الرمل وهذا لايتطابق مع المواصفات العراقية البيئية التي تقدر ب 60 ملغم / لتر أوأقل أو المواصفات العالمية البيئية والتي تقدر ب 30 ملغم / لتر. كما أظهرت هذه التقنية قابلية غير متوقعة (تصل الى 50 %) في أزالة كل من الحديد والكادميوم السام من مياه الفضلات.

Introduction

Sand filtration is one of the oldest wastewater treatment technologies known. If properly designed, constructed, operated and maintained, a sand filtration produces very high quality effluents [1].

Sand filtration has been an effective water treatment process for preventing the sp- read of gastrointestinal disease , especially after pretreatment processes such as roughing filters and preozonation have been developed or adapted for use with sand filters increasing the range of source water can be treated and the contaminants that can be removed in this technique .

Inclusion of layer of granular activated carbon in sand filter bed has improved capability for synthetic organic chemicals [2].

Zheng and etal demonstrated that by using the sand layer in the filter (around 0.8 m in heights , filled with silica sand) with hydrogen peroxide (H_2O_2 20 mg / L) in backwash process to treat domestic wastewater , the removing of turbidity, foulants and dissolved organics was very effective [3].

Also the efforts in Bangladesh to remove Arsenic in well water included complete oxidation of Arsenic (+3) to (+5) by dissolved Oxygen in water .the next step of co-precipitation process is coagulation to be filtered through coarse sand , sand –gravel and gravel [4].

Xianjun and etal used reactor system which composed of rectangular bed realized in cement. Each bed was filled from bottom to the top with 0.1 m of gravel (15/25 mm and 0.3 m of white sand. the wetland and developed has proven good capacities for removing COD (chemical O2 domain), NH4+ (Ammonium) and PO4-3 (phosphate) from domestic wastewater [5].

Yavuz and etal studied the activity of calcite (as a component of soil) in removing of toxic metals from aqueous solution [6].

Aim of research

Sand filtration technique is effective, simplest and very economic treatment process to reduce wastewater contaminates of s.s and some of metals. Therefore it is suitable to use in wastewater treatment plant in Iraq.

View For Rustomyia Wastewater Treatment Plants:

The east bank network terminates in a treatment plant complex at Rustomyia, the discharge of effluent being into the Diyala river, a tributary of the river Tigris. It was developed in 4 stages between 1963 and 1985.

The most recent (3rd extension) being built on a different site separated from the original site by the army canal and a high way .it's design capacity is 304,000 m^3/d.

The intended capacity of the combined plants summates to a total population of 3 million ,but no specific allowances were made for non-domestic waste or infiltration , which would have had to be accommodated within the per capita flow allowances , which themselves varied considerably (114 to 250 liter/capita) [7].

Experimental

Sampling:

Samples were taken from Rustomyia (3rd extension) wastewater treatment plant. They were collected from following positions (pictures below are shown all these points):

1. Influent wastewater in pump station (1st stage).
2. Pretreatment stage consists of screening, grit and grease removal (2nd stage).
3. Primary settling tank "PST" (3rd stage).
4. Final settling tank "FST" (4th stage) or effluent wastewater.

Sand Filter Preparation

Local sand is washed with water, dried and packed in plastic tube which has 30 cm length, 7 cm diameter and pored ended.

Sample Preparation

No pretreatment processes were done on fresh samples, because efficiency of sand filters is to be tested without interaction of aerobic or non-aerobic treatment processes.

After mixing sample, 100 ml was filtered through Buckner funnel. Suspended solids on filter paper (Whatman GF/C with 70 mm as thickness) were dried in oven at 105Co for 1hour. After samples were cooled in discator, they were weighed (X_2=weight of S.S in grams).

If sand filtration technique was used, sample would pass through sand filter, and then steps above were repeated. All measurements were done in laboratory of Rustomyia project-3rd extension to ensure of dealing with fresh samples.

To calculate the concentration of S.S in sample (ppm or mg/L) = $(X_2 - X_1) \times 10 \times 1000$.

X_1 is represented weight of filter paper (in gm.) after it was heated , cooled ,dried and weighed with same way as sample treatment.

Apparatus

Analytic atomic absorption spectrophotometer, Analytikjena-2006 (Germany), with acetylene as fuel gas and hollow cathode lamp of different elements (Cd, Co, Pb, Ni,Fe). Measurements are done in Ministry of science and technology – center of water researches.

In every country the first water treatment techniques are used, involved processes of a purely physical and mechanical nature to reduce the solids content [9].

The solids in wastewater can be divided into two kinds:

- 45% of suspended solids.
- 55% of filterable solids.

About 75% of suspended solids are organic in nature, therefore sand filtration has an effective manner in removing not only inorganic but also organic contaminates from wastewater [10].

It is important that the sand particles all be about the same size. If the grain sizes vary greatly, the smaller ones will fill in the spaces between the larger particles, making it easier for the system to clog.

The larger the grain size, the faster the wastewater moves through the sand and the more wastewater to be filtered but with low efficiency. Therefore identical small particles will be good choice to use as sand filters to remove s.s.

1. How does sand filter work?

A sand filter purifies the water in three ways:

- Filtration, in which particles are physically strained from the incoming wastewater.
- Chemical sorption, in which contaminates stick to the surface of the sand and to biological growth on the sand surface.
- Assimilation, in which aerobic microbes eat the nutrient in the wastewater.

2. Suitable position of sand filters

It is important to put these filters after pretreatment stage which has physical nature (not chemical like coagulation, flocculation, and sedimentation but physical like grease removal and screening….) to ensure that sand filters will not clog [12].

The most important maintenance for sand filters is to make sure the retreatment system is working properly.Applying solids, grease or scum to the surface of a buried filter greatly reduces its life [1].

3. Effect of sand filter thickness

Efficiency of removal S.S increases with increasing filter thickness, but with increasing sand filter, speed of filtration will be very slowly.

5. Efficiency of sand filter on removing metals:

Heavy metals are often present together with organic pollutants in industrial wastewater but may originate also from commercial and domestic activities [13].

Sand filtration is good mean to remove 71% of iron (same ratio of ordinary stages of treatment plant) and 50% of cadmium (more efficiency than treatment plant),by chemical sorption on sand surface[12].

Conclusions

The most important characteristic of treated wastewater is suspended solids (S.S).

Using of sand filtration technique after pretreatment stage is reduced concn. Of S.S with very effective way. That leads to accordance of effluent with Iraqi environmental conditions, even with international environmental conditions.

Scope of all advanced countries is to reduce S.S and BOD concn. More and more, improve the quality of effluent. For industrial wastewater treatment unit and overloaded influent, sand filtration is very effective and economic technique.

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Table (1) Design wastewater characteristics [8]

Parameters	Influent	Final effluent
S.S concn.(mg/L)	377	29.4
BOD concn.(mg/L)	251	19.3

Table (2) suspended solids concentration in different stages of line (1) in Rustomyia (3rd extension) wastewater treatment plant.

Stage	Suspended solids concentration(ppm)	Average value	Removal efficiency %	Constant Error	Relative Error	Standard deviation
Raw water (1)	**1180** **1190** **1185**	**1185**	**-**	**-5** **5** **0**	**0.429** **0.429** **0**	**5**
Pretreatment (2)	**328** **336** **326**	**330**	**72**	**2** **6** **-4**	**0.602** **1.818** **1.212**	**5.291**
Primary (3)	**93** **88** **86**	**89**	**73**	**4** **-1** **-3**	**4.301** **1.112** **3.37**	**3.605**
Final (4)	**65** **70** **72**	**69**	**22**	**-4** **1** **3**	**5.797** **1.449** **4.347**	**3.605**

Table (3) suspended solids concentration in different stages of line (2) in Rustomyia (3rd extension) wastewater treatment plant.

Suspended solids concentration (ppm)	Average value	Removal efficiency %	Constant Error	Absolute Error	Standard deviation
1185		-			
330		72			
55 49 52	52	84	3 -3 0	5.454 5.454 0	2.121
40 38 45	41	21	-1 -3 4	2.439 7.317 9.756	3.605

Table (4) suspended solids concn. of wastewater samples from line 1 with and without sand filtration

Stage	S.S.concn. (ppm) without sand filtration.	S.S.concn. (ppm) with sand filtration.	Average value	Constant Error	Absolute Error	Standard deviation
1	1185	-*		-	-	
2	330	77 81 79	79	-2 2 0	2.531 2.531 0	1.414
3	89	62 65 62	63	-1 2 -1	1.587 3.076 1.587	1.732
4	69	49 54 50	51	-2 3 -1	3.921 5.882 1.96	2.645

***The sand filter can be clogged because of physical or biological factors.**

Table (5) the effect of sand filter thickness on removal efficiency of s.s.concn. for pretreatment wastewater samples.

Suspended solids concn. (ppm)	Average value	Removal Efficiency (R.E)%	Absolute Error	Relative Error %	Standard deviation
135 129 129	131	74	4 -2 -2	3.053 1.526 1.526	3.464
118 122	120	76	-2 2	1.666 1.666	2
119 114 115 116	116	77	3 -2 -1 0	2.526 1.724 0.862 0	2.160
55 53	54	89	1 -1	1.851 1.851	1.414
50 54	52	90	-2 2	3.846 3	2

Table (6) typical composition of untreated domestic wastewater [11]

Contaminates	Unit	Weak	Medium	Strong
Total Solids,(TS)	mglL	350	720	1200
Total DissolvedSolids,TDS	=	250	500	850
Suspended Solids (S.S)	=	100	220	350

Table (7) concentration of different elements in wastewater from pretreatment and final stages without sand filtration

Stage	**Iron concn. (ppm)**	**Cadimiumconcn. (ppm)**	Nickleconcn. (ppm)	Cobaltconcn. (ppm)	Leadconcn. (ppm)
Pump station	**0.11**	**0.04**	0.03	0.04	0.125
Final	**0.04**	**0.05**	0.016	0.045	0.07

Table (8) concentration of different elements in wastewater from pretreatment and final stages with sand filtration

Stage	**Ironconcn.(ppm)**	**Cadmium concn. (ppm)**	Cobalt concn. (ppm)	Leadconcn. (ppm)
Pump statio(without sand filtration)	**0.14**	**0.04**	0.04	0.125
Pump station (with sand filtration)	**0.04 R.E=71%**	**0.02 R.E=50%**	0.07*	0.19*

***Sand may contain high concentrations of lead, nickel…..depending on its source [14].**

Table (9) average concentrations (of two measurements) of metals in washing water of sand filter.

Lead concn.(ppm)	Cobalt concn.(ppm)	Nickel concn.(ppm)
0.06	0.03	0.045

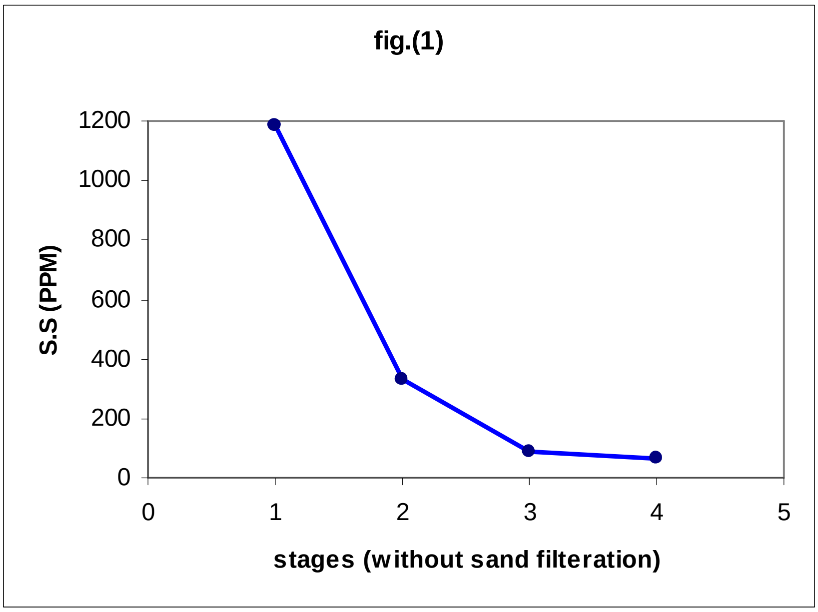

Figure (1) suspended solids concentration in different stages of line (1) in Rustomyia (3rd extension) wastewater treatment plant.

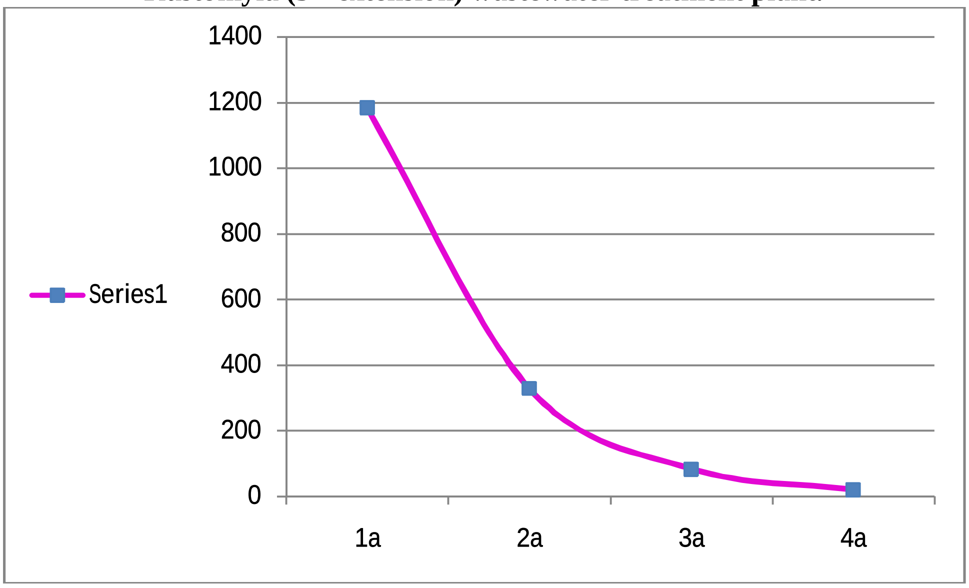

Figure (2) Suspended solids concentration in different stages of line (2) in Rustomyia (3rd extension) wastewater treatment plant.

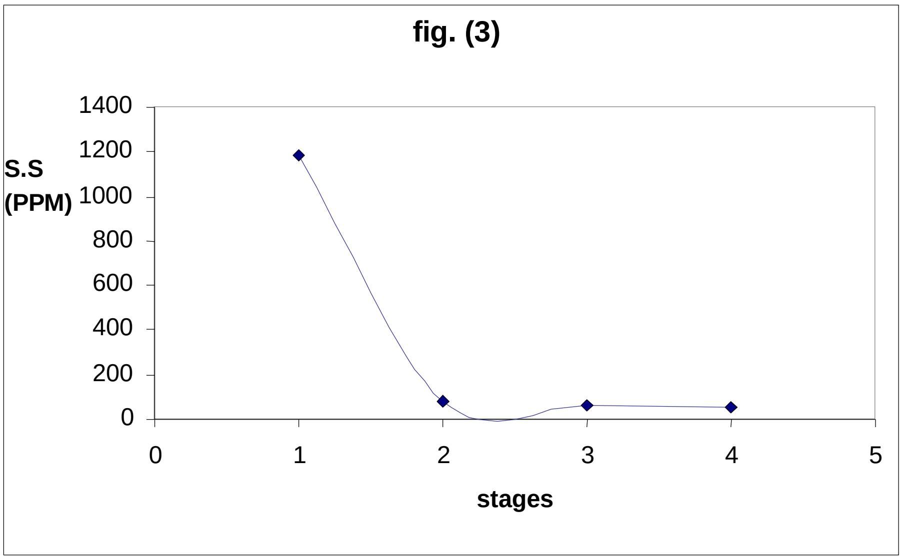

Figure (3) the effect of using sand filtration technique on removal efficiency of s.s.concn. for pretreatment wastewater samples.

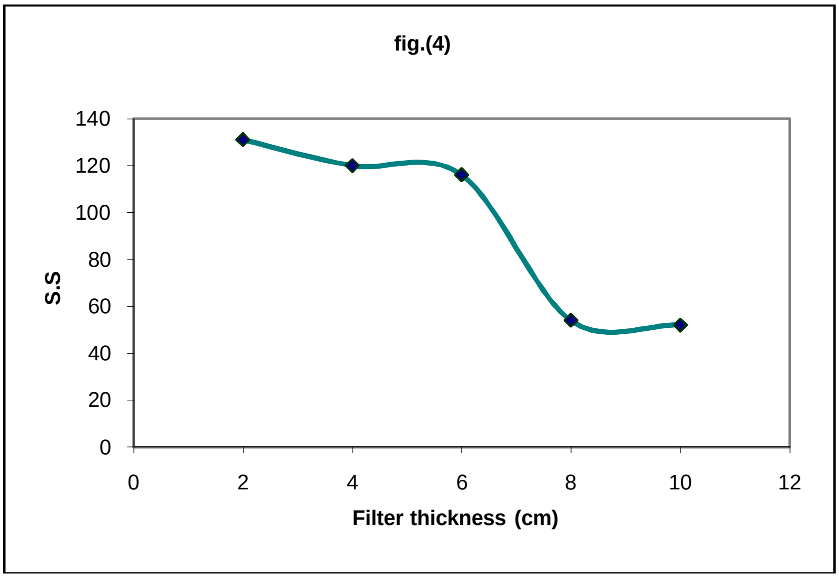

Figure (4) the effect of sand filter thickness on removal efficiency of s.s.concn. for pretreatment wastewater samples.

Main lift pump station (stage I)

Bar-raked screens

Aerated grit and grease removal channels(pretreatment).

Primary settling tank (PST)

Final settling tank (FST)