Al-Azhar University Civil Engineering Research Magazine (CERM)
Vol. (44) No. (1) January 2022

FEASIBILITY OF DYNA-SAND FILTER APPLICATION AGAINST VARIABLE SOLID LOADS IN WATER

El Taher, E.M.[1], El Nadi, M.H.[2], Wahab,E.S.[2] & Ahmed,S.I.A.[3]

1- M.Sc. student, PWD, Faculty of Engineering, ASU, Cairo, Egypt.
2- Prof. of Sanitary & Env. Eng. , PWD, Faculty of Engineering, ASU, Cairo, Egypt.
3- Associated Prof. of Sanitary & Env. Eng. , PWD, Faculty of Engineering, ASU, Cairo, Egypt.

ملخص البحث :

يناقش هذا البحث إمكانية مقابلة المرشح الرملي الديناميكي لأحمال مختلفة من المواد الصلبة من المياه الداخلة لتحديد إمكانية استخدامه في محطات مياه الشرب والصرف الصحي و الصناعي ومعالجه مياه المصارف الزراعية سواء بديل للمرشح الرملي أو كمحطة ترشيح مباشر غير مسبوق باى معالجة مع إمكانية تطوير المحطات القائمة بإحلال المرشح الرملي التقليدي به.

وقد تم عمل نموذج عملي لوحدة المرشح الرملي الديناميكي واستخدام مياه محضره بالمعمل بأحمال متفاوتة من المواد الصلبة العالقة لتحديد كفاءة الإزالة القصوى باستخدام معدلات ترشيح متغيرة .

وقد توصلت الدراسة إلى قابلية هذا المرشح للتعامل مع الأحمال المتغيرة من المواد الصلبة العالقة (50-250 جم/م3) و بمعدلات ترشيح متفاوتة بين (200-500)م3/م2/يوم محققه كفاءة إزالة بين (85-95%).

ABSTRACT:

This paper discusses the Dyna-sand filter feasibility to be applied with water variable solids loads to check its applicability for both water and wastewater treatment plants also for agricultural drains water treatment plants and check its realability to be applied as direct filtration.

Lab scale pilot was applied under sensytic water with variable solid load to determine its maximum removal efficiency with different filtration rates. The study resulted the system applicability against all applied variable solid load between TSS (50-250ppm) with variable rate of filtration between (200-500m3/m2/d) with inversely proportional between them, and removal ratio variable between (85% up to 95%).

1-INTRODUCTION

A new technology called Dyna sand filter which is a continuous-backwash, up flow, deep bed, granular media filter was used successfully in water treatment plants with very small area compared with traditional rapid sand filter units. It could be applied for water treatment and as tertiary treatment for wastewater. The filter media is continuously cleaned by recycling the sand internally through an airlift pipe and sand washer. The cleaned sand is redistributed on top of the sand bed, allowing for continuous, uninterrupted flow of filtrate and reject (backwash) water [1].

This paper discusses the Dyna-sand filter feasibility to be applied with water variable solids loads to check its applicability for both water and wastewater treatment plants also for agricultural drains water treatment plants and check its suitability to use as direct filtration [2].

2-LITRATURE REVIEW

Up-flow filtration has an obvious theoretical advantage because coarse-to-fine filtration can be achieved with a single medium such as sand with almost perfect gradation of both pore space and grain size from coarse-to-fine in the direction of filtration (upward) [3].

Parallel plates or a metal grid are used at the top of the fine media in the United States. The media grains arch across the open area to constrain the bed against expansion, and the spacing of the plates or the size of the opening in the grid is such that the media grains arch across the open space to restrain the bed against expansion. In the best designs developed to date, these restraining bar systems contain around 75% open area. An up-flow filter with a restraining grid structure is illustrated [4].

The problem with up-flow filtering occurs when the head loss exceeds the weight of the bed above a certain level, causing the bed to raise or partially fluidize, enabling previously removed materials to escape into the effluent. The ideal relative locations of fine media are maintained or reestablished with each backwash because the bed is back washed in the same direction but at higher flow rates. The intrinsic advantage of up-flow filtration has long been established, and the expected high filtering efficiency has been well-verified under laboratory circumstances by numerous workers [5].

The basic principle of continuous contact filtration is that flocs removal take place directly in Dyna sand filters. The sand bed acts as a filter and a flocculation reactor. As a result, the treatment plant space need can be reduced by (70 to 80 %) because no flocculation, sedimentation, or flotation steps are required. Moreover, continuous operation eliminates the need for backwash water pumps, automatic backwash valves, and control systems, as well as backwash water storage [6].

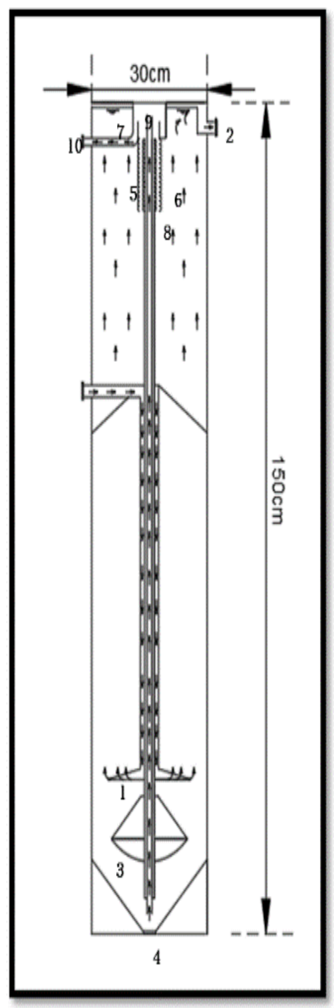
3-MATERIALS&METHODS

The experimental work on the studied pilot shown in figure (1) which erected in sanitary engineering laboratory in the faculty of engineering, Ain Shams University was done on six runs to determine the feasibility of the unit and it is applicability to meet different load in raw water under variable rates of filtration.

The first run made to ensure the pilot stability and its simulation to the dyna-sand system, the other five runs was applied with under variable solid loads in raw water with TSS between (50-250ppm) and with variable filtration rates (200-500 m3/m2/d) for each TSS. Figure (2) shows the photos of pilot before and during the operation inside the lab.

1. Influent feed is introduced at the top of the filter.
2. flows downward through an annular section.
3. The feed is introduced into the bottom of the sand bed through a series of feed radials.
4. the downward moving sand bed that are open at the bottom. As the influent flows upward.
5. out through the effluent pipe.
6. The sand bed containing captured impurities is drawn downwardinto the center of the filter where the airlift pipe is located. A small volume of compressed air is introduced at the bottom of the airlift, drawing the sand into the airlift pipe.
7. The dirty slurry is pushed to the top of the airlift.
8. the reject compartment, From the reject compartment the sand falls into the sand washer.
9. lighter reject solids are carried over the reject weir.
10. the reject pipe.

Figure (1) Unites description



(2-a)before working **(2-b) During working**

Figure (2) Pilot unit

The TSS was calculated from the turbidity reading measure by turbidity meter apply in the system using it is calibration curve illustrated in figure (3).

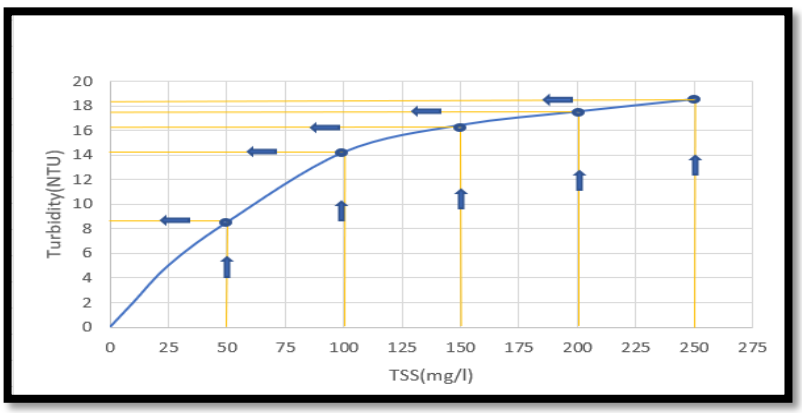


Figure (3) Relation Between TSS, Turbidity

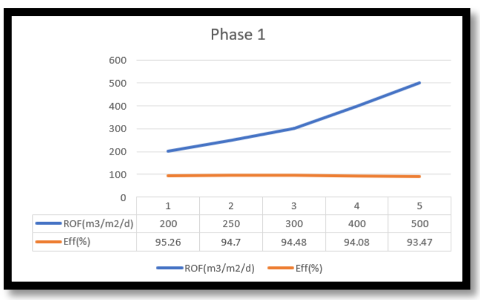
4 -RESULTS&DISCUSSIONS

The first run was made and resulted the simulating of the pilot to the dyna sand system, with acceptable error due to lab scale size. Table (1) illustrates the results of this run that shows removal efficiency for TSS between 95.76%-93.53% which is acceptable specially with high TSS loads. Taking into consideration that the applied TSS loads are higher than the general loads enters any filter unite inside water treatment plant and also no flocculation applied in this study.

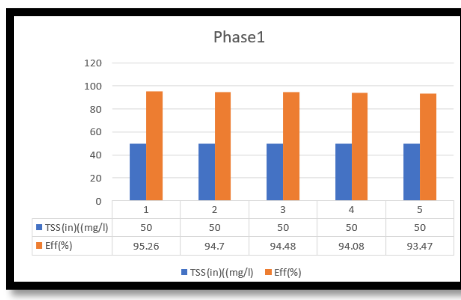
Table (1) First Run Input and output results

time	Input				Output					Efficiency
	Turbidity	TSS	Temp.	pH	Turbidity	TSS	Av. TSS	Temp.	pH	
	(NTU)	(mg/l)	(c°)		(NTU)	(mg/l)	(mg/l)	(c°)		(%)
day1	8.33	50	24	8.4	0.13	2.40	2.34	21	7.3	95.32
	8.33				0.12	2.30				
	8.33				0.1	2.32				
day2	14.23	100	24	8.5	0.2	6.50	6.57	21	7.5	93.73
	14.23				0.3	6.70				
	14.23				0.2	6.50				
day3	16.48	150	24.5	8.7	0.45	9.75	9.71	21	7.7	93.53
	16.48				0.44	9.71				
	16.48				0.43	9.67				
day4	18.48	200	24	8.9	0.56	10.07	10.39	21	7.7	94.81
	18.48				0.71	10.64				
	18.48				0.66	10.45				
day5	19.18	250	24.5	8.9	0.74	10.66	10.59	21	7.8	95.76
	19.18				0.69	10.47				
	19.18				0.73	10.65				

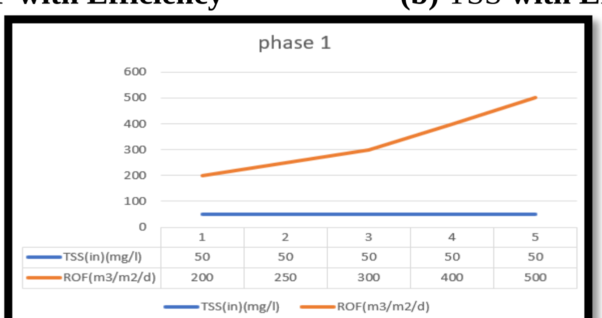
The second run resulted reading that shown in figure (4) with raw water TSS 50 mg/l and variable ROF (200-500 m3/m2/d) mention before as illustrated results.



(a) ROF with Efficiency



(b) TSS **with Efficiency**

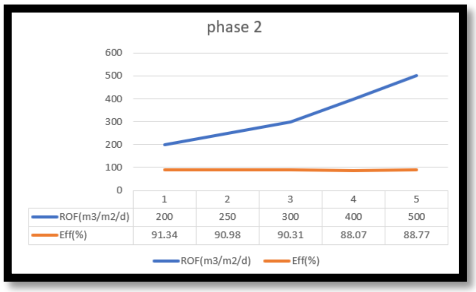


(c) TSS with ROF

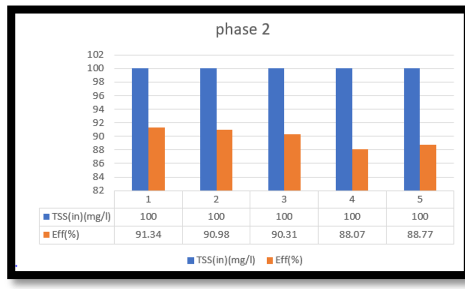
Figure (4) Run 2 Results Relations

Run 2 with TSS=50mg/l, achieved removal efficiency varied between 95.26%-93.47% due to variable ROF between 200-500 m3/m2/d which is match with the all previous work for dyna sand filter even the solid load is high for filtration process. so, this removal efficiency is very acceptable for such solids load.

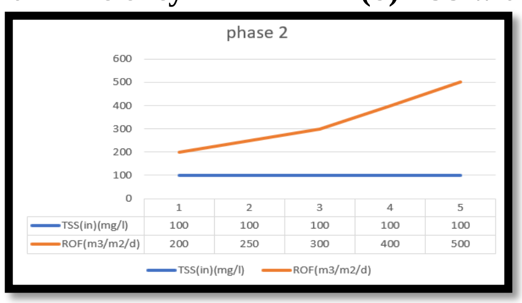
The third run resulted reading that shown in figure (5) with raw water TSS 100 mg/l and variable ROF **(**200-500 m3/m2/d**).**



(a) ROF with Efficiency



(b) TSS **with Efficiency**

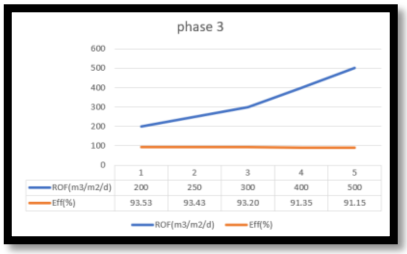


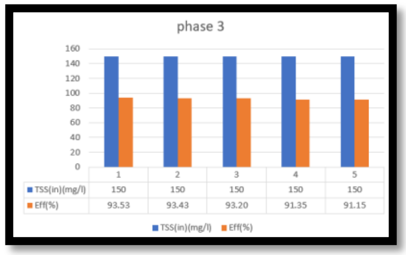
(c) TSS with ROF

Figure (5) Run 3 Results Relations

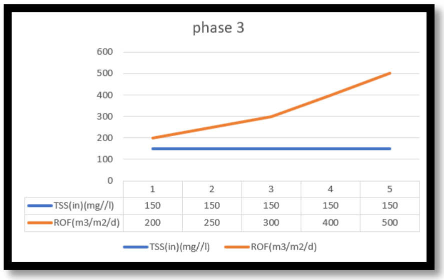
Run 3 with TSS=100mg/l, achieved removal efficiency varied between 91.34%-88.77% due to variable ROF between 200-500 m3/m2/d which is match with the all previous work for dyna sand filter even the solid load is high for filtration process. so, this removal efficiency is very acceptable for such solids load as shown in figure (5).

The fourth run resulted reading that shown in figure (6) with raw water TSS 150 mg/l and variable ROF **(**200-500 m3/m2/d**).**





(a) ROF with Efficiency **(b)** TSS **with Efficiency**

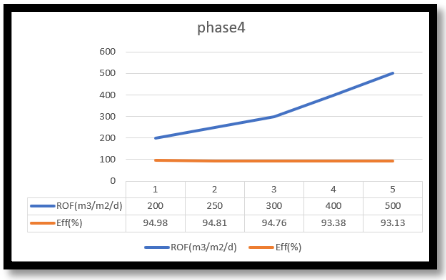


(c) TSS with ROF

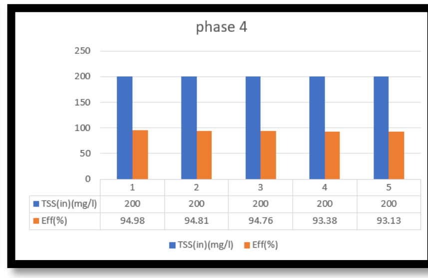
Figure (6) Run 4 Results Relations

Run 4 with TSS=150mg/l, achieved removal efficiency varied between 93.53%-91.15% due to variable ROF between 200-500 m3/m2/d which is match with the all previous work for dyna sand filter even the solid load is high for filtration process. so, this removal efficiency is very acceptable for such solids load.

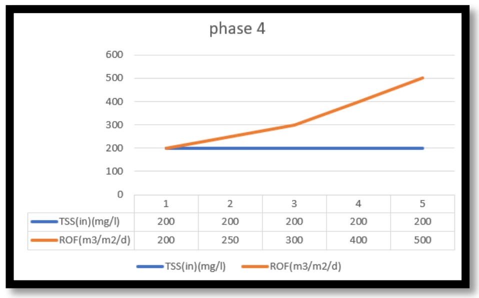
The fifth run resulted reading that shown in figure (7) with raw water TSS 200 mg/l and variable ROF **(**200-500 m3/m2/d**).**



(a) ROF with Efficiency



(b) TSS **with Efficiency**

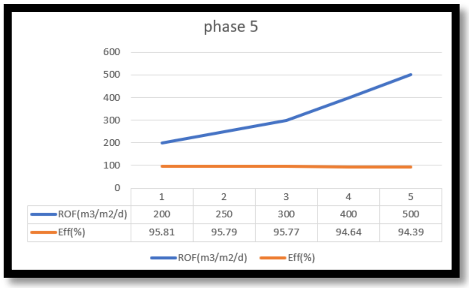


(c) TSS with ROF

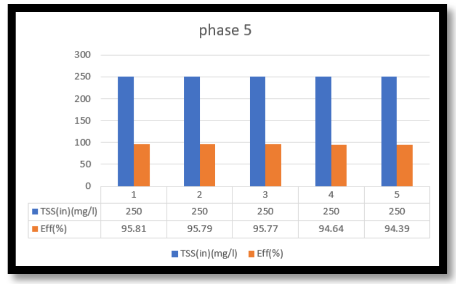
Figure (7) Run 5 Results Relations

Run 5 with TSS=150mg/l, achieved removal efficiency varied between 94.98%-93.13% due to variable ROF between 200-500 m3/m2/d which is match with the all previous work for dyna sand filter even the solid load is high for filtration process. so, this removal efficiency is very acceptable for such solids load.

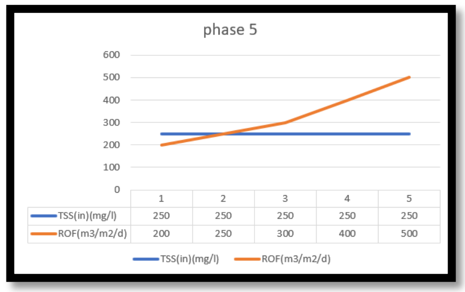
The sixth run resulted reading that shown in figure (8) with raw water TSS 250 mg/l and variable ROF **(**200-500 m3/m2/d**)**



(a) ROF with Efficiency



(b) TSS **with Efficiency**



(c) TSS with ROF

Figure (8) Run 6 Results Relations

Run 6 with TSS=150mg/l, achieved removal efficiency varied between 95.81%-94.39% due to variable ROF between 200-500 m3/m2/d which is match with the all previous work for dyna sand filter even the solid load is high for filtration process. so, this removal efficiency is very acceptable for such solids load.

5-CONCLUSION

The study concluded the following:

1. The suitability of dyna sand filter application against variable solid loads TSS50-250mg/l, and variable ROF 200-500 m3/m2/d with acceptable removal efficiency.
2. The previous results illustrated the acceptability of dyna sand filter to be applied as direct filtration system for low solid load in water resources.
3. The suitability of dyna sand to be used inside water treatment plants after sedimentation with higher ROF compared with traditional rapid sand filter that minimized the required area and construction cost.
4. The applicability of using the dyna sand filter for wastewater treatment plants as tertiary treatment with domestic wastewater plants and as secondary with some industrial wastewater plants.
5. The feasibility of the system to be applied for up grading the existing water treatment plants by replacing the mechanical equipment of rapid sand filter with dyna sand

mechanical equipment that increase the area production by (2-3) times the of existing plants.

6-REFERENCES

1. Conference paper, "Continuous Sand Filter", prepared by Anonymous company. Copy right at (1982).
2. Journal Article, "Combined nitrogen and phosphorus removal in a full- scale continuous up-flow sand filter", prepared by Hultman, B. Jonsson, K. Plaza, E. Sweden. Copy right at (1982).
3. paper, "Continuous Sand Filter Application", prepared by WATER UTILITY company. Copy right at (2004).
4. Nordic Water Products, "Dyna-sand Handbook." Nordic.water@waterlink.com. (1998).
5. Harris, W. Leslie, “High-Rate Filter Efficiency”, Journal American Water Works Association (1970).
6. Hamann. Carl L. and Mckinney, Ross E., “Up flow Filtration Process”, Journal American Water Works Association (1968).