

TREATMENT OF EARLY SEASONAL CLOGGING OF SAND FILTERS BY USING STERILIZED RICE STRAW AND ACTIVATED CARBON AT EL- FOSTAT WATER PLANT

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ABSTRACT

The present study was carried out in EL-Fostat water plant in order to find out the problem of early seasonal clogging of the sand filters during Autumn season and during the low level of the Nile River. This problem causes a lot of damages, e.g. losing of water during the back washing process and increasing of the used chemical doses used in the process of drinking water treatment (chlorine and aluminum sulphate). Also the study provides proper information on the phytoplankton communities, turbidity and phenol. The phenol experiment is very important to insure that the produced filtered water from the sterilized rice straw doesn't contain any phenolic compounds. Water samples were collected from stage1 (the raw water), stage 2 (after pre-chlorination), stage 3 (the clarifier) and stage 4 (the ordinary filters, sand only).

The results revealed that the algae, especially diatoms (*Synedra ulna*) were the main cause of the early clogging of filters. In order to find a solution for this problem, several experiments were done by using two types of filters (activated carbon and sterilized rice straw beside the ordinary sand filters). These treatments proved the solving of this problem and helped to extend the filtration period to about 24 hours instead of 8 hours. So that this reduction of

the washing time of the sand filter for one time, instead of three times leads to a provision of large quantities of water at El- Fostat water plant and reduce the doses of the used chemicals.

Keywords: Sterilized rice straw, activated carbon, filters, Clarifier, In take, back washing.

INTRODUCTION

Lapsongpon *et al.* (2017) reported the major algae-related problems in water treatment plant are unpleasant tastes, odors and filter clogging. Filter clogging by algae has been reported as a technical problem by many water treatment plants (WTPs). For example, water treatment plant in South Korea faced the decrease of filter run time from 20 hours to below 5 hours by the occurrence of diatom, *Synedra* sp. (Jun *et al.*, 2001).

The bloom of blue green algae, particularly *Anabaena* sp. and *Microcystis* sp. seriously impacted on filtration process in Morton Jaffray (MJ) water as evidenced by the increased backwashing frequency reported to be at every 4–8 h (Hoko and Makado, 2011).

General methods to remove algae are physical processes such as filtration, membrane filtration and adsorption by activated carbon, biological processes such as activated sludge and chemical processes such coagulation and chlorination. Among these methods, the chemical treatment process has been considered to be cost-effective way because many chemical agents are inexpensive and they usually do not require plants to significantly change work-flow and structure (Shen *et al.*, 2011 and Wu *et al.*, 2012).

A number of studies have reported that pre-treatment using oxidants such as ozone, chlorine, potassium permanganate and potassium ferrate can improve algae removal by coagulation (Plummer and Edzwald, 2002, Henderson *et al.*, 2008 and Hoko and Makado, 2011).

Pre-chlorination can also reduce the pollutants in raw water, such as organics, suspended solids, virus, pathogenic bacteria, and algae (Nieuwnhuijsen *et al.*, 2000 and Tardiff *et al.*, 2006).

Consistency in quantity or rate of supply is normally readily controllable and is a fundamental requirement for the proper operation of sedimentation systems. This becomes increasingly important for floc blanket systems treating thin coloured waters where even very slight disturbances in the rate of flow can lead to disruption of the floc blanket, which is then swept over to impose an extra load on the filtration stage, often resulting in poor filtered water quality. The divisions between Coagulation, Flocculation and Clarification are not rigid. A large number of plants in this country include hopper bottomed tanks formed as inverted pyramids with tank sides sloped at about 60° to the vertical. Water, which has been treated with coagulants, is discharged downwards near the bottom centre of the tank and turns through 180°, giving conditions suitable for flocculation. As the water flows upwards, its velocity decreases as the cross sectional area of the tank increases. The bottom portion of the tank is effectively a zone of coagulation and flocculation. As the water rises further up in the tank, clarification takes place

so that coagulation, flocculation and clarification occur in the one tank (EPA, 2002).

Phytoplankton, mainly represented by algae, forms a vital part in almost all the fresh water ecosystems and plays an important role through primary productions in the food chain and is also a useful tool for the assessment of water quality. It is essential to document the diversity of algal flora for biodiversity mapping of the wetland. Algae play a significant ecological role and are being used extensively, as indicators of water pollution. Assessment of physic-chemical and biological parameters serves as a good index in providing particular status to a water body (Annalakshmi and Amsath, 2012).

Description of El-Fostat water plant Site

El-Fostat water plant provides drinking water to is located in EL-Fayoum Street at Dar EL- Salaam area, in Cairo Governorate. It has an area of about 66 acres. The intake is the place where the water samples were collected before the treatment which located at Corniche El-Nile Road of Maadi. This occurs through several stages; First stage is the disinfection of the water by chlorine which disinfects micro-organisms and oxidization of water entry (River Nile). Second one is coagulation in which aluminum sulphate was added to coagulate the flocs inside clarifiers, then finally is the filtration which is essential to filtrate the flocs escaped from clarifiers.

El-Fostat water plant was first operated in 1988. The total designed production, after the last expansion, is 1200000 m³ / day. The total actual

production was 1000000 m³ / day before the expansion. El-Fostat water plant serves several parts in Cairo Governorate.

Soheir *et al.* (2017) found in the Benha City, Egypt that, the highest turbidity value of 8.37 N.T.U. (Nephelometric Turbidity Unit) was shown in March 2016 with high numbers of microorganisms in the raw water while it was 0.95 N.T.U. in October 2015 in the produced water. The lowest turbidity value (2.4 N.T.U.) was in February 2016 in the raw water by uptake of suspended matter by phytoplankton's as well as penetrating the water surface by high intensity solar radiation.

Mohamed *et al.* (2018) found that the maximum values were in the winter with 20.8 NTU while the minimum value was 2.71 NTU recorded in the summer.

Sayed *et al.* (2019) observed that the results indicated moderate positive correlation between the algae count and water turbidity.

Biological Parameters: Ahmed and Isaac (2015) observed that the total counts of phytoplankton tended to increase in autumn and winter, remain high in spring and then decrease in summer. Relatively low water temperature during winter and autumn probably favoured the growth of diatoms which dominated the phytoplankton.

Fathi and Abd El-Zaher (2003) and Sobhy (2007) recorded the first peak during spring and the second during winter whereas the lowest values occurred in autumn. Agale *et al.* (2013) found that the Cyanophyceae was the

dominance group. Sayed *et al.* (2019) indicated that the total algae count was highest during winter season followed by autumn then spring and summer.

Salwa *et al.* (2008), Mohanty and Adhikary (2013), Sarojini *et al.* (2013), Sharma and Singh (2013) and Ramesh *et al.* (2016) reported that the Bacillariophyceae was present as the dominant group.

Bhatnagar and Bhardwaj (2013), Jyotsna (2013), Ajayan *et al.* (2013), Suresh *et al.* (2013) and Karikari *et al.* (2013) found that Chlorophyceae was the predominate class.

Phenol: Nadita and Fakhruddin (2017) found that among all three types of adsorbent as raw rice straw, physically and thermally treated rice straw, <1 mm size particles had higher phenol removal efficiency than 1 mm size particles. For 1 mm particles, percentage of phenol removal for rice straw ash was 76.67 % for 2.5 g adsorbent dose. On the other hand, phenol removal efficiencies for 1 and <1 mm raw rice straw were 12.59 and 22.22 %.

Back washing: Kawamura (2000), Crittenden (2005) and Edzwald (2011) observed that the backwashing continues for a fixed time, or until the turbidity of the backwash water is below an established value. At the end of the backwash cycle, the upward flow of water is terminated and the filter bed settles by gravity into its initial configuration. Water to be filtered is then applied to the filter surface until the filter clogs and the backwash cycle needs to be repeated.

Letterman (1999) pointed that the function of rapid sand filters, is to remove the particulate matter in the influent suspension and provide significant pathogen removal, must have a higher filtration rates were 5~10 m³/m²/hr.

Damages caused by clogged filters: EPA (1995) observed that a filter is usually operated until just before clogging or breakthrough occurs, or a specified time period has passed, generally 24 to 40 hours and is related to the efficiency of the clarification process. Save money, energy and water by maximizing production before backwashing, filters are sometimes run until clogging or breakthrough occurs.

American Water Works Association (AWWS) (2002) observed that algae can lead to clogging of filters in treatment plants, thereby drastically reducing the length of filter runs and necessitating frequent back washings. In extreme cases, clogging may require more water to backwash than the amount of filtered water produced, severely diminishing the efficiency and cost-effectiveness of the process. This problem was caused by certain diatoms.

Ways to treat clogged filters: Norfahana *et al.* (2018) pointed the current global production of rice straw is 731 tons The rice straw mainly contains high amount of silica and lignin.

EPA (1995) reported the primary purpose of filtration, was to remove the suspended particles and flocs from the water being treated. Another dimension was added to the filtration process, by the use of activated carbon

(granular form), as a filter media. The high adsorptive capacity of the activated carbon enables it to remove taste and odour-causing compounds, as well as the other trace organics from the water. Not all the organic compounds are removed with the same degree of efficiency. Activated carbon filtration is very effective in removing the taste and odour-causing compounds.

Pengkang *et al.*(2013) who reported the high adsorptive capacity which enables it to remove taste and odour-causing compounds. Activated carbon has a high surface area and a highly developed porous structure, so it has a great effect on absorbing dissolved oxygen and organic matter into raw water. Biocatalyst technology consists of the reaction of molecules of activated carbon, microorganisms, pollutants and dissolved oxygen in water. Meanwhile, activated carbon can absorb DO and adsorbed microorganisms on the surface of activated carbon.

Ball *et al.* (2011) found that the 5g/m³ of rice straw is more effective in controlling the growth of algae, with 80% reduction in chlorophyll 'a' concentrations. However, barley of 2g/L and rice straw of 5g/m³ are also found to control the growth of the algae. The results express barley of 5g/m³ was highly significant. Used of straws to control the growth of algae represents an inexpensive, effective and environmentally acceptable method. However, further research is needed on the effect of straw content on the natural ecosystem of the aquatic body.

Deepa and Savitha (2015) found the dosage of the rice straw was added about 25g/m³. The time required for the activation of rice straw was about 2 weeks, in the presence of sunlight at the temperature of < 20°C. The pond was left undisturbed, after adding the calculated dose of rice straw for activation. On the zero day (before applying the straw), the algal cell count was recorded to know the density or number of cell counts in drop of water. Algal cell counts were monitored for every five days, after the straw activation (20 days) and were continued till the algal cell counts reduced to zero or 1 cell per drop of water.

Jonathan and Barrett (2002) and Salwa et al. (2007) observed that when straw is first placed in water, the soluble components of the straw are washed out, causing water to turn a brown color. When decomposition of lignin and other cell wall components starts to occur, decomposition of lignin leads to the production of a soluble lignin and other decomposition products. Also the cell wall components decompose at different rates.

MATERIALS AND METHODS

After collecting the water samples from the four stages of the water plant: stage 1 (raw water), stage 2 (after pre-chlorination), stage 3 (clarifier represented by tank with capacity 50 liter which have the treated water before filtration) and stage 4 (ordinary sand filter) an algal counting and measuring of turbidity have been done. After that different experiments were performed every two hours for 24 hours during autumn season to measure turbidity,

algal counting and back washing for the different types of filters : the first is activated carbon (200 gm) with sand (represented by bottles of 2 liter capacity), the second is sterilized rice straw (15 gm) with sand (represented by bottles of 2 liter capacity) and finally the ordinary sand filter (2000 gm). Analyses of phenol for sterilized rice straw with sand have been done.

The materials (Figs 1, 2 and 3): 700 grams of gravel, 2000 grams of sand were used (0.8 -1.4 m), 200 grams of active carbon, 15 grams of sterilized rice straw, 2-liter rectangular plastic bowl, 4 funnels, 2 bottles of 2 liter capacity, and Tank [has 50 liter].



Fig. (1): Activated carbon filter with sand

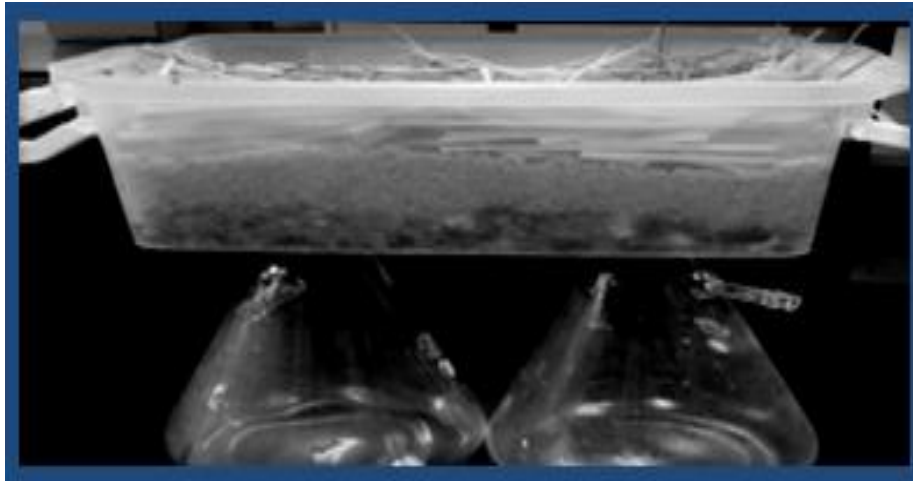


Fig. (2): Sterilized rice straw filter with sand



Fig. (3): The filtration process through the activated carbon with sand and sterilized rice straw with sand during autumn season

Turbidity (N.T.U): Turbidity was measured for the clarifier and all filters by Hach-USA, Model 2100.

Counting of phytoplankton: Counting of phytoplankton for all stages before and after the treatment of water plant was done and also for the different types of filters. Using a plunger sampling pipette, the phytoplankton organisms were identified and counted under binocular microscope phase contrast Carlzeis - Germany. The numbers of phytoplankton organisms were given as unit per liter.

The ratio that has been used for the calculation of percentage reduction of Bacillariophyceae number:

$$\frac{\text{Species composition of Bacillariophyceae no (in the filter)}}{\text{Species composition of Bacillariophyceae no (in the clarifier)}} = \%$$

Back washing: Air blower for 2 min, air and pressed water for 8 min. and finally rinsing by water for 10 min. for all types of filters.

Sterilization of rice straw filter with sand by using autoclave at 120 °c and 1 bar. Hyrayama-Japan.

Phenol: Two concentrations of standard phenol solutions (0.1 and 0.2 mg of phenol) were prepared to measure the ratio of phenols in the water produced from the sterilized rice straw filter with sand. Phenol was determined

colorimetrically, by using UV/Visible spectrophotometer at 500 nm wave length APHA (2009). Jenway U.K model 6715.



Fig. (4): The experiment of phenols (C_6H_5OH (nm)) in the filtered water after using the sterilized rise straw filter with sand.

RESULTS AND DISCCUTION

Turbidity:

1) **Seasonal variations:** Seasonal variations of water turbidity were shown in Fig 5. The results revealed that the minimum value of turbidity was 7.5 NTU during summer in stage 1, while the maximum value was 12.8 NTU during autumn in the same stage. Also the seasonal average values of turbidity ranged between 2.7 NTU during summer and 3.9 NTU during

Autumn. The present results are in agreement with that obtained by Sayed *et al.* (2019) who observed the turbidity level recorded little monthly variations and were in the range from 9.71 to 11.90 NTU.

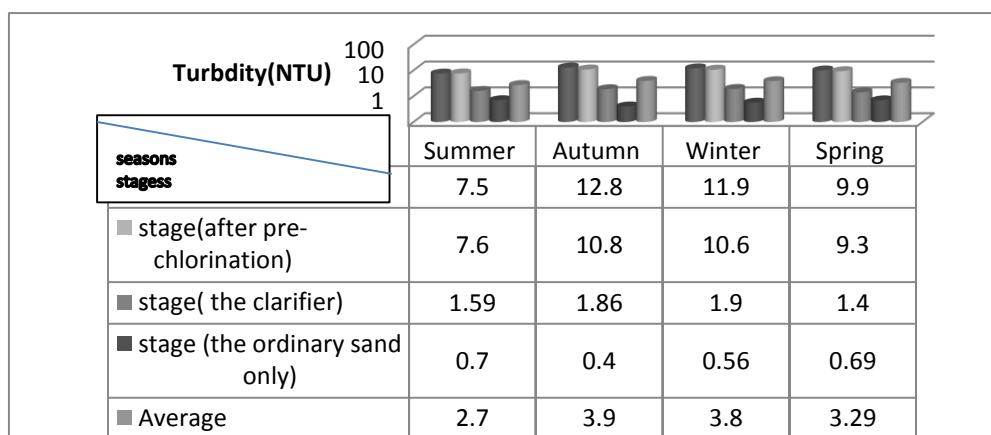


Fig. (5): Seasonal variations of turbidity values at all stages at EL-Fostat water plant.

2) Turbidity for clarifier and different types of filters during Autumn:

Fig 6 shows the turbidity measurements for clarifier (before filtration) and different types of filters (after filtration) during autumn. The results revealed that (after 24 h) the value of 2.6 NTU was at the clarifier, 0.66 NTU at the ordinary filters (sand only), 0.57 NTU at the sterilized rice straw with sand and of 0.64 NTU at the activated carbon with sand. Shape refers to the filter clogging. The present results revealed that the turbidity was very high particularly exceeding in the autumn season. These findings were not in agreement with that obtained by Soheir *et al.* (2017) who

found that in the raw water, the highest turbidity value was 8.37 N.T.U in spring with high numbers of microorganisms, while the lowest turbidity value of the raw water was 2.4 N.T.U in winter.

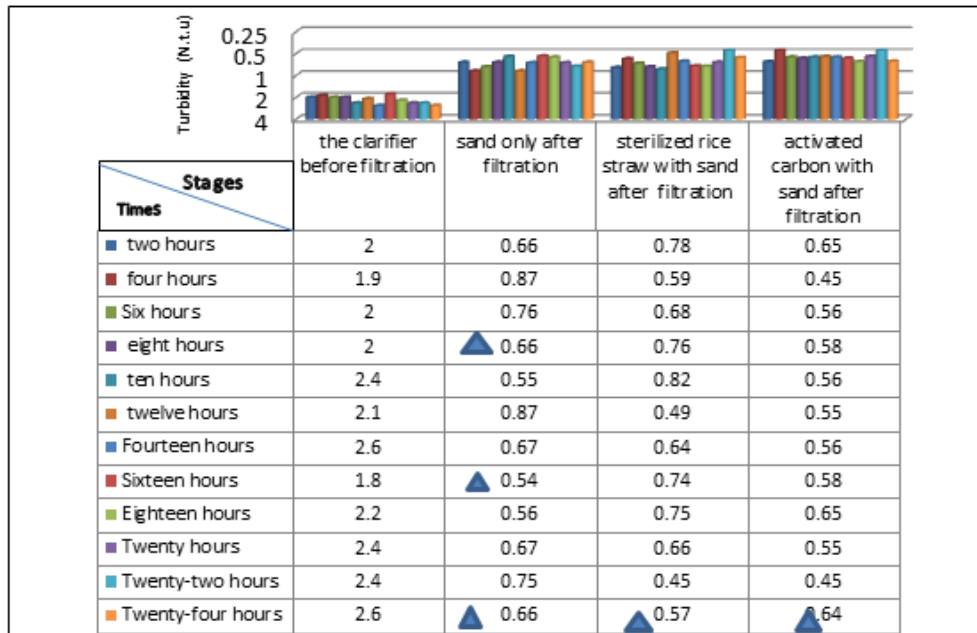


Fig 6: The turbidity values in the experimental process through 24h for the filters (sand only, sterilized rice straw with sand and activated carbon with sand) (after filtration) and the clarifier before filtration during autumn

Phytoplankton: Table 1 revealed that the phytoplankton communities are represented mainly by 3 classes namely: Bacillariophyta, Chlorophyta and Cyanophyta.

The presented data showed that the phytoplankton main classes can be arranged in the descending order: Bacillariophyta > Cyanophyta > Chlorophyta. It was observed that the highest value of algae in the first stage, before treatment (raw water) and after adding doses of chlorine and alum to water in the other stages (2, 3 and 4) the total number of algae decreased significantly. The present results are in agreement with that obtained by Ahmed and Isaac (2015) and Sayed *et al.* (2019) who indicated that the total algal count was highest during winter season followed by autumn then spring and summer.

The present results are not in agreement with that obtained by Fathi and Abd El-Zaher (2003) and Sobhy (2007) who recorded the first peak during spring and the second during winter whereas the lowest values occurred in autumn.

The total number of phytoplankton unit counted in the stage1 during autumn were 5989.3×10^3 unit/L while during winter were 5495.6×10^3 unit/L, during spring were 2632.5×10^3 unit/L and during summer were 2425.1×10^3 unit/L. It was observed that Bacillariophyceae, Chlorophyta and Cyanophyta thrive remarkably with lower temperatures during the autumn and winter seasons.

Bacillariophyceae was the dominant, during summer with 2259 X10³unit/L at stage1 also during autumn with 4740 X10³unit/L at stage1, during winter it was 4514 X10³unit/L and during spring was 2183 X10³unit/L.

The predomination of Bacillariophyta at EL- Fostat water plant was similar to the results that obtained by Salwa *et al.* (2008), Mohanty and Adhikary (2013), Sarojini *et al.* (2013) and Sharma and Singh (2013) who reported that the Bacillariophyceae was present as the dominant group.

Chlorophyta during summer was 99.6 X10³unit/L, during autumn was 149.6 X10³unit/L, during winter was 481.7 X10³unit/L and during spring was 383.2 unit/1ml. The present results were not in agreement with that obtained by Bhatnagar and Bhardwaj (2013), Jyotsna (2013), Suresh *et al.* (2013), Karikari *et al.* (2013) and Ajayan *et al.* (2013) who found that Chlorophyceae was the predominate class.

Cyanophyta during summer was 66.5 X10³unit/L, during autumn was 1099.7 X10³unit/L, during winter was 500 X10³unit/L and during spring was 249.9 X10³unit/L. The present results were not in agreement with that obtained by Agale *et al.*(2013) who found that the Cyanophyceae was the dominance group.

Table (1): Species composition of the total no. of taxa for algal groups (X10³unit /L) at all stages in EL-Fostat water plant during the investigation period

Total No. of Species composition and % of reduction									
Seasons	Stage	Bacillariophyceae		Chlorophyceae		Cyanophyceae		Phytoplankton	
		No	%	No	%	No	%	No	%
Summer 2017	1	2259	7	99.6		66.5		2425.1	
	2	1200	47	32	68	33.3	50	1265.3	48
	3	118	91	20	39	6	82	122.6	90
	4	9	92	6	69	3	50	18	88
Autumn 2017	1	4740	20	149.6	98	1099.7	82	5989.3	
	2	3199	33	33.2	77	216.6	80	3448.8	42
	3	300	91	6	82	21	90	327	91
	4	45	82	0	100	3	86	48	85
Winter 2018	1	4514	18	481.7	86	500	91	5495.6	
	2	2149	52	366.2	74	250	50	2765.03	50
	3	162	92	9	98	60	76	231	92
	4	21	87	3	67	6	70	30	87
Spring 2018	1	2183	17	383.2	85	249.9	90	2632.5	
	2	1475	32	199.6	48	66.6	73	1924.8	27
	3	132	91	19.6	90	6	91	157.6	92
	4	6	90	0	100	3	50	9	94

Fig. (7) shows that the maximum peak of algal taxa trapped in the intermediate filtration was 297 X10³unit/L during autumn season while the minimum was 105 X10³unit/L during summer. which confirms the occurrence of a large clogging of stage 4. The number of algae trapped in the intermediate filtration (stage 4) works to clogging the filter's sand surfaces,

which leads to a partial inability of the filter to perform its function normally and therefore needs to be back washed.

Also the maximum peak ratio of algal taxa of elimination was 94% during spring and the minimum was 85% during autumn.

The maximum peak of filtered algal taxa (the total number of algae present in the filtered water) was 48×10^3 unit/L during autumn while the minimum was 9×10^3 unit/L during spring.

The present results were in agreement with that obtained by EPA (1995) and AWWA (2002) who observed that algae can lead to clogging of filters in treatment plants, thereby drastically reducing the length of filter runs and necessitating frequent back washing. In extreme cases, clogging may require more water to backwash than the amount of filtered water produced, severely diminishing the efficiency and cost-effectiveness of the process. This problem was caused by certain diatoms.

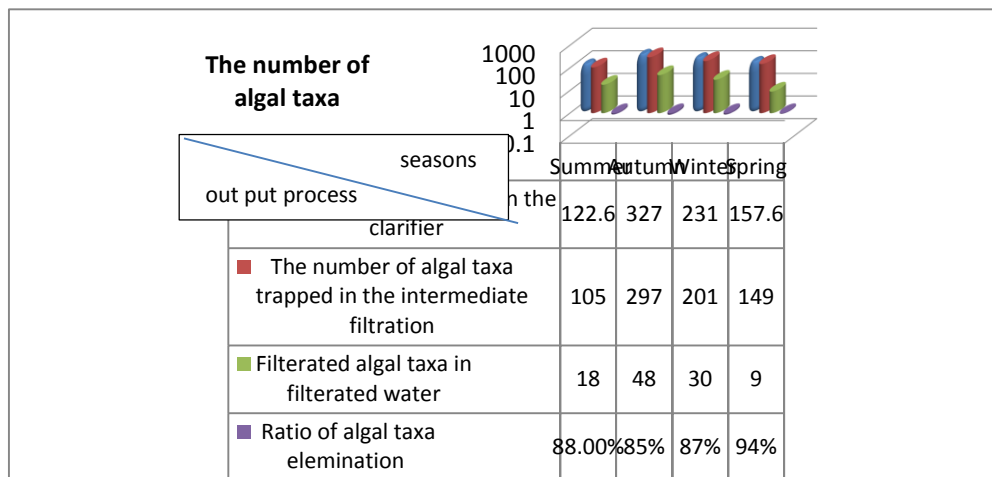


Fig (7): The number of filtered algal taxa and the ratio of elimination during all seasons.

Fig. (8) shows that the number of algal taxa trapped in the intermediate filtration was 288×10^3 unit/L at the activated carbon filter with sand, was 279×10^3 unit/L at the sterilized rice straw filter with sand and was 261×10^3 unit/L at the ordinary filter (sand only).

The ratio of algal taxa elimination was 94% at the activated carbon filter with sand, was 91% at the sterilized rice straw filter with sand and 85% at the ordinary filter (sand only).

The number of filtered algal taxa in filtered water was 45×10^3 unit/L at the ordinary filter (sand only), was 18×10^3 unit/L at the activated carbon filter with sand and 27×10^3 unit/L at the sterilized rice straw filter with sand.

Although the number of algal taxa trapped on the surface of the activated carbon filter with sand was high the filter does not become clogged which explains that there was a high occurrence of adsorption of the algal taxa. On the other hand the sterilized rice straw filter with sand does not become clogged also because there was a high occurrence of adsorption of the algal taxa on its surface, while the ordinary sand filter (sand only) does not cause adsorption on its surface where a clogging was happened.

The present results are in agreement with that obtained by EPA (1995) who reported by using the activated carbon (granular form), as a filter media, also with that obtained by Pengkang *et al.*(2013) who reported the high adsorptive capacity which enables it to remove taste and odour-causing compounds. Activated carbon has a high surface area and a highly developed porous structure, so it has a great effect on absorbing dissolved oxygen and organic matter into raw water.

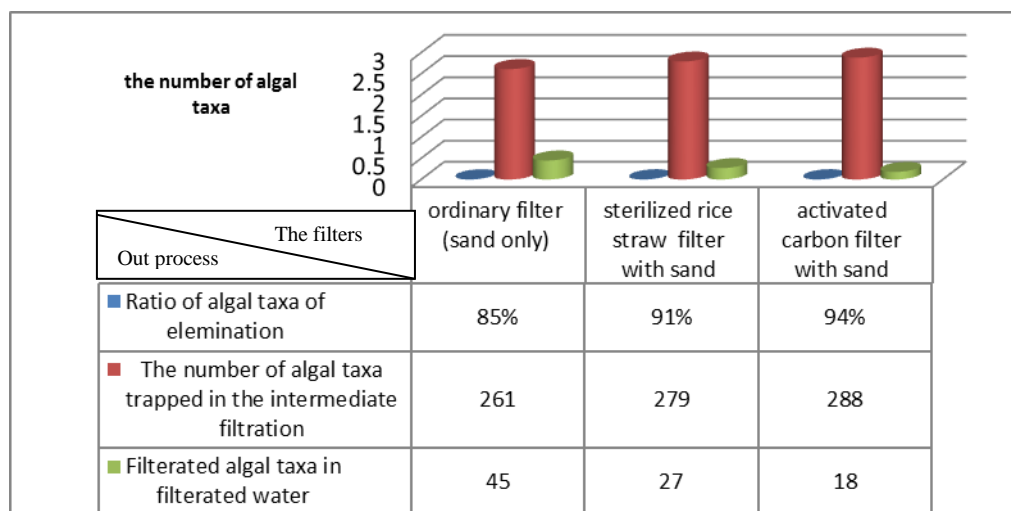


Fig. (8): The ratio of eliminated and the filtered algal taxa during the autumn season

Counting of phytoplankton: Table 2 shows the species composition of Bacillariophyceae in all the types of filters and the clarifier through 24h. The major peak of Bacillariophyceae (*Syndera ulna*) at the clarifier was 143×10^3 unit/L, at the ordinary filter (sand only) was 36×10^3 unit/L, at the sterilized rice straw filter with sand was 18×10^3 unit/L and at the activated carbon filter with sand was 18×10^3 unit/L.

The total no of Bacillariophyceae at the clarifier was 306×10^3 unit/L, so that the reduction in the number of Bacillariophyceae was 45×10^3 unit/L (85%) at the ordinary filter (sand only), 27×10^3 unit/L (91%), the present results confirmed that rice straw filter with sand control the growth of algae at

the sterilized rice straw filter with sand and 18×10^3 unit/L (94%) at the activated carbon filter with sand.

The present result also confirmed that the active carbon has a high capacity for adsorption of algae. It was observed that the cause of the early clogging of the ordinary sand filters was increased during autumn season and during the decrease of the Nile level. It was clear that phytoplankton especially Bacillariophyceae (*Synedra ulna*) was the main reason for the process of clogging filters.

The present results are in agreement with that obtained by Jun *et al.* (2001) who reported the filter operating time has decreased due to the presence of diatom, *Synedra* sp.

Also are in agreement with that obtained EPA (1995) who reported the primary purpose of filtration, is to remove the suspended particles and flocs from the water.

The present results also were in agreement with that obtained by Ball *et al.* (2011) and Deepa and Savitha (2015) mentioned that the rice straw which used ranged between 5 g/m^3 and 25 g/m^3 . Ball *et al.* (2011) who reported who reported that using straw to control algae growth is an inexpensive, effective and environmentally acceptable method.

Since lignin, which is one of the main ingredients of rice straw, decomposes over time, it has been found better not to be in the filter for a long time. The present results were in agreement with that obtained by Jonathan and Barrett (2002) and Salwa *et al.* (2007) who observed that when

straw is first placed in water, the soluble components of the straw are washed out, causing water to turn a brown color. When decomposition of lignin and other cell wall components starts to occur, decomposition of lignin leads to the production of a soluble lignin and other decomposition products. Also the cell wall components decompose at different rates.

The present study showed from the analysis of the water at El- Fostat water plant (the physico-chemical parameters, biological parameters and sand analysis) that the process of clogging of filters occur in autumn and winter (low temperatures).

Table (2): Species composition of Bacillariophyceae (X10³unit/L) in the all types of filters and the clarifier through 24h

Taxa \ clarifier and Types of filters	clarifier before filtration	ordinary filter (sand only) after filtration		sterilized rice straw filter with sand after filtration		activated carbon filter with sand after filtration		
	No of Species composition and % of reduction.							
	No	No	%	No	%	No	%	
Cyclotella ocellata Pant	27	0	100	0	100	0	100	
Melosira granulata (Her.) Ralfs	18	9	50	0	100	0	100	
Melosira granulata var. angustissima Muller	27	0	100	0	100	0	100	
Synedra acus (Kutz.)	36	0	100	0	100	0	100	
Synedra delicatissima W. Smith	45	0	100	9	80	0	100	
Synedra ulna (Nitz.) Her.	54	9	83	9	83	9	83	
Syndra ulna var.biceps (kutz)	45	9	80	9	80	0	100	
Syndera ulna nitz.heronella	54	18	66	0	100	9	83	
Total No of Syndera ulna	143	36	75	18	87	18	87	
Total No of Bacillariophyceae	306	45	85	27	91	18	94	

Phenol: The present results (Fig 4) revealed that no phenolic compounds were formed after the filtration process for 24 hours through the sterilized rise straw filter. This is due to the very strong adsorption capacity of the rice straw, These findings were in agreement with that obtained by Nadita and Fakhruddin (2017) who found that among all three types of adsorbent as raw rice straw, physically and thermally treated rice straw, <1 mm size particles had higher phenol removal efficiency than 1 mm size particles. For 1 mm

particles, percentage of phenol removal for rice straw ash was 76.67 % for 2.5 g adsorbent dose. On the other hand, phenol removal efficiencies for 1 and <1 mm raw rice straw were 12.59 and 22.22 %.

Back washing: The results revealed (Fig 9) that the filters (sterilized rice straw with sand and activated carbon with sand) remained in filtration process for 24 hours and need backwashing every 24 hours (once for 20 minutes each) while the ordinary filter (sand only) stops every 8 hours daily, which it needs to be backwash every 8 hours daily also (for 20 minutes each). The ordinary filter (sand only) produces about 10.000 m³ / day water and when it stops, it needs washing three times (for 20 minutes each), (with an average of one hour per day), i.e. It loses about 400 m³ / day from the clarified water, in addition to the loses of the treatment water which used in the washing of the filters. When applied all the ordinary filters of El-Fostat water plant (a maximum of 100 sand filters), the loss reaches daily about 40.000 m³ / day. While the use of sterilized rice straw or active carbon in the filtration process work effectively, reduce the loss of water for about 139 m³/ day, (in other words, the reduction loss is about 13.900 m³ / day).

The present results in agreement with that obtained by Jun *et al.* (2001) reported that the treatment plant in South Korea faced the decrease of filter run time from 20 hours to below 5 hours by the occurrence of diatom, *Synedra* sp.

The present results revealed that the filtration rates for the ordinary filters (sand only about 100 filters) were $5\text{m}^3/\text{m}^2/\text{hr}$. It carried out on the rapid sand filters, this requires washing rate every 8 hours daily as in the following steps: (2 minutes compressed air, 8 minutes water and air and 10 minutes water only). The examination for the samples of the sand filter, indicate that the early clogging may be due to the formation of a very massive quantity of diatoms and algae (especially *Syndera ulna*), above the sand filter.

The present results in agreement with that obtained by Letterman (1999) who observed that the function of rapid sand filters, is to remove the particulate matter in the influent suspension and provide significant pathogen removal, must have a higher filtration rates were ($5\sim 10\text{ m}^3/\text{m}^2/\text{hr}$).

The present results in agreement with that obtained by Kawamura (2000), Crittenden (2005) and Edzwald (2011) who observed that the backwashing must be continued for a fixed time, or until the turbidity of the backwash water is below an established value. At the end of the backwash cycle, the upward flow of water is terminated and the filter bed settles by gravity into its initial configuration water to be filtered is then applied to the filter surface until the filter clogs and the backwash cycle needs to be repeated.

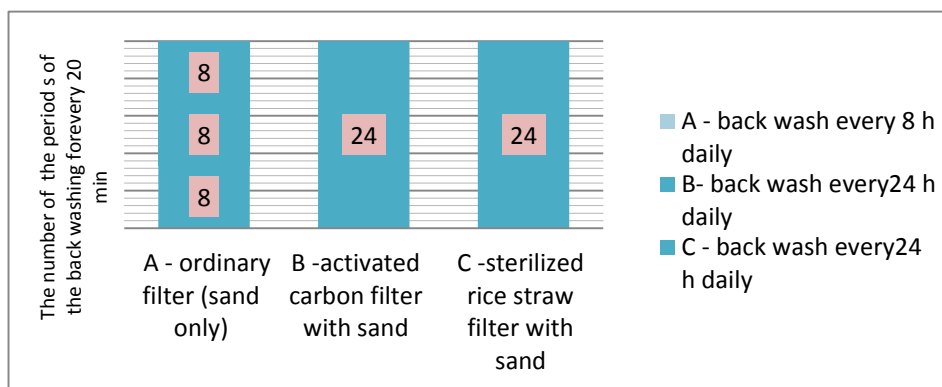


Fig (9): The number of periods of back washing for all the types of filters

CONCLUSION

After conducting of physico chemical parameters and biological analyzes for the treated and the untreated water, it was observed that the cause of the early clogging of the ordinary sand filters was increased during autumn season and during the decrease of the Nile level. It was clear that phytoplankton especially Bacillariophyceae (*Synedra ulna*) was the main reason for the process of clogging filters. As a result of the filtration process, it has been found that in the two filters (sterilized rice straw with sand and activated carbon with sand) an adsorption process for phytoplankton occurs on their surface during the 24 hours continuously, while the ordinary filter (sand only) stops after 8 hours daily (for three times a day). Therefore, many experiments have been done using activated carbon and sterilized rice straw as an auxiliary layer in each sand filter after it has been shown to be effective

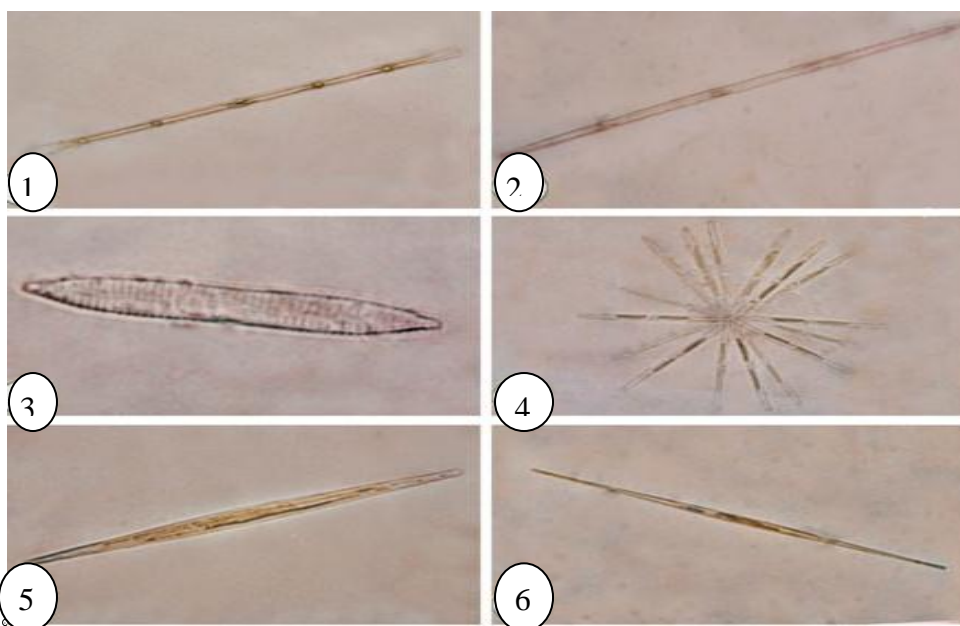
in algae growth, which may solve the problem (clogged sand filters). A phenol experiment was carried out on a sterilized rice straw filter to ensure that it was suitable for drinking water. After measuring phenol in filtered water using a sterilized rice straw filter, the result was negative. This means that chlorinated water does not react with the basic components of rice straw (lignin-silica) but this does not mean that rice straw ingredients do not decompose by time.

RECOMMENDATION

It is recommended to use activated carbon and sterilized rice straw as an auxiliary layer in each sand filter. These may solve the problem because of their effect in reducing algal growth. It is also preferable to place a layer of sterilized rice straw only once on the sand filters during the clogging period then change it because decomposition of lignin leads to produce a soluble lignin and other undesired decomposition products. Also it may use the sterilized rice straw as a mat at the intake (Nile water before reaching El-Fostat plant). Although the activated carbon gave a higher ratio of algal reduction yet it is very expensive, therefore, sterilized rice straw is recommended for its low price and good results.

Plates:

- | | |
|--|--------|
| 1- <i>Synedra Ulna</i> (Nitz.) Her | X 400 |
| 2- <i>Synedra ulna</i> var. <i>biceps</i> (Kutz.) | X 400 |
| 3- <i>Synedra ulna</i> var. <i>ramesi</i> (Herib.) Hust. | X 1000 |
| 4- <i>Synedra actinostriodes</i> Lemmer | X 1000 |
| 5- <i>Synedra acus</i> Kutz. | X 400 |
| 6- <i>Synedra delicatissima</i> W.Smith | X400 |



Plates:

- | | |
|--|-------|
| 7. <i>Cyclotella ocellata</i> Pant | X1000 |
| 8. <i>Melosira granulata</i> (Her.) Ralfs | X 800 |
| 9. <i>Melosira granulata</i> var. <i>angustissima</i> Muller | X500 |



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معالجة الانسداد الموسمي المبكر للمرشحات الرملية باستخدام قش الأرز المعقم والكربون النشط في محطة مياه الفسطاط

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المستخلص

أجريت الدراسة الحالية بمحطة مياه الفسطاط للتعرف على مشكلة الانسداد الموسمي المبكر للمرشحات خلال موسم الخريف وأثناء انخفاض منسوب نهر النيل وكانت المشكلة هي انسداد المرشحات الرملية مما أدى إلى إيقافها وهذا يؤدي الي الكثير من الأضرار، على سبيل المثال، فقدان الماء أثناء عملية الغسيل العكسي وزيادة الجرعات الكيميائية المستخدمة في عملية معالجة مياه الشرب (الكور وكبريتات الألومنيوم). من أجل إيجاد حل لهذه المشكلة، توفر الدراسة أيضاً معلومات مناسبة عن مجتمعات العوالق النباتية والعكارة والفينول. تعتبر تجربة الفينول مهمة للغاية لضمان عدم احتواء الماء المفلتر الناتج من قش الأرز المعقم على أي مركبات فينولية. تم جمع عينات المياه من (الماء الخام) و (بعد الكلورة) و (المروق) و (المرشحات العادية بالرمل فقط).
أوضحت النتائج أن الطحالب، وخاصة الدياتومات (*Synedra ulna*) كانت السبب الرئيسي في انسداد الفلاتر في وقت مبكر. تم إجراء العديد من التجارب باستخدام نوعين من المرشحات (الفحم المنشط وقش الأرز المعقم بجانب مرشحات الرمل العادية). أثبتت هذه العلاجات حل هذه المشكلة وساعدت على إطالة فترة الترشيح إلى حوالي ٢٤ ساعة بدلاً من ٨ ساعات. بحيث يؤدي تقليل وقت غسل مرشح الرمل لمرة واحدة، بدلاً من ثلاث مرات، إلى توفير كميات كبيرة من المياه في محطة مياه الفسطاط وتقليل جرعات الكيماويات المستخدمة.
الكلمات المفتاحية: قش الأرز المعقم، الكربون النشط، المرشحات، المروق، المأخذ، الغسيل العكسي.