Enhancement of Wastewater Treatment Plant Effluent Characteristics using Polyethylene Strips

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Abstract*: The disposal or reuse of treated wastewater needs to ensure the effluent quality to prevent the environmental problems especially with the variable inlet criteria. This leads to have a tertiary or additional treatment to the effluent of the secondary treatment which still till now is very expensive. This study try to use the polyethylene strips which is very cheap material, as a buffer media inside the effluent channel of WWTP to decrease the pollutants loads in it and achieve a control for the effluent quality to prevent its bad reflection on environment with low cost and easy control method. The study was applied on Abu Rawash WWTP effluent channel using the polyethylene strips that forming a biofilm layer above its surface. The removal ratio for one line of polyethylene strips for BOD and TSS was varied between 8.8 and 10.6% respectively. Also the results shown slightly difference between the concentrations of the BOD and TSS at the effluent of the wastewater treatment plant and after the media which mean that the BOD and TSS were removed using this kind of media.

KEY WORDS: wastewater treatment, Polishing treated wastewater, New innovative techniques, Polyethylene strips.

I. INTRODUCTION

The major challenges which facing sustainability development is water availability for different purposes and how these activities will be influenced the fresh water in the local environments. The study is presenting many substantial aspects in this regard, starting with applying new techniques in examined water qualities (the use of biofilms) regarding to the pollutants collection and treatment efficiency. The study proposed new frameworks for the preliminary or polishing treatment for wastewater by simple and cheap technique. This research is mainly devoted to study the ability of enhancement wastewater characteristics using polyethylene strips as a low cost material.

II. LITERATURE REVIEW

The biofilms are societies of microorganisms which improve in humid environment. The inorganic and organic materials that involve biofilms can range from decaying products in wastewater, and to millions of types of microorganisms in lakes [1]. Deibel, et al., [1], found that, when the integration between the nutrient and the moisture are taken place on the surface, it is probable to detect the biofilms there. The biofilms are capable for grow on natural material below and above the ground, plastics, on metals, plant and body tissues, and medical implant materials. Moreover, the biofilms in the suitable environment have the ability to grow up and become highly connected with the surface it lives on. The biofilms sometimes have harmful effects; they also offer huge potential for certain applications, such as bioremediation hazardous waste sites, bio-filtering municipal and industrial water and wastewater, and forming bio-barriers to protect soil and groundwater from contamination. When used in engineered systems of wastewater treatment, biofilms are often beneficial [2]. Passive sampling techniques were indicated and recommended by the European Union's Water Framework Directive and Marine Strategy Framework Directive for the long-term monitoring of water environments as a technique of analysis not causing excessive costs. In this context, the advantage of passive sampling is that it can give more representative information about water environment quality than traditional spot sampling [3]. Passive sampling can be defined in its broadest sense as any sampling technique based on free flow of analytes molecules from the sampled medium to a receiving phase in a sampling device, as a result of a difference between the chemical potentials of the analytes in the two media. The net flow of analytes molecules from one medium to the other continues until equilibrium is established in the system, or until the sampling period is stopped [4]. Sampling proceeds without the need for any energy sources other than this chemical potential difference. Up to now, passive sampling techniques have been adapted for the monitoring of water environments throughout the world to measure the time-weighted average (TWA) concentration of organic and inorganic pollutants [5], for example in wastewater [6], river water [7] and drinking water [8]. The Chemcatcher technique utilizes three types of sorbents (C18, styrene-divinyl benzene or chelating resin) and membranes (polyether sulfone (PES) or low density (PE)) depending on the type of analytes being measured [9]. The monitoring of polar chemicals by the ‘‘chem-catcher’’ passive sampler employs the use of a high surface area adsorptive sequestering phase, the styrene- divinyl benzene-reverse phase sulfonated (SDB-RPD) Empore disk (ED).

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The ED was first employed in the determination of time weighted average (TWA) concentrations of non polar organic water pollutants [10], and has since been extended for use in the monitoring of hydrophilic compounds [11].

Previous studies investigating the inclusion of EDs as a receiving phase within passive samplers have reported that the uptake and release of chemicals appears to be governed by isotropic kinetics [12].

However, Shaw et al. published that for polar herbicides, including diuron and atrazine, desorption of preloaded standards from the ED didn't mirror the isotropic kinetics observed during uptake. Subsequently, the authors found that the performance reference (or depuration) compounds (PRC) derived exchange rates were consistently higher than that predicted from uptake and lead to the underestimation of the TWA Cw [13].

III. MATERIALS AND METHODS

The applied material (polyethylene strips) for this study was previously used for monitoring of sewage properties at networks in Germany and Turkey. The polyethylene strips which is very cheap, as a buffer media inside the effluent channel to decrease the loads in this effluent and achieve a control for the effluent quality prevent its bad reflection on environment with low cost and easy control method.

The experimental work was divided into two main phases. The first phase was targeted to determine the characteristics for the used material, while the second phase was made using only one line of strips to ensure the application possibility and determine its efficiency for improving wastewater. The experimental works for the first stage were took place at the environmental lab. of the faculty of engineering at Necmettin Erbakan University (Konya-Turkey). On the other side the second stage took place at Abu Rawash wastewater treatment plant (Giza- Egypt), using its lab. We had used the effluent of the primary sedimentation tank (which is the only treatment stage in Abu Rawash wastewater treatment plant). Our sampling for the second stage was taken before and after the line of the polyethylene strips that had been placed at the channel, also; the samples had been taken at the influent of the wastewater treatment plant.

Figure (1) the Sample for the polyethylene strips

IV. RESULTS & DISCUSSIONS

The first phase was targeted to determine the main characteristics for the used material. The main characteristics for the media were the surface area, the porosity and the material type of this media. Table (1) shows the calculated surface area for the applied media as the result of the BET test "Brounauer Emmett Teller".

Table (1) Result of BET test

Sample No.	Surface area (m^2/g)	Porosity
1	0.389	----
2	0.393	----
3	0.003	----
4	0.000	----

And the following figure (1) shows the result of the SEM analysis "Scanning Electron Microscope" for the applied media.

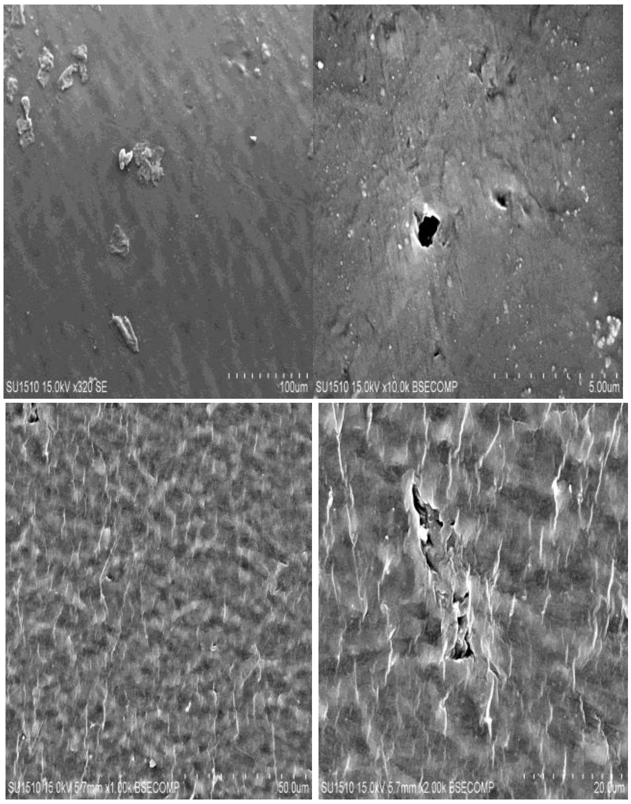

Figure (1) The SEM results for the applied media

The results that had been shown identified that the surface area for the media is 0.391±0.002 m2/g as average value for the results of the first and the second samples, while the results for the third and the fourth samples are equal to zero, which means that the sample surface area flat and no pores in the sample. By comparing this results with the literature it was found that the surface area for the composite materials (from polyethylene and polystyrene).

On the other side, the second stage was aimed to determine the efficiency for the polyethylene strips to enhance the wastewater characteristics (BOD and TSS).

The results of using polyethylene strips for reducing the BOD concentration at the effluent for the wastewater are shown in table (2) and figure (2).

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Table (2) BOD concentration at the plant entrance, effluent and after the media

Sample NO.	Entrance of WWTP (mg/l)	Effluent of WWTP (mg/l)	After the media(mg/l)
1	324	138	129
2	300	135	111
3	189	114	105
4	201	147	139
5	187	126	118
6	192	121	111
7	186	110	103
8	240	126	121
9	223	150	139
10	180	135	120
11	210	150	120
12	202	118	113
13	194	115	108
14	188	102	100
15	203	113	103
16	174	115	101
17	203	107	100
18	185	108	92
19	211	118	103
20	193	108	95
21	218	148	136
22	200	110	103
23	197	118	116
24	202	121	112
25	198	111	105
26	210	126	120
27	228	156	147
28	210	126	117
29	180	129	114
30	210	114	106
31	190	100	93
32	200	111	100
33	215	118	100
34	212	113	102
35	217	118	106
36	225	125	110
37	222	120	107
38	220	120	112
39	220	119	113
40	239	123	105
41	228	112	99
42	217	115	97

Sample NO.	Entrance of WWTP (mg/l)	Effluent of WWTP (mg/l)	After the media(mg/l)
43	231	130	116
44	224	119	101
45	215	114	98
46	195	97	84
47	200	108	99
48	202	111	96
49	203	68	64
50	200	65	55
51	199	63	56
52	156	89	81
53	198	65	61
54	195	82	77
55	195	84	79
56	249	105	100
57	195	81	72
58	231	101	99
59	196	84	82
60	221	96	87
61	200	78	69
62	223	84	76
63	205	75	66
64	180	95	91
65	192	93	88
66	198	89	89
68	210	86	86
70	234	91	89
71	231	86	82
72	237	83	78
73	231	83	76
74	236	81	79
75	211	88	85
76	228	85	78
77	220	90	85
78	216	108	94
79	212	91	81
80	195	89	85
81	218	98	90
82	228	93	79
83	204	96	84
84	220	98	80
85	228	97	89
86	228	90	77
87	225	87	72
88	202	82	75
89	223	92	84

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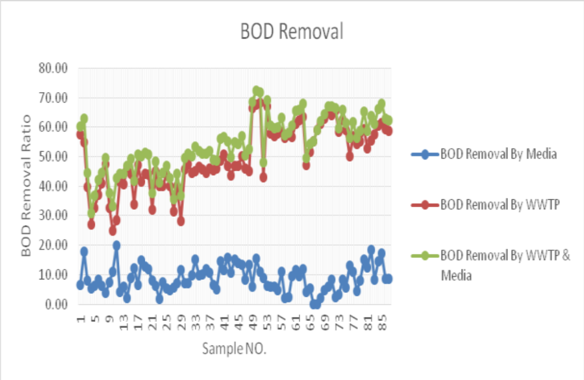

Figure (2) BOD Removal Ratio in %

Table (2) & figure (2) illustrate that polyethylene media has efficiency to remove the BOD from the wastewater with average removal ratio of 8.8% using one line of the media, the removal ratio of media for BOD was increasing at the first few days then the removal was decreased, which indicated that the media had the ability to remove BOD until it reached the saturation state, after that part of the accumulated biofilm had been fallen into the wastewater, at this stage the amount of the biofilm that had been fallen equally to the uptake rate of the media, where the removal ratio for the media didn't get negative results.

Table (3) TSS concentration at the Plant entrance, effluent and after the media

Sample NO.	Entrance of WWTP (mg/l)	Effluent of WWTP (mg/l)	After the media (mg/l)
1	255	121	70
2	224	105	78
3	160	93	82
4	130	90	88
5	162	76	74
6	223	117	106
7	165	84	79
8	146	78	64
9	175	81	73
10	144	78	72
11	228	87	75
12	194	136	100
13	157	84	74
14	176	88	79
15	210	91	85
16	190	74	70
17	214	92	90
18	197	80	80
19	143	83	80
20	170	90	86
21	220	85	80
22	166	93	85
23	158	82	78
24	228	79	72
25	232	98	90
26	160	104	96
27	156	100	94
28	220	89	78
29	231	90	81
30	197	93	83
31	218	81	74
32	225	77	70
33	230	82	75
34	218	78	71
35	240	83	77
36	238	91	82
37	250	95	85
38	247	90	81
39	266	98	79
40	301	118	99
41	270	100	90
42	251	82	70
43	262	91	79
44	255	91	79
45	231	86	76
46	218	79	69
47	238	79	68
48	244	91	78
49	233	84	66
50	220	76	64
51	225	83	66
52	220	73	71
53	280	53	51
54	208	77	72
55	304	89	81
56	244	63	59
57	240	75	68
58	300	89	79
59	232	76	66
60	224	63	54
61	206	63	53
62	243	67	54
63	200	67	53
64	197	70	68
65	160	70	68
66	180	75	73
68	188	73	72
70	185	73	70
71	220	69	64
72	248	67	63
73	240	67	62
74	228	50	49
75	234	77	71
76	254	68	64
77	255	70	64
78	240	77	73
79	255	71	63
80	240	86	77
81	240	72	64
82	278	72	58
83	222	76	62
84	260	73	58
85	226	76	69
86	240	68	64
87	268	64	53
88	200	76	69
89	280	80	64

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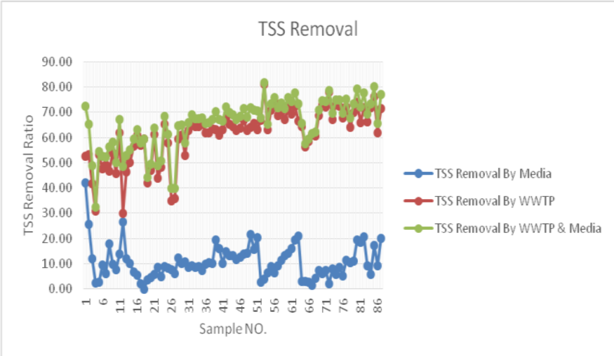

Figure (3) TSS Removal Ratio %

Table (3) and figure (3) show that the media able to decrease the concentration of the TSS by average removal ratio 10.60%, and sometimes the removal ratio of the media reached 0.00 % which indicated that the weight of the biofilm collected on the surface of the media becomes heavy and it was fallen into the water and another SS were accumulated on the media or the media wasn't able to uptake more SS than that it contain.

V. CONCLUSION

The study was done to enhance the effluent of the wastewater using simple solution (polyethylene strips) which was placed at the existing channel at the effluent for the wastewater treatment plant, and it was concluded the following:

1. The used media has the capability for forming bioflim layers above its surface.
2. The formed biofilm layers have the strength to remove organic matter that found in the wastewater.
3. The media strips work for accumulating the suspended solids on its surface.
4. The polyethylene strips has the ability to reduce the concentration for the BOD from the wastewater by 8.8%.
5. The concentration for the total suspended solids can be decreased by 10.60% using one line of the media.

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