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Effect of Polyethylene Strips Surface Roughness on Its Efficiency for Enhancement of Wastewater Treatment

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Abstract: ***This study aimed to determine the effect of roughness surface for polyethylene strips on its quality for enhancement the characteristics of wastewater treatment plant effluent as a very cheap method. The study was applied at Abu Rawash WWTP effluent channel using the smooth and rough polyethylene strips where a biofilm layer forms above its surface. The removal ratio for smooth polyethylene strips for BOD and TSS was 4.45 and 4.33% respectively, while for the rough polyethylene strips was 14.10 and 13.37 respectively. This shows the success of the polyethylene strips even smooth or rough to remove both the BOD and TSS from treated wastewater. The results show that the material roughness affected the treatment efficiency with proportional effect. And the rough surface has a good removal efficiency that makes it more applicable for such purpose of enhancing the treated wastewater with very low cost technique.***

Keywords: ***wastewater treatment, Polishing treated wastewater, Polyethylene strips, Roughness of polyethylene strips.***

I. INTRODUCTION

This study presents the applying of old quality monitoring technique used with sewerage system as a low cost technique for polishing effluent treated wastewater, where this technique was successfully applied before in Germany, Turkey, Jordon and Egypt. This new technique will help in upgrading the existing wastewater treatment plants without establishing any new constructions or modifications in existing structure, by just adding the strips frame at the effluent channel for the wastewater treatment plants.

As the result for success for using the polyethylene strips specially that exported from Germany for enhancement and improve the effluent wastewater characteristics at the effluent for the wastewater treatment plant, new local type of the strips had been applied in this study to check its suitability for such application [1].

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To decrease the cost, several companies in local markets produce different shapes for polyethylene sheets with different surface roughness which had been used in our study as polishing for wastewater.

This research is mainly devoted to determine the effect of roughness surface for polyethylene strips on its quality for the target for enhancement wastewater characteristics using 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 [2].

Msu center for Biofilms Engineering publishes in 2008, that the biofilms population can be processing of as little as one kind of bacteria, and it doesn't restricted to any special amount of species. For example, Dental plaque is one type of biofilms that is including over 500 bacterial species [3].

The most popular devices for the passive extraction of polar compounds are Chemcatcher [4], and the Polar Organic Chemical Integrative Sampler (POCIS) [5].

One of the advantages of the Chemcatchers design is its potential application to a variety of both organic and inorganic contaminants by the use of a suitable combination of receiving phase and membrane. For inorganic compounds, the most commonly used receiving phase is the iminodiacetate functionalized chelating disk. The chelating disk is associated to a cellulose acetate (CA) membrane for trace metals such as Cd, Cu, Ni, Pb and Zn [6].

Chemcatcherss are often used with a membrane covering the receiving disk. The role of this membrane is threefold: (a) protection of the disk, (b) selectivity of the accumulated compounds depending on the material used and (c) control of analyte uptake. A large variety of membranes were tested by different authors [7].

Kingston et al. [8], tested 10 different membranes [polyethersulfone (PES), polyvinylidenefuoride (PVDF), Poly Carbonate (PC), PolyTetraFluoroEthylene (PTFE), glass fiber, cellulose dialysis, 3 types of polyethylene (PE) and polyvinylchloride (PVC) with a C18 disk. This work showed that PE and PVC materials were more suitable for the sampling of Poly-Chloro-Biphenyls (PCB) and Polycyclic Aromatic Hydrocarbons (PAH) whereas PES, PVDF and PC membranes were more adapted to sample pesticides. PTFE, glass fiber and cellulose dialysis sampled pesticides, PCB and PAH but with low accumulation factors.

Tran et al. [7], compared accumulation of five non-ionized pesticides with the use of two different membranes (PS and PES) and showed that PES was more suitable for all compounds except diuron. Also, they extracted the membrane and the disk separately to study the partition between compartments and observed that diuron was highly accumulated in the membrane compared to the other tested pesticides. After 6 days, the ratio of diuron accumulated in the PES membrane compared to the Empore disk was 3.3:1 whereas this ratio was in the range of 1:1.2 and 1:1.5 for four other pesticides.

The polar organic chemical integrative sampling (POCIS) were developed by Alvarez et al. in 2004 for the sampling of polar organic contaminants in the aquatic environment. In POCIS, the sorbent is contained between two membranes (most of the time polyethersulfone) sandwiched between two stainless steel support rings [9].

Semi-permeable membrane devices (SPMDs) have been used extensively for the screening and the source identification of a variety of non-polar organic contaminants [10].

SPMDs consist of a thin layer of a neutral lipid (usually trioleine) enclosed within a thin-walled, flat-lying, low-density polyethylene (LDPE) tubing. In the aquatic environment, also, SPMDs allow the measurement of not only the presence but also the bioavailability and bioconcentration potential of organic contaminants. The diffusion of the chemical compounds through the polyethylene tubing mimics the passive diffusion of bioavailable organic contaminants through biomembranes [11].

III. MATERIALS AND METHODS

The used material (polyethylene strips) for this study was previously used for enhancement the wastewater characteristics of sewage properties at effluent of the wastewater treatment plant in Egypt.

The experimental work was included two main stages. The first stage was applied for the smooth media, while the second stage was going on rough media. Both stages are targeted to determine its efficiency for improving wastewater. All the experimental works 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 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.

(a) (b)

Figure (1) Samples for smooth (a) rough (b) polyethylene strips

IV. RESULTS & DISCUSSIONS

The first stage was targeted to determine the efficiency for the smooth polyethylene strips to enhance the wastewater characteristics (BOD and TSS).

The results of using smooth polyethylene strips for reducing the BOD concentration at the effluent for the wastewater are shown in table (1) and figure (2).

Table (1) BOD concentration at the plant entrance, effluent and after the smooth media

Sample NO.	BOD at the Entrance of WWTP (mg/l)	BOD at the Effluent of WWTP (mg/l)	BOD after smooth media (mg/l)
1	198	111	108
2	207	122	110
3	186	93	90
4	201	113	111
5	186	102	100
6	201	116	105
7	180	86	84
8	207	119	110
9	240	125	111
10	192	111	106
11	186	90	86
12	219	110	105
13	240	111	104
14	246	118	111
15	216	119	113
16	192	102	95
17	204	107	100
18	224	97	95
19	220	105	102
20	255	145	141
21	228	117	108
22	237	114	110
23	252	134	126
25	228	141	134
27	195	105	100
28	219	105	103
29	204	120	114
30	195	90	90
31	174	104	99
32	162	101	96
33	226	96	91
34	220	105	103
35	225	132	125
36	186	102	96

Sample NO.	BOD at the Entrance of WWTP (mg/l)	BOD at the Effluent of WWTP (mg/l)	BOD after smooth media (mg/l)
37	198	113	106
38	180	104	97
39	200	92	87
40	200	102	98
41	220	104	100
42	210	99	97
43	218	94	90
44	175	86	84
45	197	111	94
46	210	97	96
47	216	118	115
48	195	110	106
49	228	107	102
50	204	106	105
51	240	111	108
52	228	118	111
53	231	106	102
54	218	110	109
55	225	115	110
56	223	112	110

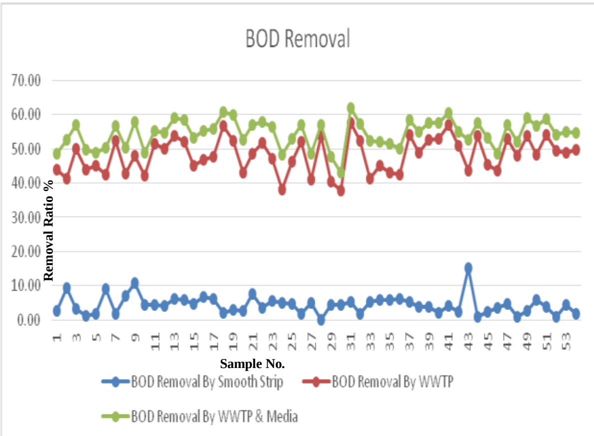

Figure (2) BOD Removal Ratio for smooth media in %

Table (1) & figure (2) illustrate that smooth polyethylene media has efficiency to remove the BOD from the wastewater with average removal ratio of 4.45%, the removal ratio of media for BOD was increasing at the first few days then the removal was decreased, which presented that the media capable to remove BOD until it reached the saturation state, after that part of the collected 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 (2) TSS concentration at the Plant entrance, effluent and after the smooth media

Sample NO.	TSS at the Entrance of WWTP (mg/l)	TSS at the Effluent of WWTP (mg/l)	TSS after smooth media (mg/l)
1	208	77	70
2	216	78	76
3	220	76	72
4	204	62	60
5	224	82	80
6	272	58	52
7	236	64	61
8	220	60	56
9	392	104	91
10	280	80	73
11	324	70	66
12	276	90	85
13	226	98	95
14	212	84	80
15	208	59	53
16	214	82	79
17	244	92	90
18	228	89	85
19	235	81	79
20	228	77	76
21	218	92	87
22	256	82	79
23	250	90	86
25	177	80	77
27	202	78	75
28	240	89	86
29	235	85	82
30	226	87	85
31	248	88	85
32	264	82	77
33	380	90	86
34	271	94	92
35	222	70	70
36	233	76	71
37	217	62	60
38	216	86	83
39	229	86	80
40	214	77	74
41	212	74	70
42	242	86	86

Sample NO.	TSS at the Entrance of WWTP (mg/l)	TSS at the Effluent of WWTP (mg/l)	TSS after smooth media (mg/l)
43	231	82	79
44	230	79	74
45	225	86	81
46	229	82	78
47	240	79	77
48	240	89	87
49	278	78	75
50	222	82	80
51	260	77	77
52	240	81	77
53	224	78	76
54	224	82	80
55	268	79	76
56	280	91	88

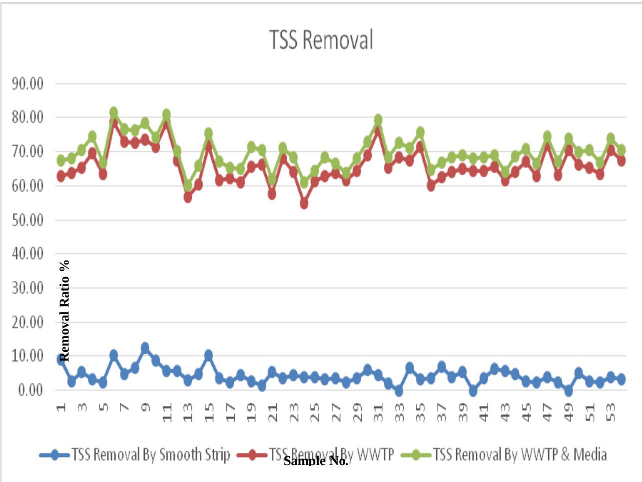

Figure (3) TSS Removal Ratio for smooth media %

Table (2) and figure (3) show that the media able to decrease the concentration of the TSS by average removal ratio 4.33%, 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.

On the other side, the second stage was aimed to identify the capability for the rough polyethylene strips to reduce concentration of pollutants at the wastewater (BOD and TSS).

The results of using rough polyethylene strips for reducing the BOD concentration at the effluent for the wastewater are shown in table (3) and figure (4).

Table (3) BOD concentration at the plant entrance, effluent and after the smooth media

Sample NO.	BOD at the Entrance of WWTP (mg/l)	BOD at the Effluent of WWTP (mg/l)	BOD after rough media (mg/l)
1	198	110	92
2	219	105	96
3	210	116	116
4	261	135	83
5	237	111	83
6	249	138	138
7	234	107	89
8	228	107	97
9	203	102	95
10	192	93	93
11	183	87	74
12	231	126	102
13	186	83	73
14	246	93	84
15	270	159	123
16	195	132	128
17	198	93	85
18	252	152	144
19	222	132	124
20	264	114	102
21	260	117	104
22	198	111	103
23	141	85	73
25	212	111	107
27	210	110	100
28	198	111	107
29	190	91	91
30	231	117	104
31	181	91	83
32	181	85	65
33	216	99	67
34	216	116	97
35	216	114	102
36	219	108	87
37	180	83	59
38	160	85	65
39	176	92	68
40	186	116	98
41	174	96	72
42	192	114	82

Sample NO.	BOD at the Entrance of WWTP (mg/l)	BOD at the Effluent of WWTP (mg/l)	BOD after rough media (mg/l)
43	228	104	89
44	198	117	92
45	204	122	102
46	264	156	132
47	285	156	132
48	264	120	83
49	231	133	117
50	210	123	107
51	204	114	114

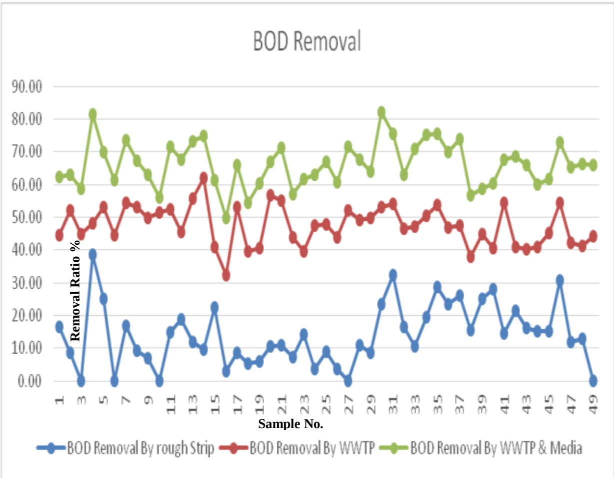

Figure (4) BOD Removal Ratio for rough media in %

Table (3) & figure (4) presented that smooth polyethylene media has capability to reduce the concentration of BOD from the wastewater with average removal ratio of 14.10% using one line of the media, the removal ratio of media for BOD varied from 0.00 to 38.52%, 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 (4) TSS concentration at the Plant entrance, effluent and after the rough media

Sample NO.	TSS at the Entrance of WWTP (mg/l)	TSS at the Effluent of WWTP (mg/l)	TSS after rough media (mg/l)
1	262	94	94
2	368	83	74
3	242	82	55
4	400	95	82
5	288	73	63
6	220	49	37
7	246	48	42
8	202	64	60
9	258	81	81
10	258	86	74
11	232	93	75
12	166	62	55
13	230	82	73
14	286	70	70
15	202	56	52
16	200	71	55
17	210	58	49
18	190	72	60
19	218	66	66
20	254	84	72
21	239	91	79
22	202	78	72
23	136	80	71
25	188	80	77
27	218	82	76
28	280	105	90
29	274	74	74
30	284	93	83
31	222	90	84
32	226	70	55
33	280	80	47
34	282	96	81
35	242	87	84
36	244	73	63
37	254	82	55
38	216	77	59
39	204	79	69
40	226	86	68
41	216	63	54
42	220	53.8	53.8
43	222	82	67
44	220	85	76
45	224	70	61
46	144	77	64
47	244	81	66
48	270	77	65
49	260	63	54

Sample NO.	TSS at the Entrance of WWTP (mg/l)	TSS at the Effluent of WWTP (mg/l)	TSS after rough media (mg/l)
50	344	86	71
51	264	98	88

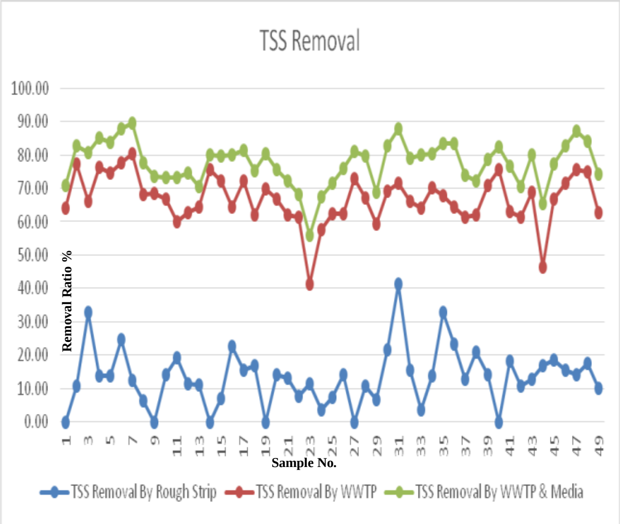

Figure (5) TSS Removal Ratio %

Table (4) and figure (5) show that the average removal ration for the rough media for total suspended solid range from 0.00 to 41.25% with average 13.37%, where when the removal ratio reached 0.00 % 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 compeer between the efficiency for smooth and rough media to enhance the effluent of the wastewater which was placed at the existing channel at the effluent for the wastewater treatment plant, and it was concluded the following:

1. The rough polyethylene media capable to form biofilm layers above its surface better than the smooth polyethylene media.
2. The rough and smooth polyethylene media has the capability for reducing the BOD concentration with average removal ratio 4.45 and 14.10 % respectively.
3. The rough polyethylene media able to collect high concentration of the suspended solids on its surface rather than the smooth polyethylene media.
4. The rough and smooth polyethylene media has the capability for reducing the TSS concentration with average removal ratio 4.33 and 13.37 % respectively.

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