Treatment of Sewer Water Using Alum Salt

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Abstract

This investigation was carried out to study the effect of addition of different concentrations of alum salt used in the treatment of sewer water of the pond and also to study the physico-chemical parameters such as pH ,electrical conductivity ,salinity and total sediments besides that the bacteriological analysis such as total viable count (TVC) or standard plate count (SPC) and total coliform count (MPN) content were analysed in the water sample collected from the pond estimation of viable bacteria (CFU) of the pond water ,the pond located nearby to the Faculty of Education, Ataq city, Shabwa, Yemen. Addition of 6 different concentrations to the water sample were studied and compared with tap water from the area itself .The results were obtained showing the significance of alum concentration in treatment of pond water.

Keywords: alum; water treatment; sewer water; pond water.

1. **Introduction**

 The Arab region suffers from water scarcity, while a population of Arab countries comprise (4%) of the world's population, these countries possess only not more than (1.4%) of the water resources in the world. Indeed, three-quarters of the Arab region is a barren land, which makes it the most arid region of the world.

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Therefore, most Arab countries suffer from a shortage of water resources, increasing demand for water resulting from the increase in population and the growing requirements of economic and social development and also as result of limited opportunities for traditional water resources development and decreased quantity and quality degradation [1].

The volume of available water resources in the Republic of Yemen is about 2.5 million m^3 hence the annual shortage is 0.7 billion m^3 [2]. The Water sector in Yemen has faced tremendous challenges during the past three decades, due to the high population growth , particularly in urban and rural areas which resulted in increase of demand on water resources and created a huge additional demand on infrastructure in the water and sanitation, which increased the problems facing the water sector. There is another factor that increases the severity of the problem, the lack of a unified approach in the management of water resources.

 Gray water (all waste water other than toilet water) can be considered as one the important water resources and can be re-used after treatment such as sewer water from kitchens, laundries, bathrooms ,and washing basin Gray water are characterized by high concentration of nitrogen, phosphorus, organic matters, dissolved solids, suspended oil, grease and detergents, also contains high numbers of bacteria resistance to heat, which cannot be re-used without treatment. Increasing quantities of sewage resulting in the environmental pollution , so they should be collected, processed and re-used. This will provide an additional water resource to reduce the deficiency in water, and to achieve the safe disposal of sewage pollutants which harmed to the environment. The management of water treatment did not pay attention in Yemen where nearly 80% of the population living in rural areas. However the ancient Yemen knew how to manage and solve their problems, while in recent decades, although the increasing demand for water, the management and treatment of contaminated water do not have enough care , especially in rural areas, whether by the local communities or the governments. However, the environmental sanitation services never exceed 19% in rural areas [2].

The absence of sanitation projects usually lead people to decide how to dispose their drainage water according to its potential and the degree of consciousness to discharge wastewater into any medium, which sometimes causes many problems such as the spread of serious disease among the population and pollution of water and soil [3]. Most of Shabwa families having their own septic tanks, in their cities and villages. The absence of water treatment systems create the necessities to apply a simple treatment techniques which help families to exploit wastewater, especially gray water which have low risk to health. However, most treatment systems for water sanitation in Yemen is a sedimentation basin and are concentrated in large cities such as Sana'a, Aden, Taiz, Dhamar, Hodeidah, with no sedimentation basins in Shabwa governorate for sewage treatment [4].

 Owing to the high proportion of the population in rural areas and small communities, the sewage treatment through simple, affordable methods should be taken into consideration. In this regard, a number of methods of treating water according to various factors such as volume of water, the nature and purpose of the treatment, the most important treatment methods that do not require large construction requirements are filtration, leaching and precipitation methods [5]. Gray water has been the subject of research and applied by many researches in many countries. Alum has been used since ancient times to leach the loose material in drinking water as well as in wastewater [6], domestic water [7], freshwater lakes and floods [8].

The present work aims to study the effect of alum treatment of sewer water of the pond , and physicochemical properties of the treated water.

2. Experimental Procedures

2.1 Materials and Apparatus

All chemical used were AnalaR grade and used without further purification. pH meter (inoLab pH 720) of Taierh Bmhalel Organization, The inoLab cond.720 device to measure Electrical conductivity and salinity properties.

2.2 Methods

Sewer water samples were collected from the pond of sewer water located near to the college of Education (Shabwa) at depths of 10, 80, 150 cm with 20 liters each. Samples were mixed well for homogeneity and taken into a transparent plastic bottles and labeled. A six different concentrations of fine powdered – alum salt were added to the bottles containing the sewer water   as : (0.00, 0.20, 0.40, 0.60, 0.80, 1.00) g/l, in addition to that,alum salt were added to the tap water. Bottles were shaken well after alum addition, to ensure complete dissolving of alum salt, then bottles were kept aside for 24 hours(Duplicate experiments were carried out for each concentration) to achieve a folc formation and sedimentation and subjected to the following tests:

- pH was measured using pH meter (inoLab pH 720) of Taierh Bmhalel Organization, calibrated using two pH points, 7.0 and 10.0 [5].
- Electrical conductivity and salinity were measured using inoLab cond.720 device. The device was calibrated using KCl standard solution [5].
- Total sediments: The supernatant of each sample (bottle) was carefully eliminated, then the remaining bottom sediments were transferred into beaker. Bottles were washed with distilled water to ensure better collection of most sediments, and then were first dried using water bath at 70 ^{0}C to get rid of most water, and latter transferred to the oven at 105 ^{0}C, until constant weight [9,10].
- Bacterial colony forming unit per milliliter (CFU mL^{-1}): The CFU mL^{-1} of each unfiltered sample of sewer water was measured under sterile conditions using blood agar media, Bacterial colonies were manually counted in 3 dishes (replicates) per treatment [5, 11].
- Results were analyzed statistically using the statistical analysis program [12]. A comparisons of means were done were conducted using the least significant difference test (LSD) at probability of 5% [13]. Differences between means were estimated as percentages in times in comparison to the untreated sewer water.

3. Results and discussion

3.1 Effect of alum on pH

Table -1 shows that the pH was decreased significantly with the increase of alum concentration from 7.83 at the lowest concentration (0.2 g/L) to 6.79 at the highest concentration of alum (1.0 g/L). The decrease ranging between

10-22%, respectively, compared to untreated sewer water (8.72). The results also revealed a significant decrease in the pH of tap water (8.10) compared to untreated sewer water with difference around 7.0%.

% change in pH = [(observed value of the treated sample – value of untreated one) / value of untreated one] x 100   (1)

Table 1 Effect of alum treatment on pH, Electrical Conductivity (EC) and Salinity of sewer water

Alum (g/l)	pH	% change in pH	Electrical Conductivity (EC)	% change in EC	Salinity (%)	% change in Salinity
0.0	8.72	0.0	2.11	0.0	0.90	0.0
0.2	7.83	-10	2.23	+06	1.00	+11
0.4	7.76	-11	2.29	+09	1.00	+11
0.6	7.50	-14	2.32	+12	1.10	+22
0.8	7.06	-19	2.39	+14	1.10	+22
1.0	6.79	-22	2.40	+14	1.10	+22
TW	8.10	-07	1.96	-07	0.80	-11
LSD (0.05)	0.197	-	0.009	-	0.115	-

The results showed that the pH of the tap water in the area which supplied by the City's drinking water system was moderately (8.10). Sewer water pH was higher by 0.61 units compared to drinking water as given the table - 1. The pH increases of sewer water may be due to the dust and other pollutants . Alum treatment showed a gradual decrease in pH as given in figure-1, these findings are consistent with the overall studies and research on the impact of the use of alum salt in water and wastewater treatment. It was found that the treatment of polluted lake water resulting from the flow of rainwater and floods lead to reduce the pH of the water (10.0). Other studies [9, 14, 15], revealed the possibility of avoiding any adverse effect on plants and aquatic life by the use of alum salt in the treatment of contaminated water as long as the pH value higher than six.
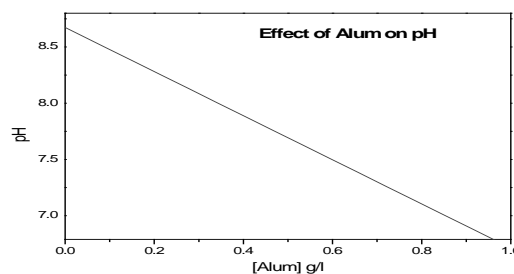

Figure -1,The effect of pH on Alum concentration

3.2 Effect of alum on electrical conductivity

Table-1" shows that the conductivity of sewer water was significantly increased from 2.23 up to 2.40 mScm^{-1} with the increase of alum concentration from 0.2 up to 1.0 g/L with the increase ranging from 6-14%, respectively, comparing to untreated sewer water (2.11 mScm^{-1}). There were no significant differences in the degree of conductivity between 0.8 to 1.0 g/L alum concentrations.

% change in electrical conductivity = [(observed value of the treated sample – value of untreated one) / value of untreated one] x 100   (2)

The results also revealed that the electrical conductivity of sewer water was higher than tap water (1.96 mScm^{-1}). Collectively, alum treatment of sewer water resulting an increase of the electrical conductivity as shown in figure-2, this may due to the dissociation of alum in water to produce ions which raise the electrical conductivity of sewer water [5,16].
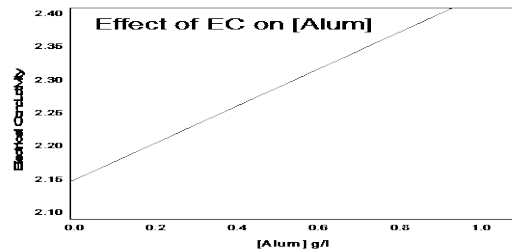

Figure -2, The Effect of Electrical Conductivity on Alum Concentration

3.3 Effect of alum on salinity

The results shown in "Table 1" reveals that the salinity was significantly increased only with high alum concentration (0.6,0.8,1.0,g/*l*),where salinity reached 1.1% and increased by 22% at all above concentration compared with untreated sewer water (0.9).The results showed no significant difference in the salinity of sewer water compared with tap water .The increased salinity in sewer water treatments referred to the fact that aluminium sulphate is the salt, which is in agreement with most of the previous work results that use the alum salt for treating polluted water [5, 17,18].

% change in salinity = [(observed value of the treated sample – value of untreated one) / value of untreated one] x
        100   (3)

3.4 Bacterial colony forming unit per milliliter(CPF ml^{-1})

As shown in table 2 alum treatment significantly decreased CFU ml^{-1} in sewer water from 4.63 x 10^4 to 6.28 x 10^3 at concentration of alum ranged between 0.4-1.0 g/*l* , and differed by 68-96% respectively ,compared with CFU ml^{-1} in untreated sewer water (1.43 x 10^3) . The results did not show any significant affect at the lowest alum

concentration (0.2g/l). The results also showed that the CFU ml^{-1} of sewer water was significantly high compared to tap water (0.043 x 10^2) with difference reached more than 99.99% .These results are in consistent with findings of other studies [17,18,19,20].

Table 2Effect of alum treatment on Total sediment and bacteria colony forming units CPF ml^{-1}

Alum (g/l)	Total Sediments	Number of times (- or +)	CFU m^{-1}	%
0.0	0.02	0.0	1.43 x 10^3	0.00
0.2	0.11	+5.0	1.00 x 10^3	30.00
0.4	0.15	+7.5	4.63 x 10^4	68.00
0.6	0.16	+8.0	2.29 x 10^4	84.00
0.8	0.21	+10.5	1.16 x 10^4	92.00
1.0	0.25	+13.0	6.28 x 10^3	96.00
TW	0.01	-0.50	0.043 x 10^2	99.99
LSD (0.05)	0.019	-	0.009	-

3.5 Effect of alum on total sediments

The results in "Table 2" shows that the alum treatment caused a significant increase in the sediments from 0.10 up to 0.25 g/*l* when sewer water treated with 0.2 -1.0 g/*l* an estimated increase between 5 to 13 times higher than that of 4.63x10^4 to 6.28x10^3 at concentration of alum ranged between 0.4-1.0 g/*l* ,and differed by 68-96% respectively, compared with untreated sewer water (0.02 g/*l*) .The results also showed no significant difference in the concentration of the solids deposited from untreated sewer water compared with tap water (0.01 g/*l*). These results indicating the effectiveness of alum treatment to settle down the suspended materials from sewer water which are in consistent with most studies used alum as water clarifier [3,17,18,20].

4. Conclusion

The study showed a clear effectiveness of using alum in the removal of suspended solids and bacteria from sewer water according to the concentrations used, and hence can be used to treat sewer water before using it for plant irrigation or for any other purposes, taking into account the maintenance of pH higher than 7.0 to avoid toxicity of

aluminum ions, because it is usually soluble in acidic medium, and to prevent the high salinity, which affect the specification of treated water.

We recommend researchers to develop research concerning water treatment of sewer water or other gray water resources through the use of other materials from the local environment to use it with alum to increase the effectiveness of water treatment and to reduce the use of alum salt to the possibility of minimum concentrations.

Acknowledgement

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