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Provision of Safe Drinking Water for Armours Colony – Nowshera Pakistan

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Abstract

Different water samples from the various water sources of Armour Colony Nowshera District were collected at regular interval for a period of 4-6 months. The samples were analyzed by using standard laboratory techniques as per available standards. The main objectives of the study were to investigate the water quality of the area and to determine the optimum coagulant dosage for the removal of excessive microbial contamination. The results obtained from the tests indicate that the water quality in most parts of the subject area is polluted in one way or the other. The main pollution identified is high turbid microbial contaminated water. The lime, alum and magnesium sulfates were used a coagulant dosage during this study. The optimum turbidity and microbial contamination by using lime dosage of 16mg/L were observed as 9.50% and 10%, respectively. The total estimated cost of lime required per day for the water treatment flowing at the rate of 5.0GPD was calculated to be 0.42USD.

Keywords

Drinking Water, Microbial Contamination, Coagulants, Dosage

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1. Introduction

Water is a basic element of life. But in most of the countries in the third world this basic necessity is not available in potable form. According to an estimate more than one thousand million people in this whole world do not have an access to clean drinking water [1,2,]. Out of total deprived off people from clean drinking water throughout the world, 50 to 80 percent alone live in just only five countries, which are India, China, Indonesia, Pakistan and Nigeria. In Pakistan, according to United Nations' statistical data, 40 percent of people do not have an access to clean water. In Pakistan 80 percent of deaths of children with the ages less than 5 years die of diarrhea, pneumonia and nutritional deficiency [4].

There are two main sources of water in Pakistan. These sources are groundwater, and fresh surface water in lakes and rivers. Groundwater is generally obtained with the help of pumps and wells. Earlier it was thought to be the safest source of drinking water. But the investigations have revealed that even groundwater is no more a reliable source of clean drinking water, and its quality varies specially [5].

Surface water may also be used for drinking purposes. The most probable source of contamination in this case is the disposal of domestic and industrial waste directly into the rivers or other water bodies without any treatment. It is also in practice that rain water or river water is stored in the lakes and then after treatment it is supplied for public use [6,7]. This method is a boiler option to obtain good quality of water. It is most often referred for well-developed communities. But water supplied in this manner may also get polluted due to the inefficiency of the treatment plant or because of the mixing of the sewage with water supply lines due to the leakage in the distribution network. Thus the drinking water provider must ensure that the drinking water supplied is safe for human consumption [8]. In fact, the primary reason for the development and installation of a public water system is the

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protection of public health. Basically, a properly operated water system serves as a line of defense between disease and the public. Properly operated water treatment and supply systems arc those that remove or inactivate pathogenic microorganisms including bacteria, viruses and protozoan, reduce or remove chemicals that can be detrimental to human health, and produce good quality water [9,10].

So, it is the basic need of hour that the water treatment facilities must ensure that water delivered to the public is properly treated and arrives as clean, wholesome and as safe a product that it should be. Since, the water resources of the subject area, i.e., Armour Colony Nowshera, KPK, are highly turbidity and microbial contaminated, therefore, this study was design to investigate water quality of the area, and to investigate the cost-effective water treatment option for the pollutants identified.

2. Material and Methodology

Various water samples were collected from the Armour Colony, Nowshera District were collected for a period of 4-6 months, at regular interval. The samples were analyzed by using standard laboratory techniques as per AWWA (American Water Works Association) [11]. Namely three coagulants, i.e. lime, alum and magnesium sulfates were tested to remove the microbial contamination.

3. Results and Discussion

The results obtained from the physical, chemical and biological analysis of water samples obtained from various sources are shown below in Table 1-3. The results obtained from the tests indicate that the water quality in most parts of the subject area is polluted in one way or the other. The main pollution identified is in terms of microbial and turbidity. To determine the optimum and feasible treatability solution for the water treatment, synthetic samples were made containing the subject pollutants, namely, arsenic, nitrates, fluoride and maximum turbidity for the microbial pollution were added. These samples were than tested first by making trials on plain sedimentation and than by adding various types of coagulants like during the Jar Test to find an optimum treatability solution for them. Namely the coagulants used were, alum, lime and magnesium sulfate. Since, the water samples from various locations were highly polluted, didn't meet the criteria of the WHO drinking water parameters standards, therefore, in the first attempt the synthetic water sample was tried in a model sedimentation tank of about 10cft. At regular interval of time 20min, 40min, 60min…..and 220min, the percentage removal of microbial contamination and turbidity were observed and the data obtained is shown in the Figure 1.0.

The minimum turbidity and microbial contamination of 4% and 11% were observed at hydraulic retention time of 20min in a plain sedimentation basin, whereas at hydraulic retention time of 220min the maximum turbidity and microbial removal were observed as 42% and 31.5%, respectively. Since, the maximum and minimum percentage removal of turbidity and microbial removal during the plain sedimentation tests trial does not meet the requirements of WHO drinking water quality standards, and at 220min of hydraulic retention time the design of sedimentation tanks become totally uneconomical, therefore, it requires advanced or conventional treatment using some coagulants to bring down these various pollutants to the desired standard. In order to determine the optimum dosage of alum coagulant, varying dosages ranging from 10mg/L to 220mg/L were tested to check their treatability performance against turbidity and microbial contamination removal as shown in the Figure 2.0. The minimum turbidity removal efficiency 8% and microbial removal efficiency of 8.2% were observed by using an alum dosage of 10mg/L. Whereas, the maximum turbidity removal efficiency 19.5% with a coagulant dosage of 100mg/L, and that of microbial removal efficiency of 20% were observed by using an alum dosage of 220mg/L. The optimum turbidity and microbial contamination by using an alum dosage of 120mg/L were observed as 18.60% and 17.20%, respectively.

In order to determine the optimum dosage of lime coagulant, varying dosages ranging from 2.0mg/L to 24.0mg/L were tested to check their treatability performance against turbidity and microbial contamination removal as shown in the Figure 3.0. The minimum turbidity removal efficiency 5.0% and microbial removal efficiency of 4.0% were observed by using lime dosage of 2.0mg/L. Whereas, the maximum turbidity removal efficiency 10.20% and microbial removal efficiency of 21.20% were observed by using a lime dosage of 14mg/L and 24mg/L, respectively. The optimum turbidity and microbial contamination by using a lime dosage of 16mg/L were observed as 9.50% and 16%, respectively.

The optimum dosage of magnesium sulfate coagulant, varying dosages ranging from 3.0mg/L to 36mg/L were tested to check their treatability performance against turbidity and microbial contamination removal as shown in the Figure 4.0. The minimum turbidity removal efficiency 3.2% and microbial removal efficiency of 19% were observed by using a magnesium sulfate dosage of 3.0mg/L. Whereas, the maximum turbidity removal efficiency 6.4% and microbial removal efficiency of 30% were observed by using a magnesium sulfate dosage of 27mg/L. The optimum turbidity and microbial contamination by using a magnesium sulfate dosage of 24mg/L were observed as 6.3% and 28.6%, respectively. Selection of coagulant on the basis of cost comparison was carried out. Since, the optimum dosage

determine by the Jar Test for alum, lime and magnesium is 120mg/L, 16mg/L and 24mg/L, respectively. To select the cost effective coagulant the following analysis was carried out for the water flowing at the rate of 5.0GPD (assumption). The detail cost analyses are given in Table 4.0. From the cost and treatability analysis, lime is determined as the most effective coagulant for the treatability performance of polluted water containing turbidity and microbial contamination. The total cost required per day for the optimum treatability of water quality is determined as 0.42USD.

Table 1. Water Quality Analysis of The Ground Source.

Ser#	Parameter	Unit	Result	WHO	Remarks
1	pH	-	7.8	6.5-8.5	Within the limits
2	Temperature	ºC	18	--	--
3	Turbidity	NTU	6.5	5	Beyond the limits
4	Arsenic	Ppb	10	10	Critical value
5	Fluoride	mg/L	1.2	1.5	Within the limits
6	Nitrates	mg/L	5.8	10	Within the limits
7	Total Coilform	No/100mL	16	Nil	Beyond the limits

Table 2. Water Quality Analysis of the Surface Source.

Ser#	Parameter	Unit	Result	WHO	Remarks
1	pH	-	9.2	6.5-8.5	Beyond the limits
2	Temperature	ºC	18	--	--
3	Turbidity	NTU	21	5	Beyond the limits
4	Arsenic	Ppb	7.0	10	Within the limits
5	Fluoride	mg/L	0.6	1.5	Within the limits
6	Nitrates	mg/L	8	10	Within the limits
7	Total Coilform	No/100mL	48	Nil	Beyond the limits

Table 3. Water Quality Analysis of the Tap Source.

Ser#	Parameter	Unit	Result	WHO	Remarks
1	pH	-	7.2	6.5-8.5	Within the limits
2	Temperature	ºC	20	--	--
3	Turbidity	NTU	6.5	5	Beyond the limits
4	Arsenic	Ppb	9.0	10	Within the limits
5	Fluoride	mg/L	0.4	1.5	Within the limits
6	Nitrates	mg/L	9.2	10	Within the limits
7	Total Coilform	No/100mL	32	Nil	Beyond the limits

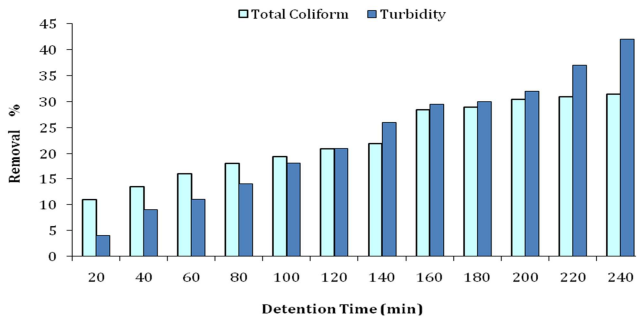

Fig. 1. Effects of sedimentation on water quality.

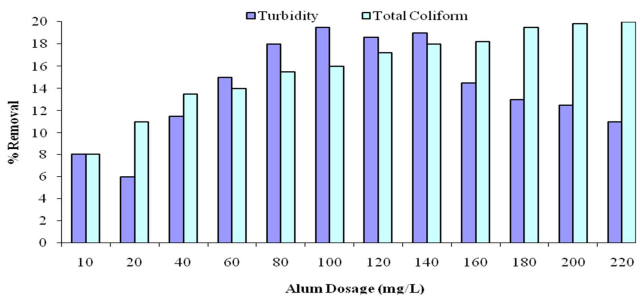

Fig. 2. Effects of alum on water quality.

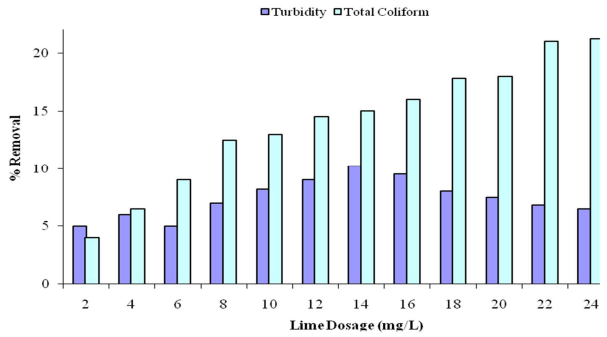

Fig. 3. Effects of lime on water quality.

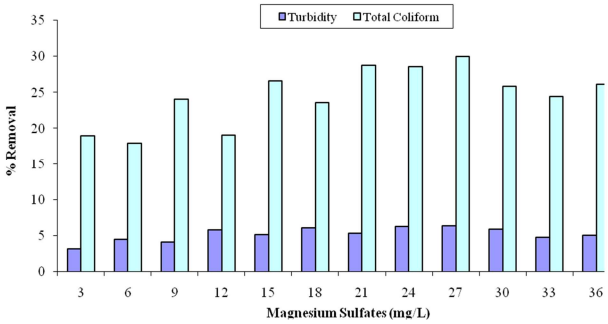

Fig. 4. Effects of magnesium sulphates on water quality.

Table 4. Selection of Optimum Coagulant Dosage.

Coagulant	Dosage (gm/day)	Unit Price (USD/gm)	Cost (USD/day)
Alum	2.27	0.5	1.13
Lime	0.30	1.4	0.42
Magnesium Sulfates	0.45	1.42	0.64

4. Conclusion and Recommendations

The following conclusions have been derived from working on the water quality samples analysis and using various coagulants;

- The water quality in most parts of the subject area is highly polluted in one way or the other, but the main pollutant is the microbial contamination.
- The maximum pollutants concentration observed in the subject area in terms of turbidity and microbial contamination is 21NTU and 48MPN/100mL, respectively.
- During discrete settling, the optimum removal of turbidity and microbial contamination corresponding to a detention time of 220min is 42% and 31.50%, respectively.
- The optimum turbidity and microbial contamination by using an lime dosage of 16mg/L were observed as 9.50% and 10%, respectively.
- Using maximum turbidity and microbial contamination removal efficiency by using the coagulants is 19.50% and 30%, respectively.
- The total cost of lime required per day for the water treatment flowing at the rate of 5.0GPD is 0.42USD.

A long-term study is required to carry out the complete water quality analysis and treatability performance of various coagulants to tackle the total submerged water resources units, which may get affected with either sewage or rainfall run-off.

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