

Treatment of Grey Water using Natural Zeolites

A. Sangeetha, M. Jamuna , N. Manoj



Abstract—Water is the inevitable source for all living things. Due to rapid development in industrialization and urbanization leads to contamination of surface water as well as groundwater which results in water scarcity. Thus grey water which is easily available can be considered as an alternate source of water. Grey water is the waste water generated from office buildings or household appliances like bathrooms, kitchens, washing machines, etc. without fecal contamination. The usage of the soap solution in bathrooms, kitchen dish washing areas and detergents used in washing areas leads to the increasing carbonates and bicarbonates of calcium and magnesium ions in grey water. The present study deals with the treatment of grey water by boiling and zeolite process for the removal of hardness. Natural zeolites are environmentally and economically acceptable hydrated alumina-silicate materials for grey water and wastewater treatment. The treated water can be used for laundry purposes, toilet flushing and gardening thereby reducing the demand for fresh water.

Keywords – Calcium ion, Grey water, Magnesium ion and Natural Zeolite

I. INTRODUCTION

Natural zeolites play a predominant role in the grey water treatment. It removes the metal ions that present in the grey water. Grey water is term used for the waste water from the households, industries. It mainly includes the waste water from bathrooms, laundries and kitchen. Though waste water contains dissolved and suspended organic and inorganic matter and odors, chemical contaminants is more dangerous. The presence of surfactants in the laundry and bathroom waste water plays a major role in causing hardness. Hardness is defined as the presence of carbonates and sulphate in the form of calcium and magnesium. It is a risk factor that affects the usage of recycled waste water. The recycled water which is used in the laundries can result in poor performance of foaming action in soap and detergent. Due to the high amount of dissolved minerals it cannot be used in irrigation. It also causes various skin diseases such as eczema which makes our skin dry. And to this water cannot be used in industrial equipment's such as cooling tower, containers and pipes, due to the formation of scalp on the surfaces and it will cause corrosion. Due to the ability of ion exchange process and adsorption, the natural zeolites producing the expected results in the hardness treatment of grey water.

Zeolites are the crystalline micro porous aluminosilicates, which allow absorbing water and other cation. Natural zeolite has a high capacity of cationic exchange through which the metal ions can be removed. It can be able to retain the particles up to 5 microns. Zeolites is of granular and powder form, here powder form zeolite is used. This paper discusses the removal of hardness using natural zeolites. And it achieves the expected results in the removal of hardness.

II. MATERIALS USED

A. Grey Water

The water from laundries and bathrooms of households is referred as grey water. It contains metal ions due the presence of surfactants which results in the usage of detergents and soaps. The presence of metal ions such as calcium and magnesium of carbonates and sulphate cause hardness of water. Grey water is has the crucial problem in discharging and treatment measures. If it is discharged to the ground or lake or the open bare land it causes various problem. It results in ground water contamination and spoiling the lands which affects in vegetation. The grey water is to be treated properly by removing all the organic and inorganic matter, odor and chemical contaminants too. The grey water to be treated is collected from our institution.

B. Sand

Sand is the excellent filtering medium which is used from ancient days. A good example is the self-purification of streaming river over the layers of sand and gravel. It traps the suspended and dissolved mater within the intercities of the pores present in it. By various mechanisms the organic and inorganic matter gets attached to the grains of sand. It removes the pathogenic microbes, colour and odour Here the crusher sand of 600 micron size is used as the filtering media. Crusher sand is an alternative to Natural River sand it suitably fits the place of river sand. Due to the scarcity of river sand it is economical to use crusher sand. It is the crushed rock sand which is the eminent source now a day's used in various purposes. The depth of sand about 30 cm is taken for this experiment. Before the experimental setup the sand is completely washed to remove the dust particles and the colour.

C. Natural Zeolites

Natural zeolite is the hydrated aluminosilicates complex. It is found only in fissures of volcanic rock. It is has good potential in removing the hardness of waste water. It mainly contains SiO_4 , AlO_4 and oxygen. It is a three dimensional crystalline structure which is connected by oxygen. It has good adsorption and ion exchange properties. Due to its less pore size than sand it involves in effective removal of metal ions. It is also referred to as molecular sieve.

Manuscript published on 30 October 2019.

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Treatment of Grey Water Using Natural Zeolites

Cation and anion is the important property of zeolite in the waste water treatment. The efficiency of treatment using natural zeolite depends on initial concentration of metal ions, the pH and the amount of water should be purified. The natural zeolite powder employed here by varying the depth to increase the efficiency of removal of metal ions.

III. EXPERIMENTAL SETUP & PROCEDURE

In this project the setup for the experiment is adopted in an economical way. The easily available materials are used for the setup. The setup is made in a small prototype model. A packed drinking can is used in the model setup. The can after the usage is taken and cut at the top and small holes are put at the bottom. The layer of sand is filled up to the depth of 30 cm and it is slightly compacted. And to that a layer of zeolite is filled. The depth is varied for the series of time and the water is collected. For the first 1 hour the zeolite depth is about 1 cm and second 1 hour the zeolite depth is about 2 cm and for the third 1 hour the zeolite depth is about 3 cm and so on. The arrangement is made for collecting the treated water at the bottom of the can. Batch process is adopted for this experiment.

- To treat the grey water collected, the prototype model is made using available materials. Batch process is adopted because of the small quantity of treatment.
- In the first instance the sand is filled up to a depth of 30 cm, and spread out uniformly.
- And the layer of zeolite is filled up for 1 cm depth for the first one hour.
- The grey water is poured from the top, the water thus poured passed through the layer of zeolite and sand and it is collected at the bottom.
- The sample is allowed to stand for 12 hours.
- As a result, the zeolite powder reacts with the grey water, by adsorption and exchanging the metal ions present in it and by removing the hardness.
- After 24 hours, the treated water is collected at the bottom. The water is then tested for hardness using volumetric analysis. And the reading is noted.
- The above procedure was done by varying the depth of zeolite bed like 1 cm, 2cm up to 5 cm at different time intervals.
- Then the treated water is collected and undergone hardness test. And the reading is noted.
- The step is then repeated for three consecutive depth 3 cm, 4 cm, 5 cm. And the reading is noted.
- And the collected water undergoes hardness test and the reading is noted.
- Finally the values are compared to the hardness level of raw water. And the efficiency is calculated.

A. Characteristics of Grey water

The grey water characteristics referred to as various parameters such as pH, turbidity, hardness, chlorides, sulphates, alkalinity and ammonia nitrogen, BOD, COD and TSS etc. These characteristics vary from place to place according to the usage depending upon the standards of living and food habits. For this research the grey water from the institution is taken. The parameters are analyzed in the lab scale, and the values are given below.

TABLE I
CHARACTERISTICS OF GREY WATER BEFORE AND AFTER TREATMENT

Parameters	Before Treatment	Drinking water standards (IS 10500:2012)	
		Desirable limit	Permissible limit
pH	7.11	6.5 – 8.5	No relaxation
Hardness	1160 mg/l	300	600
Chloride	507.65 mg/l	250	1000
Sulphate	907.2 mg/l	200	400
Alkalinity	495 mg/l	200	600
Solids	1000mg/l	500	2000
Ammonia nitrogen	25 mg/l	50	-
Turbidity	127.5 NTU	5	10
BOD	220 mg/l	350	-
COD	170 mg/l	250	-

IV. RESULTS AND DISCUSSIONS

The treated water (Fig 4 to 8) is collected and hardness is tested and compared with the raw water results.

TABLE II
CHARACTERISTICS AT THE END OF 12HOURS

Parameters	Raw water	Treated grey water				
		For 1 cm depth	For 2 cm depth	For 3 cm depth	For 4 cm depth	For 5 cm depth
Total hardness	1160 mg/l	990 mg/l	900 mg/l	820 mg/l	730 mg/l	675 mg/l
Permanent hardness	640 mg/l	520 mg/l	460 mg/l	420 mg/l	380 mg/l	350 mg/l
Temporary hardness	520 mg/l	470 mg/l	440 mg/l	400 mg/l	350 mg/l	325 mg/l

TABLE III
CHARACTERISTICS AT THE END OF 14HOURS

Parameters	Raw water	Treated grey water				
		For 1 cm depth	For 2 cm depth	For 3 cm depth	For 4 cm depth	For 5 cm depth
Total hardness	1160 mg/l	962 mg/l	870 mg/l	770 mg/l	684 mg/l	620 mg/l

Permanent hardness	640 mg/l	512 mg/l	440 mg/l	390 mg/l	357 mg/l	320 mg/l
Temporary hardness	520 mg/l	450 mg/l	430 mg/l	380 mg/l	327 mg/l	300 mg/l

TABLE IV
CHARACTERISTICS AT THE END OF 16 HOURS

Parameters	Raw water	Treated grey water				
		For 1 cm depth	For 2 cm depth	For 3 cm depth	For 4 cm depth	For 5 cm depth
Total hardness	1160 mg/l	910 mg/l	820 mg/l	730 mg/l	630 mg/l	575 mg/l
Permanent hardness	640 mg/l	489 mg/l	420 mg/l	400 mg/l	350 mg/l	305 mg/l
Temporary hardness	520 mg/l	421 mg/l	400 mg/l	330 mg/l	280 mg/l	270 mg/l



Fig. 5. Treated water at 5 cm depth

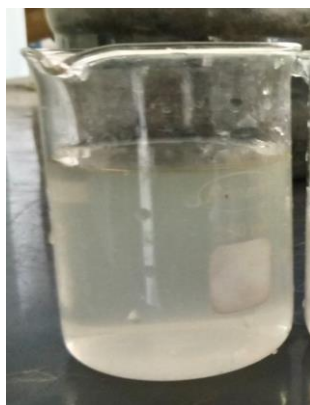


Fig. 1. Treated water at 1 cm depth



Fig. 2. Treated water at 2 cm depth



Fig. 3. Treated water at 3 cm depth



Fig. 4. Treated water at 4 cm depth

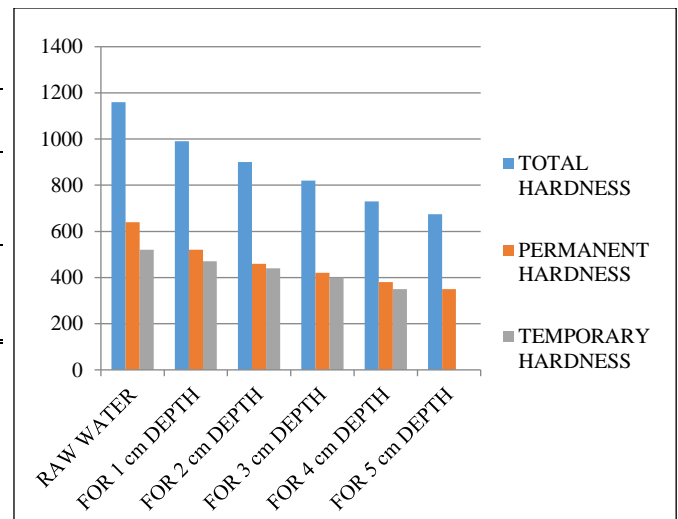


Fig. 6. Hardness at different depths of zeolites at the end of 12 hours

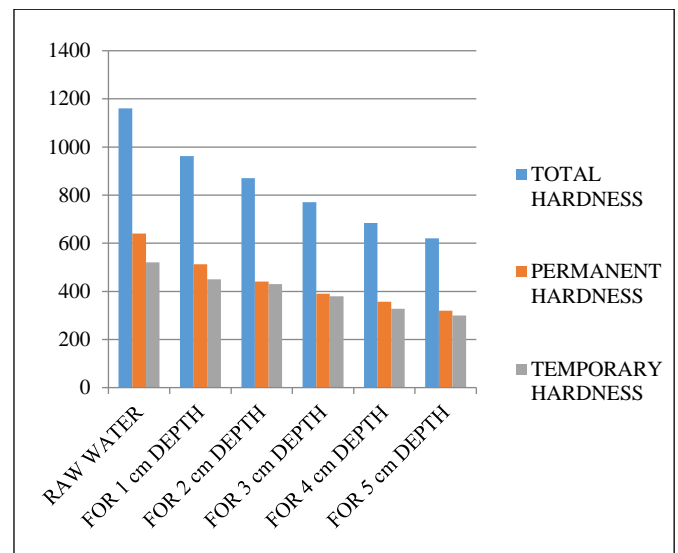


Fig. 7. Hardness at different depths of zeolites at the end of 14 hours

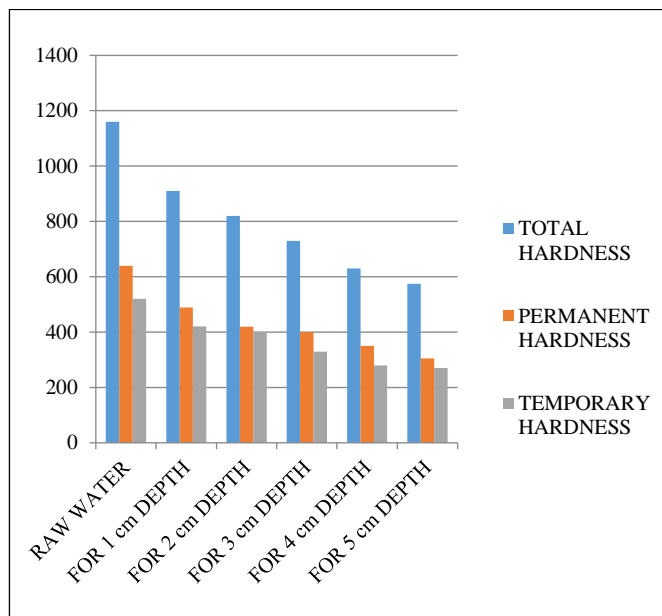


Fig. 8. Hardness at different depths of zeolites at the end of 16 hours

From the results we conclude that there is a progressive decrease in the hardness level of grey water on using natural zeolite powder. By consecutive increase in the depth of natural zeolite powder expected results are obtained. Natural zeolite powder act as a good adsorbent and it works efficiently in the removal of metal ions. Odour of the grey water is also reduced after the treatment. As it is natural available from rocks, it is easily available in market. In the same way after the treatment with zeolite powder it does not produce any harmful waste by product. So there will be no necessary for waste after treatment.

V. CONCLUSION

Natural zeolite is the new technology in the treatment of grey water. Because of its high purification and easy availability, it is very advantageous for treating the grey water. The main work of these natural zeolites is to remove the metal ion present in the grey water. Due to this the hardness is removed, hardness in the sense removal of heavy metal ions. And it produces less cautious waste after the treatment. Many researchers have found that it is more effective in the removal of heavy metals. In this laboratory scale research, found that it is effective to remove expected amount of hardness. It also removes the odour from the treated grey water and the colour changes. Further research can be done in the large scale treatment by adopting different natural zeolites. There are 40 number of natural zeolites are available. And also by modifying the structure of the natural zeolite, the research can also be progressed.

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