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ANALYSIS OF WASHING MACHINE WASTE WATER FOR PURIFICATION AND RE-USE

B. Manoj Yadav[1], P.Jyothi[2], P.V. Hari Krishna[3]

[1]Professor, Department of Civil Engineering, QIS College of Engineering, AP, India

[2]Assistant professor, Department of Civil Engineering, QIS College of Engineering, AP, India

[3]Assistant professor, Department of Civil Engineering, QIS College of Engineering, AP, India

ABSTRACT

The demand of water keeps on increasing now-a-days both for drinking as well as domestic Purposes. In most parts of India, the water supply now operates on a metering system, therefore purchasing water is now necessary for both domestic and drinking needs. In such a case, wasting those waters is highly uneconomical. People have to use the water efficiently, reduce the water wastage and re-use the water for suitable domestic purposes. According to per capita usage of water, in household, huge quantity of water is used for washing clothes through machines. In this paper, such waste water is collected and analysed, all its physical and chemical characteristics such as pH, acidity, alkalinity, chlorides, turbidity, etc., whichever is needed and a suitable method for purification of water such as boiling, filtration and/or reverse osmosis has been tried experimentally and again the values are tested. These final results are compared with the parameters of sample before purification. Finally, it will be concluded with the method suitable for purification of this wastewater and it will be checked with the standards specified, thus, making the water suitable for drinking and/or domestic purposes.

Keywords:

Washing machine waste water, Physico-chemical parameters, Purification methods, Reverse osmosis, Filtration.

I. INTRODUCTION

The demand of water keeps on increasing now-a-days both for drinking as well as domestic purposes. Earlier, people used ground water as a major source of domestic water but now the ground water levels in most of the places have gone down and scarcity of water has aroused. Rain water harvesting was considered to be the excellent method for storing the run-off water and recharging the ground water table. But monsoon keeps on failing with respect to time and quantity which leads to scarcity of rain water also.

In recent times people are forced to buy the water for drinking and domestic purpose. RO purified and UV treated waters are now in trend. 20 litres of water cost nearly 20-35₹. Reverse osmosis is considered to be the best technique for desalination of water and can be used for drinking purpose. Since the ground water source is scarce, people are forced to buy the domestic waters also. In metropolitan cities, these waters are carried through trucks and sold to residential areas. The cost of this water is nearly 100₹ for 1000 litres. In such a case, the water should be used efficiently i.e., wastage of water should be highly avoided. Moreover, re-use of the water is quite welcomed since it reduces the quantity of raw water usage.

Several researches have been conducted on the physico-chemical parameters of the water which is available from various surface sources like rivers, ponds, lakes etc [1][2][6]. Water is used for several domestic purposes like washing clothes, washing utensils and vehicles, sanitary purposes, gardening, bathing etc. In case of washing, it

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is feasible to reuse the water, since the required parameters are not needed in washing activities. People greatly use the machines to wash clothes. It uses the large quantity of water for washing, rinsing and spinning. The important things to be considered in this wastewater are, unlike other purposes, the washing of clothes with machines use a large quantity of water and the effluents can be collected. Whereas, if the water is used for purposes like gardening or washing vehicles, it cannot be collected and re-used. This paper attempts to collect the sample of waste water from washing machine and analyse all the physio-chemical parameters and try to conclude a suitable method for its purification and re-use.

2. EXPERIMENTAL PROGRAMME

2.1 Sample collection:

A sample of waste water from the washing machine has been collected. The machine is of fully automatic type; thus, the water would have been used for washing, rinsing and Spinning thus it is ascertained that it may contain all the types of contaminants. The sample is collected with the help of polythene bottles and the temperature of the sample during collection has been noted.

2.2 Laboratory analysis:

The sample collected with the required conditional parameters are taken immediately to the laboratory conditions. Initially, the sample as collected is tested for its physical and chemical characteristics like color, odor, pH, alkalinity, Chlorides, Total solids and total hardness. Then the sample has undergone various experiments like boiling, boiling with the addition of salt and filtration processes. After these experimental processes the parameters are again checked, and it is finally concluded.

3. RESULTS AND DISCUSSIONS

3.1 Testing before purification:

Initially the sample as collected from the machines are taken and without undergoing any purification methods, certain physical and chemical parameters are examined. These parameters to be tested has been chosen is based on the fact that only detergent is added for washing and so there will be content of soap and some solids alone and thus other parameters are not included in this paper [6]. Table 1 gives the test results of the sample before purification methods. Figure 1 shows the water before purification. The tests have been conducted as per the IS guidelines and the tested values are compared with the Indian standard guidelines [9] [10] and it is also referred with the WHO guidelines [7] [8]

S:NO	Parameters	Average value of results	Permissible limit (IS guidelines)
1.	Color	Grayish	Unobjectionable
2.	Odour	Detergent	Unobjectionable
3.	Temperature	25^{o}C	Unobjectionable
4.	pH	8.11	6.5 - 8.5
5.	Alkalinity	147 mg/L	200 – 600 mg/L
6.	Total Hardness	125 mg/L	200 - 600mg/L

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7.	Turbidity	175 NTU	1-5 NTU
8.	Total solids	3.00 mg/L	500– 2000 mg/L
9.	Chlorides	3.36 mg/L	250 – 1000 mg/L

Table 1 Test results of the sample before purification

3.1.1 Color:

Obviously, due to the presence of dirt, the color of the sample was looking grayish in color. It seems to be unacceptable for re-use without treatment as per psychological point of view.

3.1.2 Odor:

Since the detergent is added to wash the water with the help of machines, the sample which was collected gave the smell of the detergent. Due to this odor, this water can be used for other domestic purposes such as cleaning vehicles, cleaning houses etc. but it is unsuitable for drinking and other domestic purposes.

Fig 1 Showing image of the sample before purification

3.1.3 Temperature:

The temperature of the water sample was found out to be 25^{o}C which is suitable for drinking as well as domestic purposes.

3.1.4 pH:

The first chemical parameter checked in the laboratory was pH [9]. After calibration of the pH meter, with the help of buffer solutions, the pH of the water sample has been taken and it was found to be 8.11. As far as the acidity range is concerned, the required range of the parameter given was 6.5 to 8.5 as per IS10500:2012. Thus, it seems to be well suitable for the drinking and domestic purposes. The pH alone cannot decide the suitability of water for drinking.

3.1.5 Alkalinity:

The total alkalinity of the water sample has been determined with the help of the titration method [9]. The value was found to be 147 mg/L which is very well within the allowable limit of 200 mg/L but however up to 600 mg/L is also allowed for domestic and drinking purposes. Hence this value is considered to be suitable for the drinking and domestic

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purposes. It should be ensured that this value does not cross the allowable limit after any purification methods.

3.1.6 Total hardness:

Hardness of the water sample has been determined with the help of titration method [9]. Here the quantity of total hardness has been examined and it was found to be 125 mg\L. As per the standard specifications prescribed by the Indian standard IS10500:2012, the water should have a maximum value of 300 mg\L for drinking purposes. Thus, the value obtained in this test is well within the range hence it is acceptable for drinking and domestic purposes.

3.1.7 Turbidity:

Turbidity is one of the important physical parameters [9]. Generally, if the water is used for domestic purpose alone, it is not very important to look after the turbidity because psychologically it is accepted for domestic purpose. For drinking purpose, it is very essential to look after turbidity, since it will be harmful chemically as well as psychologically. The value of turbidity is 175 NTU, but according to drinking water specifications it should be in the range of 1 – 5 NTU. Therefore, essentially this parameter should come in range. If not, the water cannot be used for any purposes.

3.1.8 Total Solids:

As far as the wastewater from the washing machine is concerned, it is very essential to determine the total solids of the sample. The test was conducted with the help of porcelain dishes and hot air oven [9]. The initial and final weights before and after exposing to temperature has been noted and the final result is obtained. The total solids quantity was found out to be 3500 mg\L. according to specifications by IS 10500:2012 the acceptable limit is 500mg\L, however the permissible limit in case of no alternatives is 2000 mg\L. But the value obtained here is 3500 mg\L which is considered to be highly unacceptable. Hence this research should be further carried out by taking this parameter more essentially.

3.1.9 Chlorides:

This is also considered to be one of the important parameters in the water sample testing [9]. It has increased from the allowable value by 35%. Thus, it is highly unsuitable for drinking water purpose. However, this water can be used for domestic purposes as the content of chloride in water does not have much influence for the usage of domestic purposes.

3.2 Adoption of purification methods:

In the previous section, the test results for various parameters have been given. Based on the ranges of these values i.e., whether the values fall within the given specifications or not, it is required to adopt a suitable method for purification and re-use. Based upon the test results of the water sample, the following conclusions are made,

- It is obvious that, when the water is used for washing clothes, detergents are added. Firstly, it is required to remove the detergent or soap content in the water for the usage of drinking and domestic purposes.
- The color of the sample is grayish. According to IS guidelines it is not objectionable. But according to human psychology, any color other than colorless is considered as

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harmful in nature for drinking and domestic purposes. Thus, it is required to remove the color.

- The temperature of the water sample is within the range.
- The pH of the water sample is fit for domestic and drinking purposes.
- The alkalinity of the water sample falls within the allowable limit.
- The total hardness of the water sample is within the range.
- The turbidity of the water sample is heavily far away from the permissible range.
- The chloride content is also heavily far away from the permissible value.
- The major parameter to be considered here is total solids. It is around 3500 mg/L but it should be in the range of 500 mg/L, however up to 2000 mg/L is permissible. On comparing the test result of the sample with the specified standard, purification method is selected in such a way that the total solids should fall within the range.

Overall, it is now required to remove the detergent content, remove the total solids and the parameters like turbidity and chlorides should come within the range. Thus, the following steps of purification methods adopted [3][5].

3.2.1 Boiling of the sample with salt:

In order to remove the detergent content and the dissolved solids, it is required to boil the water with the addition of salt. Approximately 2 grams of salt is added in 100 ml of water and stirred well with magnetic stirrer and then boiled at a temperature of 100^{o}C for few minutes in a hot air oven. After boiling, it is observed that the content of the detergent has changed into solid form and the sample looks even dirtier. It is also observed that the moisture due to the presence of detergent has been completely removed but the content of solids has become more.

3.2.2 Sand filtration:

After the boiling test has been completed, it is observed that the level of the solids has increased a lot and the color is still appeared to be grayish. It is now important to remove the solids and there should be some change in color if possible. The best treatment for the water having more solids is sand filtration. Since the quantity of water sample to be tested is very small, a small setup of the sand filtration has made [3][5]. A cylindrical container of 10 cm diameter is filled with a layer of pebble stones (with a maximum size of 10 mm) upto the depth of 6 cm, then a layer of white sand (size-2.36 mm) up to the depth of 1 cm and a layer of white sand (size<1.18mm) up to the depth of 4 cm has been filled. Finally, the water sample, after undergoing the filtration through sand, it is made to pass through the filter paper and it is collected. The water sample after boiling has been poured from the top and finally it is collected at the bottom. Figure 2 shows the image of the water sample after boiling and sand filtration. It is observed that the color of the sample has been changed drastically from grayish to colorless, thus psychologically it will be fit for people to use the water for domestic and drinking purposes. Moreover, as far as the quantity is concerned, when 500 ml of waste water has been boiled and filtrated, it is observed that nearly 450 ml of purified water has returned. Thus, there is no loss of water greatly. Table 2 gives the test results of the water sample after undergoing boiling and sand filtration. Figure 2 shows the image of the water after above mentioned purification methods.

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3.2.3 Observation:

From the table 3, it is observed that few parameters like pH, hardness, alkalinity has increased from the original value, but these parameters fall within the range. This may be due to the addition of salt in water. Even though salt is added for purification purpose, these parameters fall within the specified range. Thus, it is well suited for the domestic purposes. Most important parameters to be considered are turbidity and total solids. Total solids have changed from 3500 mg/L to 900 mg/L. As per the Indian standards, up to 500 mg/L is good for domestic purposes, however up to 2000 mg/L is also allowed. There is drastic change in the turbidity also, changing from 175 to 3 NTU which is also acceptable. But when the content of the chloride is concerned, it is suggested not to use for the drinking purpose. Thus, after the purification methods described above, it is concluded that the water is best suited for the domestic purposes.

S:NO	Parameters	Average value of results	Permissible limit (IS guidelines)
1.	Color	Colorless	Unobjectionable
2.	Odour	Slight detergent	Unobjectionable
3.	Temperature	28^{o}C	Unobjectionable
4.	pH	8.4	6.5 - 8.5
5.	Alkalinity	420 mg/L	200 – 600 mg/L
6.	Total Hardness	375 mg/L	200 – 600mg/L
7.	Turbidity	3 NTU	1 - 5 NTU
8.	Total solids	900 mg/L	500 – 2000 mg/L
9.	Chlorides	2418 mg/L	200 – 1000 mg/L

Table 2 Test results of the sample after boiling and filtration

Fig 2 Showing image of the sample after purification

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4. CONCLUSION

This paper attempts to re-use the waste water from the washing machines for the domestic or drinking purposes. The main purpose of this paper is to purify the waste water from the washing machines within the households and re-use the water for their drinking or domestic purposes. After the observation of the water sample has been made before and after purification methods, it can now be concluded that the wastewater from the washing machines can be purified and re-used for domestic and drinking purposes. The following conclusions have been made from this research attempt.

- Since there is huge content of chloride before and after purification methods, it is not suggested to use the water for the drinking purpose. However, it will be safer to use the wastewater from the washing machines for the drinking purpose when the water undergoes boiling with salt, sand filtration and reverse osmosis. It seems to be quite uneconomical to re-use the water from the washing machines for the drinking purpose, since it involves the use of RO method.
- In order to use the water for the domestic purposes alone, the waste water should undergo boiling with salt and sand filtration. Here reverse osmosis method is not necessary hence it will be greatly economical with respect to the metering system.
- The estimation of the total cost would involve, salt, boiling and filtration processes. A small quantity of the salt is used to remove the detergent content. A separate set-up for boiling the water is not needed in the houses, since there already involves the set-up for the purpose of cooking. At last, filtration involves coarse aggregate, fine aggregate (white sand) which also does not involve huge cost. Overall it is very economical to use this process for purification of washing machine waste water.
- It is also suggested that based on these purification methods, a product can be developed and can be attached with the washing machine in such a way that the product will release the purified water and waste water separately.

REFERENCES

[1] Gupta PK. Methods in environmental analysis water soil and air. Agro Bios India. 2nd ed. 2007. p. 43-70.
[2] Mukherjee, N. R. and Christopher Samuel. Assessment of the Temporal Variations of Surface Water Bodies in and around Chennai using Landsat Imagery, Indian Journal of Science and Technology, 9 (18); pp. 1-7.
[3] N N.Basak, Environmental engineering, Tata McGraw-Hill Education, 2003, New Delhi, India.
[4] Kumar M, Puri A. A review of permissible limits of drinking water. Indian J Occup Environ Med. 2012; 16(1):40-4.
[5] K N Dugal, Elements of environmental engineering, S. Chand and company Pvt Ltd, New Delhi, India.
[6] Subba Rao N., Devadas D.J., "Fluoride incidence in groundwater in an area of peninsula India", Environment Geology, vol. 45, pp. 243–251, 2003.
[7] WHO-a, International standards for drinking water, World Health Organization, Geneva, pp. 55-79, 2004.
[8] WHO-c, Guidelines for drinking water quality, 2nd Ed., vol. 1, no. 1, 188 p., 2004.
[9] IS-3025 (parts – 4,5,7,8,11,10,16,21,23,32)., Indian Standard methods for sampling and test for water and waste water(Bureau of Indian Standards), 1959, New Delhi, India.
[10] IS-10500 (2012)., Indian Standard –drinking water specification(Bureau of Indian Standards), 2012, New Delhi, India.