Cost Effective Treatment of Well Water around Vadavathoor Dumping Yard

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***Abstract*- Kottayam Municipality is a town located in the south central part of Kerala state. It has more than fifteen thousand families as residents and a host of business and office / bank establishments and educational institutions. The solid waste generated was dumped in a yard at Vadavathoor situated in Vijayapuram Panchayat, about five kilometres from the heart of the town. Due to the unscientific waste management, the surrounding areas and the ground water is polluted due to the leachate from the yard. This paper presents the water analysis of well water around the waste dump yard at Vadavathoor. The physicochemical and biological parameters of the well water studied were pH, Turbidity, Total hardness, Acidity, Alkalinity, Chloride, Dissolved Oxygen (DO), Bio Chemical Oxygen Demand (BOD), E-coli and Chemical Oxygen Demand (COD) during different seasons. From the analysis, it was observed that the pH, Turbidity, Chloride, DO, BOD and E-coli of the collected samples did not conform to the limits set by the Indian Standards (IS) 10500, 2012 for drinking water. The quality of the well water also worsened with the onset of monsoon, mainly due to the leaching of the liquid waste generated in the yard. This made the water unfit for drinking and thus led to health issues to the residents of Vadavathoor.**

In order to improve the quality of water and to make the water fit for drinking, a cost effective, eco-friendly and simplest filter was constructed. The water quality analysis of well water before and after treatment was analysed. It is observed that after the filtration, the well water is fit for drinking as per Indian Standards. The filter could be easily constructed and can be used for daily needs by the residents of Vadavathoor once it is demonstrated.

Keywords- Solid waste, water quality, groundwater, filtration

I. INTRODUCTION

Water is an indispensable natural resource on earth. Safe drinking water is the primary need of every human and also their basic fundamental right. Fresh water has become a scarce commodity due to over exploitation and pollution of water. Groundwater is the major source of drinking water in both urban and rural areas. Groundwater is the most important source of water supply for drinking, Agriculture, Irrigation and Industrial purposes. Increasing population and necessities have led to the deterioration of surface and sub-surface water. Water is polluted on all the surface of earth. All metabolic and physiological activities and life processes of humans are generally influenced by such polluted waste and hence, it is essential to study physico-chemical characteristics of drinking water.

Kottayam Municipality is a town located in the south central part of Kerala state, headquarter of Kottayam district. It has more than fifteen thousand families as residents and a host of business and office / bank establishments and educational institutions. As a result lot of solid waste is generated in the town. The solid waste being generated was dumped in a yard at Vadavathoor, about five kilometres from the heart of the town. During the 1950s and the '60s the yard was used as a compost-manufacturing yard, since at that time the solid waste contained only organic, putrescible matter. But later on, as a result of the change in the contents of the waste, composting became difficult and no effective processing was introduced, resulting in just dumping of the waste. At times the garbage was burnt, resulted in the pollution of the surrounding areas and it affected the ground water due to the infiltration of leachate from the dump mainly during rainy season.

So it is clear that the existing system of solid waste management is totally unscientific and unhygienic which causes a lot of health problems through drinking water. Hence, it is essential to study the physico-chemical characteristics of drinking water and identify the quality of well water and find a solution if the water is not potable to use the well water for their primary needs. The main objective of this work is to find the present water quality scenario of well water around Vadavathoor dumping yard and propose a cost effective, simple and eco-friendly treatment technique. So the residents of Vadavathoor could thus adopt this method in their households and use quality drinking water for their needs as per IS specification.

II. METHODOLOGY

A. About the Dumping Yard and Present Scenario

Vadavathoor is a small village in Kottayam where the solid waste dumping yard under the Kottayam Municipality is located. The intense dumping of waste and the improper methods of waste management resulted in alarming rates of pollution within the Panchayat. During the years, when the dump was still in use, even passing along Vadavathoor

through the Kottayam- Kumily National Highway was a nightmare. This was due to the fact that, the air had such a bad stench that people even started vacating their own houses. Once the issue started getting out of hand, the authorities started taking action and with the support of the townspeople they formed groups and marched to the municipality. Strikes and protests were put up in order to convince the Municipality to shut the dumping yard. But, since there is no other means to get rid of the waste from the Kottayam city, Plans were being made to reopen the dumping yard. But the residents continued the protest and finally the yard was closed on December 31st 2013.

After the shutting down of the yard, the stench in the air has reduced and the living conditions have improved. Well water is the main source for the people of Vadavathoor village for their domestic needs. The ground water quality of Vadavathoor is continuously degraded due to the leachate from the solid waste dump yard.

The area enclosed within the dotted circle in Fig.1 represents Vadavathoor whereas the area enclosed within the smaller circle represents the Municipal Dumping yard.

Fig. 1: Study Area

B. *Primary Survey*

A preliminary survey was conducted in the houses located around the dumping yard on 24th August 2014 and the following observation was made. The survey was carried out during rainy season; the leachate from the dumping yard was flowing along the sides of the Kottayam-Kumily road. The leachate was thick and black in colour. On interrogating the residents of the panchayath, they claimed to have the following difficulties:

- Constant fevers.
- Jaundice
- Skin diseases
- Diarrhoea and vomiting
- Foul smelling air
- Breathing problems like asthma

On further exploration of the area, the wells within the area were located and is marked on a map. Further the wells in close proximity of the dumping yard were chosen for water sample collection and analysis. Care was taken to choose wells in all directions of the dumping yard. Fig.2 shows the selected wells, nine wells were selected for the sampling and analysis.

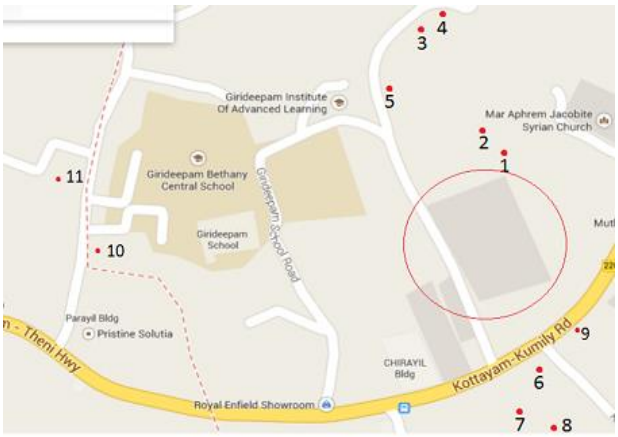

Fig. 2: Location of wells

C. *Sampling & Analysis of the Well Water Samples*

The water samples were collected from the selected wells for different seasons as per IS procedure. The water quality parameters analysed are pH, Turbidity, Chloride, Hardness, Acidity, Alkalinity, DO, COD, BOD and E-coli.

Water samples were collected on 10th September 2014, 3rd November 2014 and 7th January 2015. The averages monthly rainfall for these three months was around 175mm during September 2014, 70 mm in November, 2014 and 21 mm in January 2015.

D. *Treatment Methodology*

The points kept in mind while selecting the treatment methods were:

- The method must be economical, i.e., it must be affordable to the common man.
- The materials have to be easily available.
- The method must be easily adoptable in common households.
- The method must be eco-friendly.

Many methods were selected for the treatment. As a preliminary method, filtration was the first method selected for the treatment. Filtration is a simple process by which the water is made to percolate through a medium so as to remove the pollutants. The medium selected were different particle sizes of sand, charcoal and Gravel.

E. *Filter Construction Details:*

Two filters were made- one with coarse material; size of the charcoal and sand were between 2.36 mm - 1.18 mm and the other with fine materials; size of the charcoal and sand were between 600 µ - 300 µ. The charcoal was crushed and sieved through the required sieves. Sand was also collected and sieved. These were then filled in a 2L plastic bottle with its bottom cut open. A wire mesh was

laid first followed by gravel, so as to support the overlying layers. A layer of charcoal was then laid at a depth of 5cm, followed by sand, at a depth of 10cm. A layer of gravel was laid again so as to filter out the larger particles in the water. The charcoal is an adsorbent to remove colour and odour. The sand screens out the impurities and promotes biological activity. The filter is then saturated and washed using tap water so as to remove any sorts of impurity, dust and dirt.

The sample was then allowed to flow through the filter and the water quality analysis of the water sample and filtered water were tested and inferred as per IS 10500, 2012.

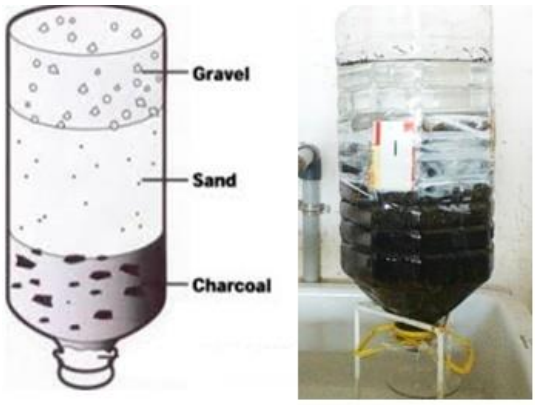

Fig. 3: Constructed Low Cost filter

IV. RESULTS AND DISCUSSIONS

Table 1 shows the water quality analysis results of well water samples collected on September 2014.

TABLE 1: PHYSICO CHEMICAL PROPERTIES ON SEPTEMBER 2014

Parameters / Well no:	pH	Chloride (mg/l)	Hardness (mg/l)	COD (mg/l)
1	5.31	293.65	70	*
2	5.29	218.68	50	*
3	6.97	99.69	60	90
4	6.53	124.96	130	97
5	5.62	156.20	60	*
6	6.43	88.72	130	*
7	6.01	74.97	60	*
8	5.73	81.22	50	*

*COD of the water was not done.

It was observed that the pH, most of the well water samples did not fall within the permissible limit of 6.6 to 8.5.The chloride value of well 1, which was closest to the dump was observed to be above the permissible value of 250 mg/l. Wells 4 and 6 were found to be moderately hard whereas the other samples were not hard. Also, the COD values of all the wells were within the permissible limit.

The second round of water samples were collected on 3rd November 2014, Table 2 shows the water quality parameters on November 2014.

TABLE 2:THE PHYSICO CHEMICAL PROPERTIES ON NOVEMBER 2014

Parameters / Well No.	pH	Temperature (°C)	Hardness (mg/l)	Chloride (mg/l)	DO (mg/l)	BOD (mg/l)
1	5.5	32	72	270	3	2
2	5.9	31	55	270	3.4	2.3
3	6.6	31.4	62	100	3.8	2.1
4	6.6	31	110	130	4	1
5	5.7	31	75	151.6	4.2	2.2
6	6.32	31	125	85	5.4	2.4
7	6.05	31.8	50	80	3.4	2.6
8	5.6	31.6	55	88	5.7	3.2

It was observed that the pH of the sample of well no 3 and 4 only lie within the permissible limit. The samples from wells 4 and 6 were found to be moderately hard. Chloride levels of wells 1 and 2 were above the permissible limit of 250 mg/l .DO values of wells 1, 2, 3 and 7 were slightly lesser than the permissible limit of 4 mg/l. The BOD values of most of the samples collected were not suitable for drinking purposes as it crossed the permissible limit of 1 mg/l.

Another set of water samples were collected on 7th January 2015. Fig 4 shows the variation of pH for 3 months collected of wells 1 to 11. During January 2015, sample from well 4 was found to be moderately hard. However both BOD and COD levels were not satisfactory.

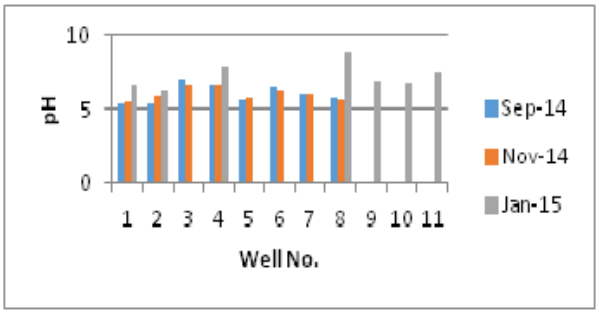

Fig.4: Variation in pH

Fig. 5 shows the variation of chloride during 3 different seasons. Chloride levels of all the wells were within the permissible limits Fig.6 shows the variation of DO, DO of

the samples were analysed only for November and December. From the results it is observed that wells 1 to 5 are polluted

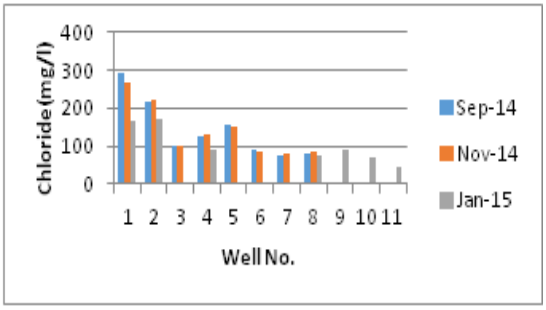

Fig.5: Variation in chloride

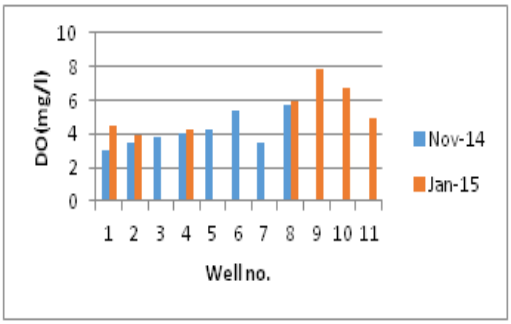

Fig.6: Variation in DO

On comparing the water quality results of 3 months, it could be inferred that the water is polluted. Also, on taking the weather conditions into consideration, it is noticed that the water is more polluted during the rainy season. This might be due to the fact that the rainwater is flowing through the waste forms a very thick black leachate. This leachate percolates through the ground and contaminates the groundwater. Also on comparing the parameters of different wells, it was observed that the flow of the leachate were towards the lower areas i.e. towards wells 1, 2, 6 and 7 as marked in Fig.2.

It can also be concluded that suitability of the water for drinking purposes decreases with the onset of monsoon season. During the monsoon season, due to the rainwater leaching through the untreated waste, reaches the groundwater, thus affecting its quality. Whereas in summer, due to the dry weather conditions, leachate does not penetrate into the ground and the water is not affected. But yet the water is not suitable for drinking as per IS specification.

From the above samples, the sample with worst results was chosen for the treatment. On filtering through the filter, the following results were obtained. From the observations,it can be seen that the pH has increased significantly and now lies within the permissible limits. But the value of turbidity has not decreased and the increase in values of DO is minimal.

Table 4 shows the quality of water after and before filtration. On observing the values of pH, turbidity and DO before and after filtration, there was observed to be considerable improvement in the parameters and the quality of water was improved and made fit for drinking.

TABLE 4: QUALITY OF WATER AFTER FILTRATION

Parameters	Raw water	Coarse filter	Fine filter
pH	4.85	7.65	7.80
Turbidity (NTU)	2.00	1.00	1.00
DO (mg/l)	3.35	4.72	4.13

V. CONCLUSIONS

The preliminary water quality analysis of the groundwater of Vadavathoor, a major water source for the domestic needs of Vadavathoor was done for months of September, November and January. On the basis of experimental findings it could be concluded that, there is high rate of pollution in the well water. The maximum rate of pollution was observed in wells 1, 2,6,7,8 which are closely located to the dump. Also, these wells are at a lower level as compared to the elevation of the dump. Thus it can be concluded that the flow of the leachate is towards the lower elevations.

People residing in Vadavathoor depend on the well water for their drinking and domestic purposes. However due to the leaching of the waste from the dumping yard, the water becomes unfit for drinking and its consumption cause serious health issues. Therefore there is an emergent need for a water treatment method which is not only effective but simple and cheap as well. The use of an effective filtration process, lead to a noticeable improvement in the water quality, thus making the water potable.

REFERENCES

[1] IS 10500 (2012),"Indian Standard Drinking Water Specification".