Rural Groundwater Treatment using Agricultural Waste Material

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Abstract— Groundwater plays a major source of water for agriculture as well as for domestic purpose in rural areas. Rapid industrialization and unplanned discharge of effluents made the natural resource groundwater as unsafe. One of the affected area is Ambur sub basin, a part of Palar river basin, Tamil Nadu, India, severely contaminated by uncontrolled disposal of treated and untreated tannery effluents. The problem may be universal and it should be tackled by no doubt no to disposal of liquid waste into land and surface water. But still the groundwater is under polluted condition by the past actions and there is no other water source for agriculture, groundwater need to be treated. There should be the affordable treatment methods for rural areas to minimize the treatment cost. The readily available agricultural waste material such as sugarcane bagasse may be utilized as filter media to treat the groundwater. In this study, different forms of sugarcane bagasse were used as filter media and developed the filters for treating the groundwater contaminated by total dissolved solids (TDS). The results revealed the reduction of TDS by adsorption. Further study will lead to the development of water treatment kit using the above said materials for rural areas.

Key words: Rural Area, Groundwater, Total Dissolved Solids, Adsorption and Sugarcane Bagasse

I. INTRODUCTION

Agriculture is the major and predominant occupation of rural areas. The demand of water and uncontaminated groundwater made the shift from their agriculture to other occupations. Ambur sub basin, a part of Palar river basin, Tamil Nadu, India, is taken for the study as this area is severely contaminated by uncontrolled disposal of treated and untreated tannery effluents with TDS level ranging from 2000 – 18000 mg/l for more than 40 years. In this sub basin 30000 m3 of treated and untreated effluents are disposed per day into land, river and other water bodies and this has resulted in severe contamination of groundwater, making it unfit for agriculture as well as domestic use.

To suit to rural areas, naturally available agriculture by product will be used to remove the pollutants present in the groundwater. Sugarcane bagasse is an agricultural residue from industrial sugar extraction process. It is a residue composed approximately of 50% cellulose, 25% hemicelluloses and 25% lignin therefore it is relatively resistant to biodegradation. It may be used as adsorbent in filter media.

The study area, Ambur sub basin is delineated from Survey of India topo sheets 57L/9, 57L/10, 57L/13 and 57L/14 and it lies in between longitudes 78◦33'19" and 78◦48'48" East and latitudes 12◦39'0.44" and 12◦45'19.36" North. It measures 394.4 km2. It is located as shown in Fig. 1 in Vellore district, Tamilnadu, India. Physiographically, this district can be broadly classified as hilly terrains and plain regions. The river Palar and its tributaries the Malatar, Guddar and Poiney drain the entire district. The river originates in the highlands of Nandi-durg in the Kolar district of Karnataka (South India) and flows in a south west direction to Vaniyambadi in Tamilnadu. The length of the river is about 295 km in this district. The physical map of Ambur sub basin is shown in Fig. 2.

Many studies revealed the low cost materials application in filter media as adsorbent such as Ravanappan Srinivasan Ramya etl (2016), Billy T H Guan etl (2013), Anuj Kuma etl (2014), Siti Khadijah (2012), Niraj S. Topare etl (2011), Nevine Kamal Amin (2008), Jaguaribe(2005), Ahmednaa etl (2000) and Max Ruiz and Carlos Rolz (1971). In this study, the sugarcane bagasse in different forms is used as adsorbent to remove total dissolved solids (TDS) from water.

The objective of the study is to prepare adsorbent using the natural byproduct of agriculture waste such as sugarcane bagasse in different forms sush as (a) dried sugarcane bagasse (DSB) (b) sugarcane bagasse activated carbon (SBAC) and (c) sugarcane bagasse ash (SBA) to treat the ground water contaminated by total dissolved solids.

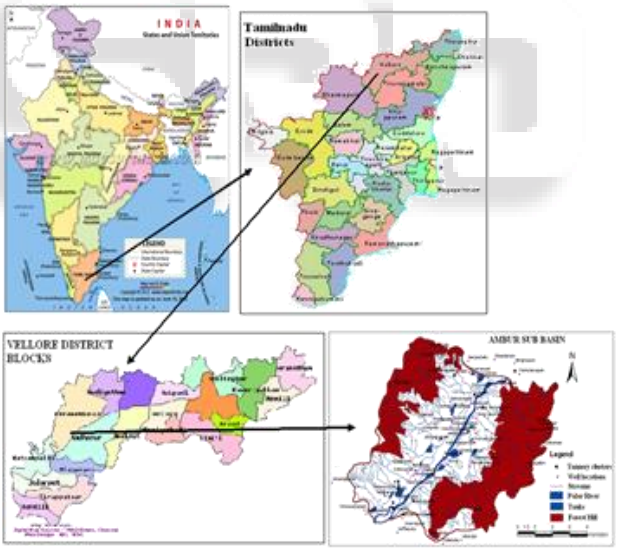

Fig. 1: Location map of Ambur sub basin

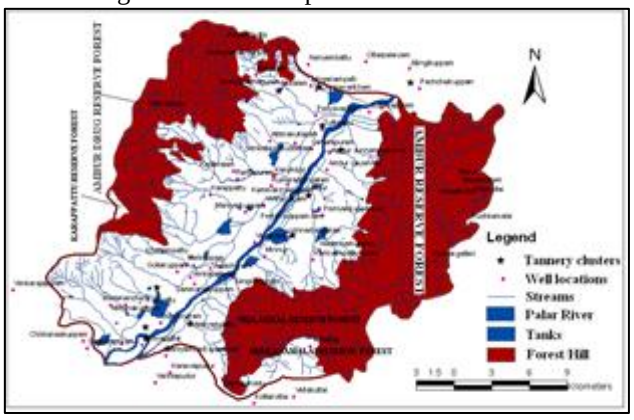

Fig. 2: Physical map of Ambur sub basin

II. METHODOLOGY

The methodology to study the efficiency of sugarcane bagasse to remove TDS using three different forms of sugarcane bagasse such as (a) dried sugarcane bagasse (DSB) (b) sugarcane bagasse activated carbon (SBAC) and (c) sugarcane bagasse ash (SBA) are explained as below.

The preparation of sugarcane bagasse for filter media as adsorbent, involves different stages such as (a) washing and cleaning (b) drying (C) after the stages (a) and (b) burning it at high temperature such as at 500° C to get sugarcane bagasse ash (d) after the stages (a) and (b), to produce activated carbon through chemical activation process such as carbonization which include impregnation using strong acid and carbonizing at 500˚C for two hours. The figures 3 to 6 show the different stages of sugarcane bagasse preparation for filter media.

The cost effective filter media with different layers is prepared by using sand passing through 1.18 mm IS sieve as middle layer, gravel passing through 2.36 mm IS sieve as bottom most layer and top layer with dried sugarcane bagasse (DSB), sugarcane bagasse activated carbon (SBAC) and sugarcane bagasse ash (SBA) in three different filters. Fig. 6 shows the three different filters.

The methodology to study the physical characteristics of sugarcane bagasse activated carbon, test was conducted using Scanning Electron Microscopy (SEM) and the data for two samples are shown in the figures 7 and 8.

Fig. 3: Sugarcane bagasse after washing and cleaning

III. RESULTS AND DISCUSSION

The synthetic salt solution is prepared using NaCl salt which represents the total dissolved solids concentration in groundwater. The test results of three different filters have shown in the Table 1. The test conducted by passing NaCl solution of 5000 mg/l concentration through the filter with DSB. The detention period for the solution in the filter is taken as 1 hr and 1 day. The TDS concentration is found by using Electrical Conductivity (EC) meter and it has revealed the adsorption of DSB by means of reduction in TDS to 2944 mg/l and 2432 mg/l for two different detention periods respectively. Similarly, NaCl solution of 3000 mg/l concentration is passed through the filter media with 0.22 g SBAC with retention time of 1 hour and the filter media with 5 g SBA with retention period of 1 hour. The results revealed the reduction of concentration to 2500 mg/l and 2740 mg/l.

Fig. 4: Sugarcane bagasse Impregnated using Sulphuric acid

Fig. 4: Sugarcane bagasse activated carbon

Fig. 5: Sugarcane bagasse ash

Fig. 6: Low cost filters with SBAC and DSB

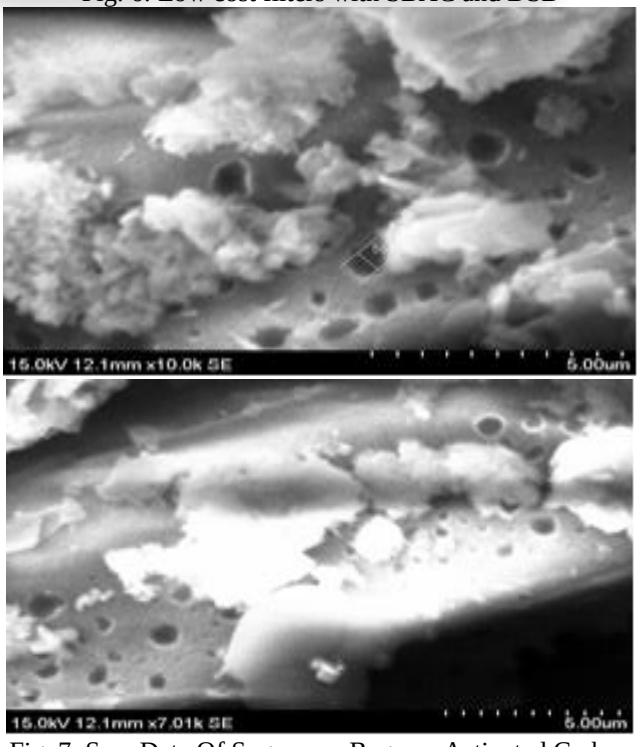

Fig. 7: Sem Data Of Sugarcane Bagasse Activated Carbon Sample -1

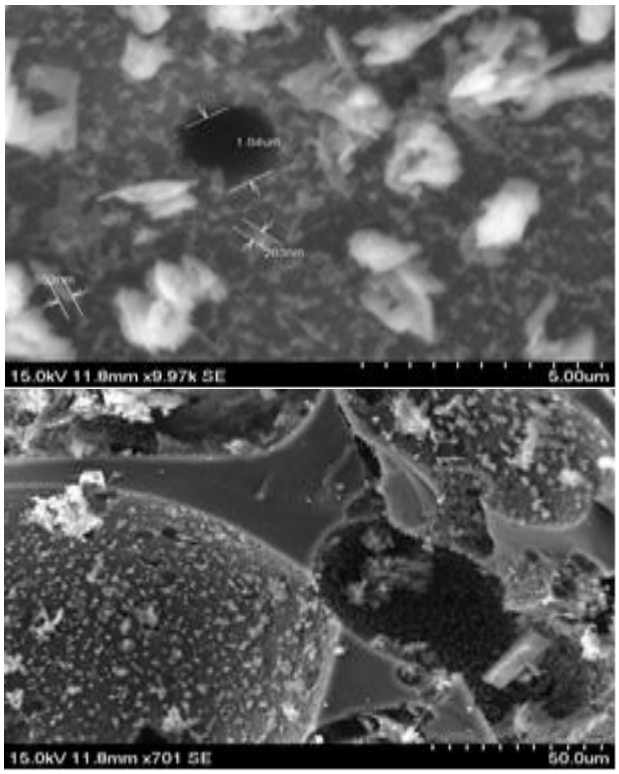

Fig. 8: Sem Data Of Sugarcane Bagasse Activated Carbon Sample -2

Physical analysis of sugarcane bagasse activated carbon tested using SEM revealed that proper carbonization has developed more pores with pore size 580 nm and particle size 280nm with irregular shapes of particles.

S. No	Filter media material	Retention time	Initial Concentration mg/l	Final Concentration mg/l			
				Trial 1	Trial 2	Trial 3	Average
1	Dried Sugarcane Bagasse (DSB)	1 hr	5000	2938	2954	2940	2944
		1day	5000	2448	2430	2418	2432
2	Sugarcane Bagasse Activated Carbon (SBAC)	1 hr	3000	2454	2495	2545	2500
3	Sugarcane Bagasse Ash (SBA)	1 hr	3000	2722	2748	2750	2740

Table 1: Test Results of Three Different Filters

IV. Conclusion

The low cost locally naturally available materials such as by product of agricultural waste can be utilized as filter media to treat and use the groundwater for agriculture and domestic purposes in rural areas to sustain their livelihood. The development of water treatment kit using low cost agricultural waste will make a big change in industrial effluents affected water bodies in rural areas.

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