Low Cost Water Purifier

Suraj Bandu Kanade[1] Prof. P. Hangergekar[2]
[1,2]Department of Water Resource Engineering
[1,2]S.T.B.C.E.T., Tuljapur, India

Abstract— About one-fifth of people on earth lack the access to safe drinking water, a condition that resulted in the death of 2.2 million people in 2004, as per the records of United Nations. Clean water use being a prime concern in many communities of developing countries. Contaminated water plays significant role in taking numerous lives in these localities, for which a number of nefforts are being made for accessing safe purified drinking water. Fortunately, efficient and cheap water purification systems are being utilized and being tried to be accessed worldwide for easy access to clean water. In the following project we had tried to develop a "Low Cost Water Purification Technique" using the basic ideas of Slow Sand Filter, some locally available filter material like charcoal, bone char, sand, manganese modified sand, clay, rice husk, banana residue ash, anthracite and try to improve the methodology using the UV Filter, RO Filter, and Activated Carbon Filter mechanism. Main focus was removal of iron from surface water by adsorption and oxidation followed by precipitation technique. Among all the adsorption media used, manganese modified sand proved to be a good adsorbent in removal of iron. For oxidation followed by precipitation, the ash produced from banana residue was used which proved to give the best result in removal of iron and also was having the cheapest material cost. A ceramic membrane with locally collected clay and rice husk was prepared which also proved to be effective for removal of turbidity, but may be due to rigorous use of the filter or any manufacturing defect, there were cracks developed on its surface and was discarded for any further use.

Keywords: Water Purifier, UV Filter, RO Filter

I. Introduction

Purified water is essential for living a healthy life as such everyone should have access to it. Drinking water conditions have great impacts on people's everyday life, especially in the rural and remote areas where access to safe drinking water is very crucial. Surface water often is the only source, thus water contaminations are difficult to avoid due to rigorous and reckless use of surface water. Unsafe drinking water may result in fatal diseases. Statistics shows that these diseases resulted in ninety percent of all deaths of children under five years old in developing countries, due to low immunization of children to infections.

The filter paper method (FPM) and carbon filter is probably the simplest of the methods available for estimating the apillary pressure (also known as soil matric suction, the reference being the atmospheric pressure) of an unsaturated soil. The FPM calculates soil suction indirectly by measuring the gravimetric water content of the filter paper at equilibrium that is related to soil suction through a predetermined calibration curve. A number of calibration functions for ash-less filter paper have been published in the literature. Significant discrepancy exists among the calibrations that are commonly used for estimating suction using the gravimetric water content of the filter paper data. This paper presents graphical and statistical comparisons of several calibration curves proposed at the literature for the Whatman filter paper. A theoretical distribution to fit the data is proposed. Experimental errors induced by using a calibration curve that differ from those frequently used in the scientific community are presented and discussed. The simplicity and low cost of the FPM recommends it for preliminary studies of soil suctions in the unsaturated zone.

II. Materials Used

A. Filtration Model Development

Here we have manufactured a simple cylindrical filtration tube as shown in figure with the following dimension
Length = 30cm
Internal diameter = 8cm
Outer diameter = 10 cm

- Base is covered with a porous plate of 5mm diameter pores
- From the base, a conical portion is extended to collect water with a tap to regulate filtered water.
- Top of the cylinder was covered with a perpex sheet of 1 inch thickness.
- A hole of 2 cm diameter was made to connect with the inlet pipe.

In the proposed design of the model, the prefabricated water of known iron concentration was passed through the inlet pipe above. Inside the cylinder, different adsorption media of specified thickness were placed with proper gravel support. Then after filtration, the filtered water was collected through the conical part in a beaker and the final iron concentration was measured in the Atomic Absorption Spectrometer (AAS). The rate of filtration was noted and for each adsorption media, three samples were tested and average iron concentration was considered for analyzing filter effectiveness.

III. Materials Used and Preparation of Adsorption Media

As per the two methods explained in the first method for removal of iron by adsorption technique, different adsorption media were used for iron removal are listed below which are locally collected at a very cheap cost. In the second methodology, ash obtained from banana residue was used for removal of iron by oxidation followed by precipitation.

A. Plane sand

Fine sand and gravel are naturally occurring glacial deposits high in silica content and low in soluble calcium, magnesium and iron compounds are very useful in sedimentation removal. But here the media is used for iron removal from drinking water. Here for the experimentation plane sand passing through 425 micron and 600 Micron IS sieve were used.

B. Activated Carbon

Activated of a used aqua guard carbon filter crushed to the size of 2mm and down was used for removal of iron from water.

C. Wood Charcoal

Bituminous coal has been used before as an adsorbent and proved to be very effective in removal of iron. Due to non-availability of bituminous coal, we used wood coal as an adsorbent media for experimentation. Locally collected wood charcoal crushed to size 10mm and down was used for removal of iron from water.

D. Wood charcoal and Rice husk mixture

Mixture of wood charcoal and raw rice husk in the ratio 3:2 by weight was taken for removal of iron from water as a trial without any prior evidence of being used as an adsorbent.
Manganese modified Sand
Sand passing through IS 850 micron sieve was collected as specified in 2.25 and cleaned with distilled water, dried in oven at 373K for 12 hours, soaked with 0.01N KMnO4 for 24 hours and then washed thoroughly by distilled water and dried at 373k for 12 hours and cooled to room temperature. This was used as adsorbent media.

E. Anthracite

Crushed anthracite is an excellent medium density filtration media. Due to high carbon content, low specific gravity, cost effectiveness, this media has been used for simple filtration. It can compare with equivalent sand filter for better filtration efficiency and longer filter run. But here well graded anthracite grains i.e., of size 625 micron and down have been used as an adsorption media for removal of iron.

F. Aluminum hydroxide coated Rise husk Ash

RHA (rice husk ash) was prepared by controlled burning process in muffle furnace at a temperature of 500 degree Celsius for 4 hours. The RHA was first soaked with 0.01 N HCl. Dry RHA of 100 gm, 0.6 M of aluminum salt (Aluminum Sulphate salt) solution and 3M sodium hydroxide was added and stirred for one hour and then the filtered RHA was kept in oven for 3 hours at 373 K. This was used as an adsorbent along with sand as a base material

G. Ash of banana leaf, Rind and stem.

For this method dried plant material of banana tree i.e. leaves, rind, pseudo stem were collected and ash was prepared by heating at 500 degrees for 4 hours in oven.For this method dried plant material of banana tree i.e. leaves, rind, pseudo stem were collected and ash was prepared by heating at 500 degrees for 4 hours in oven.

H. Preparation of ceramic filter

Locally collected clay of size 75 micron and down was used for fabrication of a ceramic filter with rise husk. A mixture of clay and rice husk of size 425 micron and down with ratio 2:1 was made with admixtures boric acid, sodium meta silicate and sodium carbonate. The amount of materials taken was given below in the table where the cost of ceramic filter has been stimated. After hand mixing the components for about 15 min, water was added in the amount of 1.25 lit/kg of rice husk. Then mixing was done properly for about 30 min. The mixture was then transferred to a cylindrical mould and dried at room temperature for about 48 hours. Then the mix took the shape of the mould and then dehydrated at 100 degree Celsius in oven for about 6 hours. Then the mould was kept in the muffle furnace for about 8 hours at a sintering temperature of 866 degree Celsius for complete bonding of the clay particles.

IV. METHODOLOGY

A. Sand

Fine sand and gravel are naturally occurring glacial deposits high in silica content and low in soluble calcium, magnesium and iron compounds are very useful in sedimentation removal. But here the media is used for iron (Fe) removal from drinking water After being cooled to room temperature, the sand was used in the filtration model previously developed with a gravel base of specified size to support the sand bed. Known concentration of 1000ml of iron solution was passed through the sand and the filtrate was collected in a beaker. The rate of filtration was calculated and final iron concentration was measured with AAS (Atomic Absorption Spectrometer).

B. Activated carbon

The micro contaminates present in water cannot be effectively removed by traditional method where as the activated carbon proved to be very useful for removal of organic as well as inorganic contaminants. As specified in 3.22, crushed activated carbon was obtained and used above sand bed of specified thickness in the filtration model for removal of water. For experimentation 1000 ml of iron solution of known concentration was taken and the filtered water was collected after filtration and the rate of filtration was noted.

C. Wood Charcoal

Due to non-availability of bituminous coal wood charcoal has been adopted as specified in 3.23 for using as an adsorption media. Wood charcoal of specified thickness was used as an adsorption media in the filtration media. For experimentation 1000 ml of iron solution of known concentration was taken and the filtered water was collected after filtration and the rate of filtration was noted.

D. Wood charcoal and Rice husk mixture

Raw rice husk and charcoal was taken in a ratio 2:3 by weight and used as a filter media with sand as a base material of specified in 3.24 in the filtration model. For experimentation 1000 ml of iron solution of known concentration was taken and the filtered water was collected after filtration and the rate of filtration was noted.

E. Manganese modified sand

For removal of heavy metal ions, use of activated unsaturated sand filter (AUSF) being the most common technique. Naturally occurring manganese oxide tend to attenuate some heavy metals, silt, sediment, due to its good sorptive capacity towards the ions such that copper, iron, arsenic etc due to high specific surface, micro pores available on its surface, possession of –OH functional group which leads to strong chemical bonding with some metal ions.

F. Aluminum hydroxide coated Rice husk ash

This adsorption media has been previously used for defluoridation of drinking water where the hydrolysis of aluminum sulphate in alkaline medium produces polyhydroxy aluminum precipitate which forms a complex with fluoride ions in water. Here without making any change to the active surface of RHA coated with Al(OH)3, the adsorption media has been tested for efficiency in removal of iron instead of fluoride. For experimentation 1000 ml of iron solution of known concentration was taken and the filtered water was collected after filtration and the rate of filtration was noted.

Here well graded anthracite grains as per mentioned in 3.26 i.e., of size 625 micron and down have been used as an adsorption media for removing iron. 15cm thickness of well compacted material was taken inside the filtration model and then 1000ml of iron solution of known concentration was passed through it and the filtered water was collected in a beaker whose iron concentration was measured by AAS. The time taken for filtration was noted.

V. RESULTS AND DISCUSSION

With the filter paper method, the results were recorded in 20 days, whereas by the traditional method, 120 days were necessary. The greater speed of the filter paper method was emphasized in other studies (Chandler and Gutierrez, 1986; Bulut and Leong, 2008; Lucas at all. 2011).The estimated values of θ ($m^3\ m^{-3}$) for the two methods were similar for the five different soils, especially for the Neossolo Quartzarênico. Lucas et al. (2011), using a 0.045 m diameter filter paper between two filter papers of 0.05 m, placed between two soil samples with the same moisture content, also found fairly similar results between the filter paper and the conventional methods for a Latossolo. By the filter paper method, the higher values for moisture content were overestimated for the Argissolo Vermelho-Amarelo, Latossolo Amarelo and Latossolo Vermelho-Amarelo. Water content was underestimated for the Planossolo, whereas for the Neossolo Quartzarênico, the R^2 was 0.99. The results of the comparison by simple regression analysis between the values obtained with the filter paper method and the traditional method, showing the error associated with each method by means of statistical indices and the confidence or performance index. The filter paper method was considered the dependent variable and the values from the traditional method, the independent variable. The values for the parameters of the regression equation were highly significant ($p<0.01$) for the five soils.

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REFERENCES

[1] Rajabapaiah, P., S. Jayakumar and A.K.N. Reddy, 1993. Biogas electricity-the Pura village case study. In Renewable Energy-Sources for Fuels and Electricity (Johansson, T.B. et al. (Eds.)), Island Press, Washington, DC.
[2] Dr. Syed Zafar Ilyas, World Applied Sciences Journal 1 (2): 2006.
[3] Kramer, M.J., 2002. agricultural biogas casebook, Resource strategies Inc. September, 2002, preparedfor Great Lakes Regional Biomass Energy Program Council of Great Lakes Gover.
[4] Bulut R, Leong EC. Indirect measurement of suction. Geotech Geol Eng. 2008;26:633-44.
[5] Bulut R, Wray WK. Free energy of water-suction-in filter papers.Geotech Test J. 2005;28:355-64.
[6] Camargo AP, Sentelhas PC. Avaliação do desempenho de diferentes métodos de estimativa da evapotranspiração potencial no Estado de São Paulo, Brasil. R Bras Agrometeorol. 1997;5:89-97.
[7] Houston SL, Houston WN, Wagner AM. Laboratory filter papersuction measurements. Geotech Test J. 1994;17:185-94.
[8] Klute A. Water retention: laboratory methods. In: Klute A, editor. Methods of soil analysis. 2nd.ed. Madison: American Society of Agronomy; Soil Science Society of America; 1986. Pt 1. p.635-62.
[9] Leong EC, He L, Rahardjo H. Factors affecting the filter paper method for total and matric suction measurements.Geotech Test J. 2002;25:322-33.
[10] Ben Aim, R., Liu, M. G., and Vigneswaran, S.: Recent development of membrane processes for water and wastewater treatment, Water Sci. Technol., 27, 141–149, 1993.
[11] Chellam, S., Jacangelo, J. G., Bonacquisti, T. P., and Schauer, B.A.: Effect of pretreatment for surface water nanofiltration, J. Am.Water Works Assoc., 89, 77–88, 1997.
[12] Choi, J. H., Cockko, S., Fukushi, K., and Yamamoto, K.: A novel application of a submerged nanofiltration membrane bioreactor (NF MBR) for wastewater treatment, Desalination, 146, 5 413–420, 2002.
[13] Glucina, K., Laine, J. M., and Robert, C.: Intergrated, multiobjective membrane systems for surface water treatment, Proceedings AWWA Membrane Technology Conference, New Orleans, USA, 1997.