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Low Cost Water Purification using Activated Carbon /Sand Filters

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Abstract: *The Surface water is polluted because of anthropogenic activity. Fresh and clean water is essential for all human beings living on the earth, yet it has been observed that worldwide millions of people are still using water contaminated by bacteria, toxic chemicals and other pollutants. So, there is a need for purification of water. The significance of this work was to improve the quality of surface water by using adsorption technique. In the recent study a low-cost water filter was designed for 17-liter capacity. The filter media consisted of 4 layers including pebbles, sand, corncob, and activated carbon, 4 cm of each component. The filtration capacity of the filter could be improved by adding 0.0001 µm filter paper. This research is based on the quality of surface water of Dhepa River, Sukh Shagor and sluice gate at Birganj in Dinajpur district. Samples of water from this source were collected and analyzed for the physical and chemical characteristics such as pH, Total Dissolved Solids (TDS), Turbidity, Hardness, Alkalinity, Biological Oxygen Demand (BOD), Potassium, Calcium, Magnesium, Sulphate and Sodium before and after filtration. Results showed that these filter media reduced the level of TDS, Turbidity, Hardness, BOD, Magnesium, Calcium, Sulphate and Sodium in appreciable amounts. Above all the parameters except magnesium brought below the limits of drinking water quality parameters given by World Health Organization. It was found that after filtering, surface water from these sources were usable for various domestic purposes and this filter was more cost effective than the other traditional filter available in the market.*

Keywords: Surface Water, Filtration, Water Quality Parameters, Activated Carbon

I. INTRODUCTION

Home In order to sustain lives of all living beings, water is one of the essential substances. Clean and plentiful water provides the root for healthy life and communities. Surface water and groundwater are the two major sources of water where surface water sources make use of large scale water supply systems and smaller water systems utilize groundwater [1]. In village areas of Bangladesh, people often use surface water for their daily needs. Surface water is polluted day by day by throwing household waste, runoff from rain, disposal of wastewater etc. Moreover, Industrial activities for the progress of a nation lead to global environmental deterioration as these activities cause depletion, degradation and deterioration of natural resources and biodiversity. Additionally, these industrial activities indirectly filled the water body with a lot of pollutants and subsequently the surface water body was also polluted [2]. Lack of safe drinking water processed in many water borne diseases. Worldwide over 4 billion cases of diarrhea annually. Despite being largely preventable and treatable, every year 1.8 million death occur due to diarrhea diseases. Due to unsafe water supply, inadequate sanitation and poor hygiene, Eighty-eight percent (88%) of these deaths are happened [3]. So there is a need for water purification. Water qualities have great impacts on people's everyday life, especially in the rural and remote areas where access to safe water is very crucial [4]. Various types of filters are designed overtime for purification of surface water, but the cost as well as the filter effectiveness are still not satisfactory and further

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improvement is still necessary [5]. Nowadays in Bangladesh water is being the biggest issue. Most of the people in the rural areas are not able to use water filters. Many efforts have been done to solve this problem due to which safe and cleaning water may become affordable for the community. Each household should be able to afford their own water purification system for drinking and other domestic purposes, this should be the aim of the study to construct any low-cost water purification technique. Filtration is a process which improves the water quality by the removal of suspended solids, colloidal matters and the reduction of number of bacteria, color, odor etc. [6, 7]. However, attention to promising low investment-cost technologies, such as slow sand filtration (SSF) techniques, is surprisingly miniscule. SSF (at a flow rate of 0.1–0.2 m3 /hr/m2) is quite effective water treatment technology [8]. The objective of this study is to develop a low cost water filter using locally available materials to improve the quality of surface water. Various researchers did their work for purification of surface water. It was analyzed that the efficiency of filters become greater at increasing filter depth and flow through rate. That study aimed to investigate the efficiency of slow sand filters at 3 different depths and flow rates. Higher the filter depth and flow through rates higher the efficiency [9]. Gulch proposed that the removal efficiency is highly dependent on physical and operational characteristics of the filter. The formation of a biological layer on the filter bed helps to remove the microbial contamination in water [10]. Shah et al [11] used Coal Fly Ash. The overall treatment increased that reached up to 80%. When FeCl3 and fly ash were applied together, it was observed that COD, color, turbidity and TSP were reduced. So the combination of FeCl3 and coal ash was found to be more efficient. It was proposed that as the rice husk is an inexpensive and abundant material in many areas and it could be utilized as the best adsorbent for the removal of various pollutants from water and waste water. Using rice husk as adsorbent, pollutants such as dyes, phenols, pesticides and heavy metals was to be reduced from wastewater [2]. It was found that using a sand filter with activated charcoal, the municipal waste water can be used for irrigation purposes [12]. It was demonstrated that a laboratory-scale slow sand filtration unit was capable of consistently removing at least 90% of the suspended solids, more than 65% of the remaining BOD and over 95% of the coliform organisms [13].

Scope of Project:

• It is observed that now a day's most of the groundwater is unfit for drinking purpose due to excessive concentration of fluoride and ions.

• water which is present in environment it is also not fit to drink due to presence of many types of bacteria and chemicals, because in many of company the waste water or waste material is disposed in rivers and other water reservoir.

• With the increase in the population, the shortage of drinking water is becoming more noticeable.

• So potable drinking water is need for humans for their healthy life.

Aim & Objective:

• To remove colour, odour and dissolved solids form the water.

• To make the water purification system user friendly.

• To make water purifier electricity free.

II. LITERATURE SURVEY

• Mobile solar water purifier Bongarde et.al (2017) investigated experimental study on Mobile solar water purifier. This equipment is based on the renewable energy source. Solar is a clean energy system which can cut down the pollution problems and gives the opportunity to generate reliable source of potable water. This design fulfils the requirement of low budget product considering the most of the places don't provide potable water. Water purification through solar power is one of the best inventions to save energy and to have uncontaminated water.

• Improved Solar Water Purifier Kimambo, et. al (2012) conducted experimental study on Improved Solar Still for Water Purification. In this study two conventional stills were constructed that differed in their absorptivity and

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reflectivity of the inside surface of the stills. Our study found that painting the internal surfaces of the walls of the still white improves the distillate output of the still. The quality of the water after distillation agreed with standards required for safe drinking water which underlines the fact that the distillation was satisfactory.

• Enhancement of Natural Organic Removal from Raw Water and Treated Water using Zeolite. Mechor, et. al. (2009) conducted experimental study on Enhancement of Natural Organic Removal from Raw Water and Treated Water using Zeolite. Standard solution of hypochlorite was used as the chlorination agent for sample preparation. Normal sand filtration, which is commonly used in water treatment plant were mixed with various 4 amounts of zeolite. The best recommendation for the sand filter and zeolite ratio is at 3:1. Its show the absorption of the total organic carbon in the sample being reduces and at the same time the chlorine residual are still managed in treated water.

• Politeknik sultan Idris Shah (2018), he worked on 'Water filter manufacturing the usage of coconut husk fiber, zeolite, charcoal and membrane for rainwater harvesting'. Water great for the samples taken from five unique places is elevated after passing via the filters. There are a number of parameter which are regarded to be extended that pH, turbidity, color, organic oxygen demand, complete suspended solids, nitrate, zinc and sulfate. From this project, it is observed that rainwater consists a quantity of chemical compounds such as zinc, nitrate and sulfate. All samples had been harvested thru roof. There are many sources of impurities may want to be on the roof such as birds drop, materials of roof and leaves. Unclean reservoir may want to be the best location for micro organic growth. This should lead to excessive BOD reading.

• Giridhar V S S Mittapalli (2016), he also study conducted on the " Use of Alum for Turbidity Removal in Synthetic Water" In this the effectiveness of alum used to be evaluated at room temperature with initial pH (6-7.4) For 2 coagulant doses 10 mg/l and 20 mg/l in 250 ml synthetic high turbid water by means of adopting guide agitation at very low settling Results confirmed that coagulation technique ought to cast off turbidity effectively the use of highly low stages of Alum. Studies expose that turbidity elimination relies upon on pH, coagulant dose, also as initial turbidity of water. The absolute best turbidity removal effectivity was 46.15 p.c. over the utilized vary of turbidity. The outcomes of the cutting-edge learn about can be used as a baseline information for drinking water cure facilities which uses Alum as a coagulant.

• Maxim Tyulenev (2016), he also conducted a study on 'Coal producers waste water purification' The analysis of dependence provided in graphics has showed that the change of oil products concentration C from filtering path L with high accuracy (R2 is not lower than 0.91) is approximated by expression:- $C = C0 \cdot e\text{-}0.016$lwhere, C0 - initial concentration of oil products in the waste waters discharged for purification, L - filtering path.

• Shilpa S. Ratnoji (2014), conducted a study on 'a study of coconut shell-activated carbon for filtration and it's comparison with sand filtration'. For conducting the pilot scale study of filtration different grades of CS-AC VIZ WT D816, WTE830 and WTE124 depending upon their sizes were produced from Indo German Carbons Limited, Kerala. These CSAC were of size 8*16 US mesh size (I, coarser), 8*30 US mesh size (II, medium), and 12*40 US mesh size (III, finer).CS-Ac were maintained at a depth of 4cm in the column. Reduction in BOD and COD is illustrated is not that pronounced and reduction in Cod and BOD proves that the organic compounds can be effectively removed by coconut shell activated carbon .coconut shell activated carbon can be looked upon for future treatment of water in removing suspended solids, iron and total organic carbon instead of sand filtration in the treatment plants and this technique is highly advantages, inexpensive and cost-effective as well as turn there will be utilization of a waste which would be otherwise simply dumped. Thus, this improvisation can be effected as a novel method as drinking water treatment taking environment into worry.

• Karmen Margeta (2013), yet as he additionally conducted a study on 'Natural Zeolites in water treatment - however effective is their Use' he work represented was partly supported by the Ministry of Science, Education and Sports of the Republic of Republic Croatia through the bilateral project. The distinctive natural process and surface assimilation properties, high consistence and glorious thermal stability of Zeolites create then terribly appropriate for several applications, additionally in water treatment processes. Many different studies have incontestable their effectiveness in reducing the concentrations of contaminants (metals, anions and organic matter) in water. The complexness of aquatic

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systems demands special attention within the choice and preparation of materials for water purification. The chemical behaviour of natural zeolites in several binary compound environments, that was additionally a topic of recent geochemical and technological studies, to boot proven their pertinency, though watching of ph and it's changes, remains vital for his or her use of real environments. Further research should be focused on the optimization of the surface modification procedures to boost their efficiency and to reinforce the potential of regeneration.

III. METHODOLOGY

Test methodology was divided into four steps, such as selection of source of water, selection of filter materials, design of filters, testing of samples before and after filtration.

A. Source Selection:

The study area was in Dinajpur district. So the sources were selected as Dhepa River, Sluice gate at Birgang and Sukh Sagor at nearest to the research location where many people use these water for their daily activity. Samples of water from these sources were collected for analyzing before and after treatment.

Fig. 1. Sukh Sagar, Dhepa River and Sluice gate at Birgang from left

B. Selection of Filter Materials:

Locally available materials were selected for the filters such as pebbles, Sand, Corncob and Activated carbon. For experimentation the pebbles passing through 40 mm and retain on 20 mm IS sieve were used in the study. Sand was collected from the Dhepa river bank which is located in Dinajpur city. For experimentation the sand passing through 4.75 mm and retained on 600µ IS sieve were used. Corncob was collected locally from Basherhat, Dinajpur. Activated carbon, which is also known as activated charcoal, is a form of carbon that has been processed to produce extremely porous. It also provides a very large surface area for adsorption and chemical reactions take place [14]. It is recommended for wastewater treatment for its high degree of micro porosity. Carbonaceous materials are the main source from which activated carbon is made such as coconuts, nutshells, coal, peat and wood. Here charcoal was used as activated carbon.

Fig. 2. Filter Materials (Pebbles, Sand, Corncob and Charcoal from left)

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C. Design of Filters:

For the design of the filter, 4 layers of filter media were used in it, bottom layer was gravel, second was corncob, third was sand and top was activated carbon. Each layer was 4 cm in height. In this experiment the model of filter was prepared using a bucket of 20 liters. Then surface water was poured in it for filtration and collected through the bottom of the filter by perforating at the bottom of the bucket.

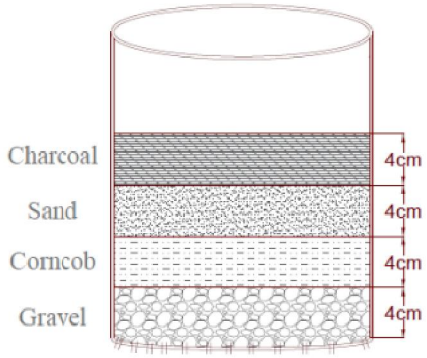

Fig. 3. Cross Selection of Filters

D. Testing :

Collected samples were tested for pH, Hardness, Total Dissolved Solids (TDS), Biological Oxygen Demand (BOD), Alkalinity, Turbidity, Potassium, Sodium, Sulphate, Magnesium and Calcium before and after filtration. According to standard procedures recommended by American Public Health Association (APHA) and "The Environmental Conservation Rules", 1997, all the parameters were tested in the laboratory

IV. RESULT & DISCUSSION

In the present study, comparative analysis of physicochemical parameters of surface water in Dhepa River, sukh shagor and sluice gate at Birganj were carried out. Here Sample 1collected from Dhepa River, Sample 2 from Sluice gate at Birgang and Sample 3 from Sukh Sagor. Test results of different water quality parameters are given below:

Parameters	Unit of Measurement	Sample 1		Sample 2		Sample 3	
		Raw	Filtered	Raw	Filtered	Raw	Filtered
pH	mg/L	7.56	7.22	7.8	7.01	7.41	7.22
Hardness	mg/L	277	123	257	137	235	143.2
TDS	mg/L	2200	280	1760	329	2170	267
BOD	mg/L	7.16	3.03	6.76	2.63	6.74	2.57
Alkalinity	mg/L	105	128	113	137	119	70
Turbidity	NTU	12	3	10	3	13	3
Potassium	mg/L	5	5	7	5	6	2.7
Sodium	mg/L	2.5	2	3.5	2.1	2.71	2.2
Sulphate	mg/L	300	200	273	197	266	154
Magnesium	mg/L	78	19.44	75	31	75	30.01
Calcium	mg/L	112	32.06	117	34.06	124	41.67

Table 1. Test results of samples before and after filtration

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Test results showed that there was an appreciable reduction of all parameters compared to influent value. Then the results compared with drinking water quality parameters given by WHO.

V. CONCLUSION

Filter was developed with gravel, sand, corncob and activated carbon of 4 layers of media. Filter was constructed in a bucket perforated at the bottom for collecting water where each material was 4 cm in height. The filtration capacity of the filter could be improved by adding 0.0001 µ filter paper. Tests were performed on the sample water before and after passing through the filter. Test results were found satisfactory compared to drinking water guidelines given by WHO except magnesium. This filter was able to reduce above all the parameters an appreciable amount. Water found from this filter could be used in various domestic purposes based on tested parameters. This filter was also made with low cost. So, with this consideration sand filtration along with activated charcoal was finalized for treatment.

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