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Study of Low-Cost Household Water Filter using Activated Rice Husk as Adsorbent

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Abstract: This project demonstrates the study of water purification. Water samples are collected from four different location namely Padumpukhuri (Hojai district of Assam), Komorakata (Hojai district), Dekargaon (Sonitpur district of Assam), and GIMT, Tezpur campus(Sonitpur district). These water samples are tested for different physical and chemical parameter in our college Environmental Engineering laboratory and Tezpur (PHE) Division. Moreover our main aim is to design a low cost filter with Rice Husk Activated Carbon as the adsorbing material for purifying water. The main focus of our project is to deal with the quality of water and recover as much as clean and fresh water. Filtered water after passing layer of different proportion of activated carbon are tested for different physical and chemical parameter and compare with that of raw water. Comparison result shows that our low cost designed filter perform well to remove certain amount of chemical-physical parameter and gives good quality water.

Keywords: Low-Cost Household Water Filter, Activated Rice Husk, Natural Adsorbent, Hojai, Sonitpur

I. INTRODUCTION

Pure drinking water is essential for living a healthy life. Drinking water conditions have great influence on everyone's daily life, especially in the rural and remote areas where access to safe drinking water is very crucial. Contaminated drinking water may result in fatal diseases. Statistics shows that water borne diseases resulted in ninety percent of all deaths of children under five years old in developing countries. A major impurity that is commonly found in groundwater is iron. Iron deposited in water may promote the growth of microorganisms leading to high contamination in drinking water. Despite iron is an essential mineral, which helps in the transportation of oxygen in the blood, its presence in ground water above a certain concentration makes water unusable due to its metallic taste discoloration, odor and turbidity. Iron "overload" in drinking water may lead to vomiting, bleeding and circulatory disorders. Another contaminant found groundwater of Assam is fluoride. According to a report, Fluoride levels in water above the permissible limit of 1 mg/liter have been found in 11 districts in the state putting an estimated 356,000 people at risk. Experts warned the numbers would rise if emergency measures were not taken. When fluoride concentration of the drinking water exceeds 1.5mg/l then removal processes of fluoride ion in drinking water is known as defluoridation.

The different methods so for tried for the removal of excess fluoride from water can be broadly classified into four categories.

(a) Adsorption methods
(b) Ion exchange methods
(c) Precipitation methods
(d) Miscellaneous methods.

In our project work we mainly focus on adsorption method.

Testing of drinking water sources by the Assam public health engineering (PHE) department has found that Karbi Anglong and Nagaon districts are the worst affected districts by fluoride contamination. Testing of drinking water sources by the department up to March 31, 2017, revealed that total 401 in undivided Nagaon were laced with fluoride, which are highest among all the districts of Assam. Though Hojai, which is badly affected by fluoride contamination,

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was recently carved out of Nagaon as a separate district, segregated figures of Hojai are yet to be compiled. High fluoride contamination in groundwater has been a problem in Assam for more than decades. Apart from Nagaon, other districts in the state which are facing the problem of fluoride contamination are Karbi Anglong, Dhubri and Udalguri districts. Consumption of water containing excessive fluoride causes dental and skeletal fluorosis. Symptoms of fluorosis are bent legs and discolored and brittle teeth.

The scope of this project is to study the existing water filtration methods, and use the knowledge of "adsorption method" to design a Low cost water filtration media. This water filtration system will focus on cutting down the cost while maintaining filter effectiveness. By providing affordable water filters for the rural and remote areas, will greatly improve people's quality of living and reduce the risk of any waterborne diseases therefore saving lives.

II. STUDY AREA

Water Samples are collected from four different places.

a) GIMT College Campus: Water sample is collected from the stream flowing through our college campus. This water sample is suspected to have more turbidity and total solids.

b) Dekargaon: Water sample is collected from a tube well, suspected to have iron concentration more than the permissible limits.

c) Komorakata: This water sample is collected from a remote area of Hojai district which is located at the border of West Karbi Anglong district and it is suspected to have high fluoride concentration.

d) Padumpukhuri: Water sample is collected from a tube well of Padumpukhuri, Hojai district and it is also suspected to have high fluoride concentration.

Latitude and longitude of each station is collected by "GPSStatus"applications.

Table I: Co ordinates of sample collection point

Sl no.	Station	Latitude	Longitude
1	GIMT College Campus	$26^0$40'55" N	$92^0$45'9" E
2	Dekargaon	$26^0$40'47" N	$92^0$45'36" E
3	Komorakata	$25^0$59'42" N	$92^0$48'40" E
4	Padumpukhuri	$26^0$0'58" N	$92^0$47'17" E

III. METHODOLOGY

To study the water parameter and changes of these parameters with the addition of activated carbon (AC) in the filter media, different tests are performed in the laboratory. Different tests namely acidity, alkalinity, fluoride, hardness, iron, P^H, total solids, turbidity test have been performed.

During our study we have developed a low cost natural adsorbent water filter. First of all the raw water samples have been tested and water allow to pass through layers including different proportion (5 % and 10%) of activated rice husk . After filtering water samples are tested for above mentioned tests and compare the values with that of raw water.

a. Preparation of Filter Model

In our developed water filter, layer of activated rice husk has been sandwich in between layers of gravel and sand.

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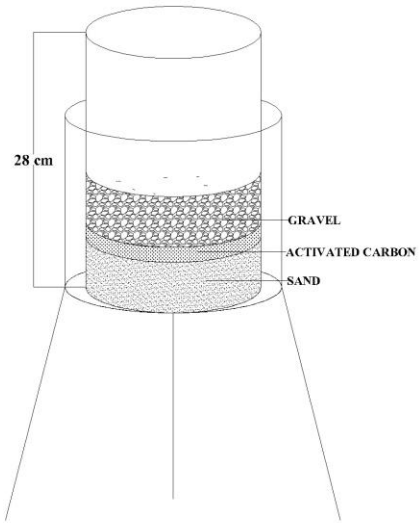

Fig 1: Filter Model

Between each layer of filter media, we use filter paper to separate them. At the base perforated holes were made through which filtered water had been passed. . At the bottom, sand layer of weight 1.5 kg is placed. Over this sand layer again place some filter paper to separate it from other layer. Now Activated carbon (Rice husk) of different proportion is placed. At the top, layer of coarse aggregates is provided. The filter media were so provided that water is in contact with these media for sufficient time. Then after filtration, the filtered water was collected through the outlet part in a beaker and the final concentrations of different parameter were measured in the laboratory.

b. Materials used and Preparation of Adsorption Media

Different adsorption media were used for filtration are listed below which are locally collected at a very cheap cost.

i. Sand was collected from the college campus and sieved with 600µ sieve. Sand was washed with clean water several times to remove dirt particles. Then it was kept in oven to remove the moisture content.

ii. Gravels were collected from the college campus. Those who had passed through 10 mm sieve were taken for our projects. Gravels were washed with clean water to remove the dirt and kept it in open atmosphere for 24 hours to remove the moisture content.

iii. Activated rice husk have activated by physical process. Rice husk were collected from the local mill. Wash with clean water and then it is dried in the oven for 24 hours. After drying, the rice husks were brought to a brick kiln, where it heated to a temperature of 1000^{o} C for 4 hours under controlled environment. Then again washed it several times with clean water before use.

Fig 2: Sand

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Fig 3: Gravel

Fig 4: Activated Carbon (rice husk)

IV. RESULT AND DISCUSSIONS

Collected water samples are tested in the Environmental Engineering laboratory, GIMT Tezpur and Tezpur (PHE) Division-I laboratory. Overall test results of all the samples (raw and filtered) are summarised in table II. .Different tests are performed in the laboratory for raw and filtered water with 0 % AC (only sand and gravel), 5% AC and 10% of AC (rice husk) and results of respective tests are tabulated and variations of different parameter with different % of AC are graphically shown.

Table II: Overall test result

Test / Location	Water sample	Alkalinity	P^H	Turbidity	Total Solids	Hardness	Acidity	Iron	Fluoride
Komorakata	Raw water	200	7.56	3	260	160	100	0.96	2.10
	Filtered only with sand and gravel	150	7.52	3	240	140	80	0.77	1.94
	Filtered with 5%AC	140	7.44	3	225	140	80	0.49	1.38
	Filtered with 10%AC	120	7.30	2	210	120	60	0.48	0.72
Padumpukhuri	Raw water	200	7.82	5	260	170	110	0.70	2.40
	Filtered only with sand and gravel	190	7.81	4	240	150	110	0.68	2.02
	Filtered with 5%AC	150	7.62	4	200	140	80	0.45	1.54
	Filtered with 10%AC	140	7.60	3	200	100	60	0.35	0.77
GIMT Tezpur	Raw water	260	7.96	20	950	450	40	1.22	0.42
	Filtered only with sand and gravel	250	7.92	15	725	370	20	0.91	0.40
	Filtered with 5%AC	200	7.79	6	540	350	30	0.71	0.35
	Filtered with 10%AC	180	7.71	4	435	300	20	0.55	0.28
Dekargaon	Raw water	120	7.20	5	285	250	100	1.09	0.70
	Filtered only with	70	7.18	3	255	200	90	0.82	0.64

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	sand and gravel								
	Filtered with 5%AC	60	7.09	3	225	180	80	0.58	0.50
	Filtered with 10%AC	50	7.08	3	210	140	60	0.47	0.34

All values are in mg/l except for turbidity (which measured in NTU)

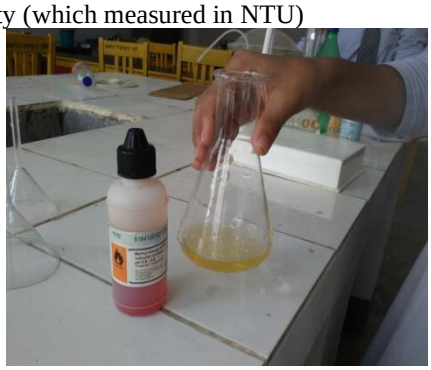

Fig 5: Laboratory Experiment

Fig 6: Laboratory Experiment

i. Alkalinity test

Total Alkalinity= (V x N x 50 x 1000) /ml sample

Normality of H_2SO_4= 0.02 N

V= Volume of burette reading

Results are tabulated in table II. From this table a comparative graph is prepared for different proportion of filter materials.

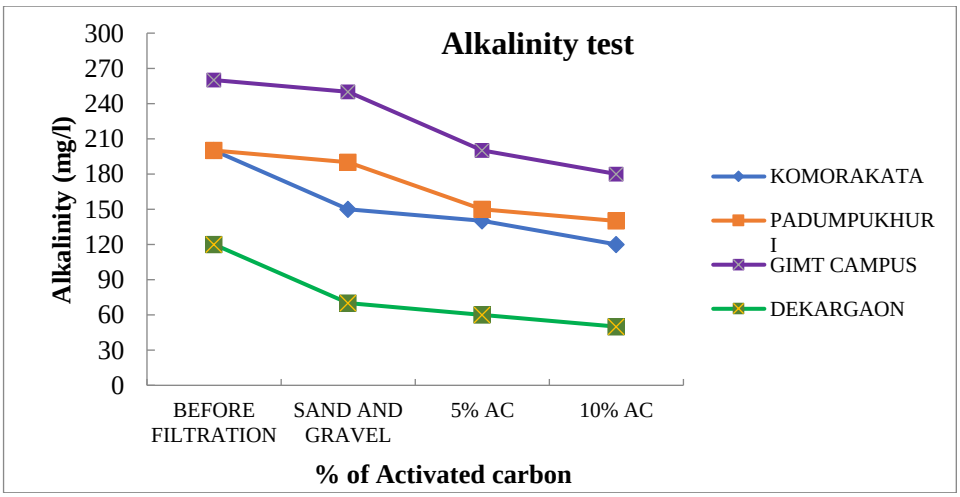

Fig 7: Alkalinity variation with different raw and filtered water

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From this comparative graph it is seen that alkalinity level decreases with increasing activated carbon content for all samples.

ii. Acidity test

Total Acidity= (V x N x 50 x 1000) /ml sample
Normality of NaOH = 0.02 N
V= Volume of burette reading.

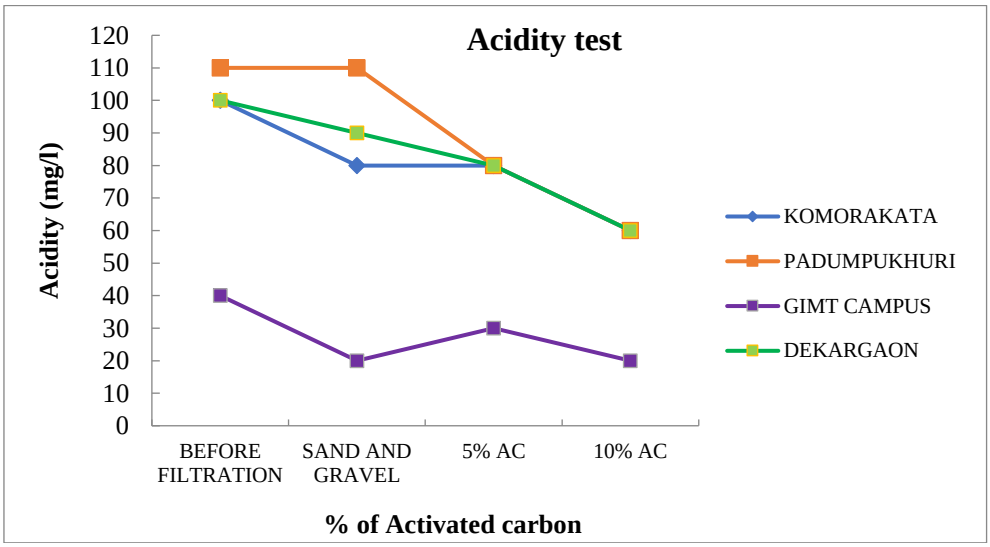

Fig 8: Acidity variation with different raw and filtered water

From this comparative graph it is seen that the acidity level of all the samples decreases at a rate of 20-40 mg/l with addition of 10% AC in filtered media.

iii. P^H test

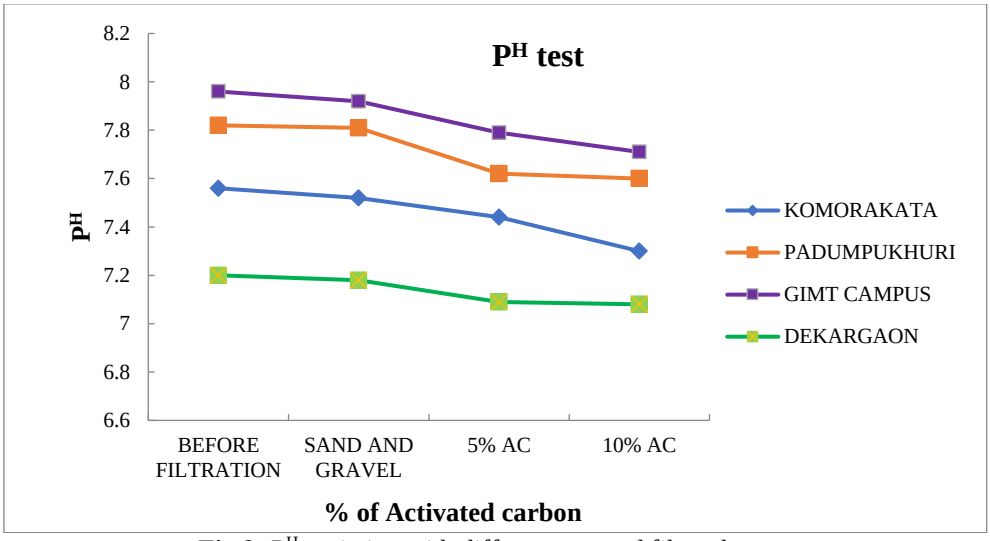

Fig 9: P^H variation with different raw and filtered water

From this graph we can see that before filtering, all the water samples have P^H more than 7. With the addition of activated carbon in the filter media, little drawdown of P^H is noticed.

iv. Hardness test

Total Hardness = (VXMX100X1000)/ml sample
Molarity of EDTA=0.01M

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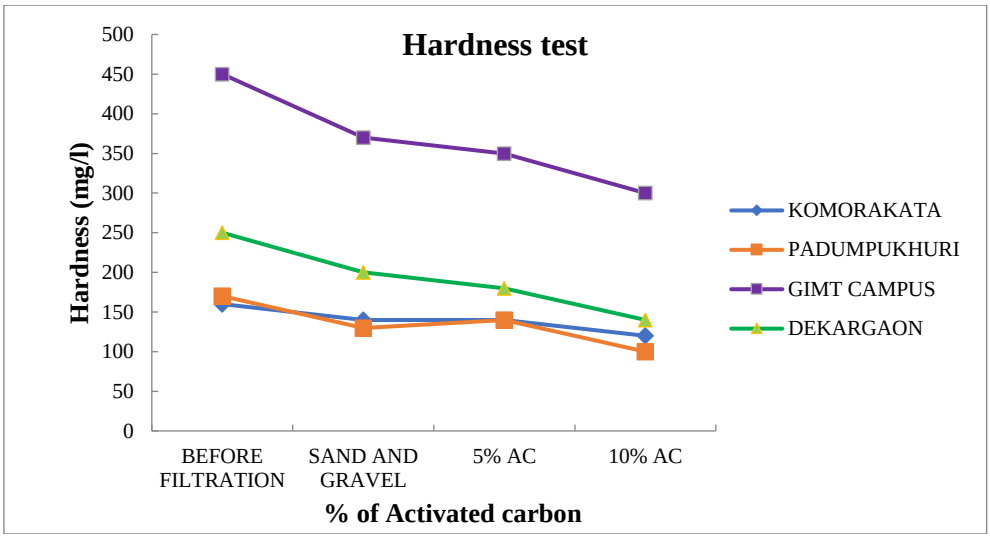

Fig 10: Hardness variation with different raw and filtered water

From this graph we can see that before filtration, hardness of the water sample collected from GIMT CAMPUS is on the higher side. Filtering with AC (from rice husk) and also sand and gravel gave the best results because after filtering with these filters media, all the samples have hardness with in permissible limits.

v. Iron test

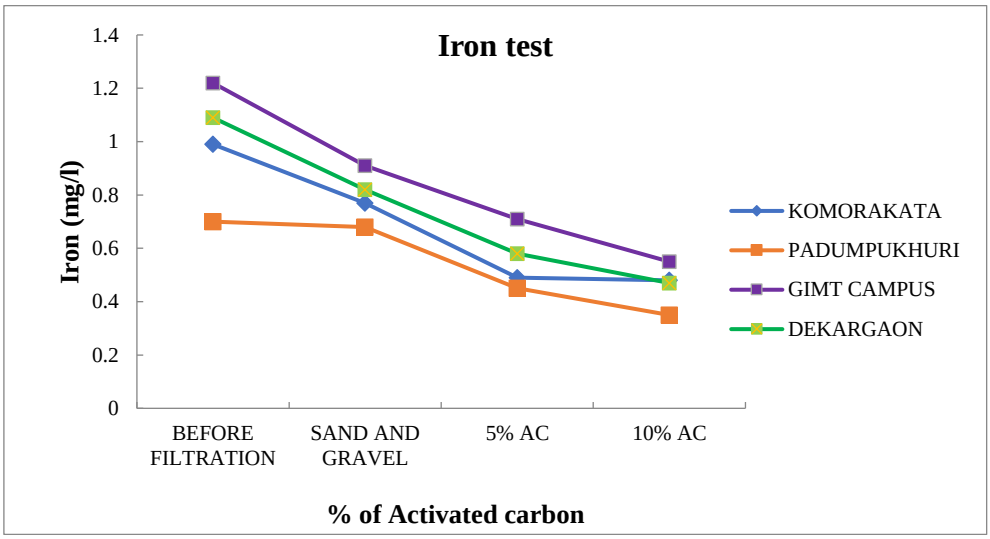

Fig 11: Iron variation with different raw and filtered water

From this graph we can see that before filtration, iron concentration the water sample collected from Dekargaon and GIMT CAMPUS are above the permissible limits. Filtering with AC (from rice husk) decrease the iron content, all the samples have iron concentration with in permissible limits. Sand and Gravel also can be used as filter media to remove iron content. 5% and 10% AC of rice husk gave good results.

vi. Total Solids

Total Solids = $(W_2\text{-}W_1)$ x 1000 x 1000/ ml of sample

W_1= weight of empty evaporating dish

W_2= weight of dish with sample after 1hr of evaporation

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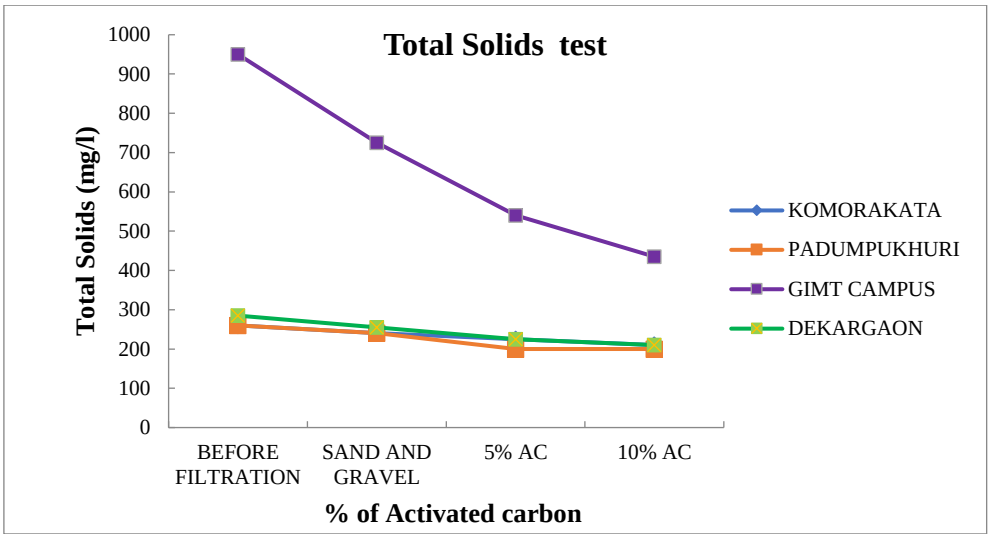

Fig 12: Total Solids variation with different raw and filtered water

From this graph we can see that before filtration, total solids of the water sample collected from GIMT is above the desirable limits. Filtering with 5% and 10% AC (rice husk), all the samples have total solids with in desirable limits.

vii.Turbidity test

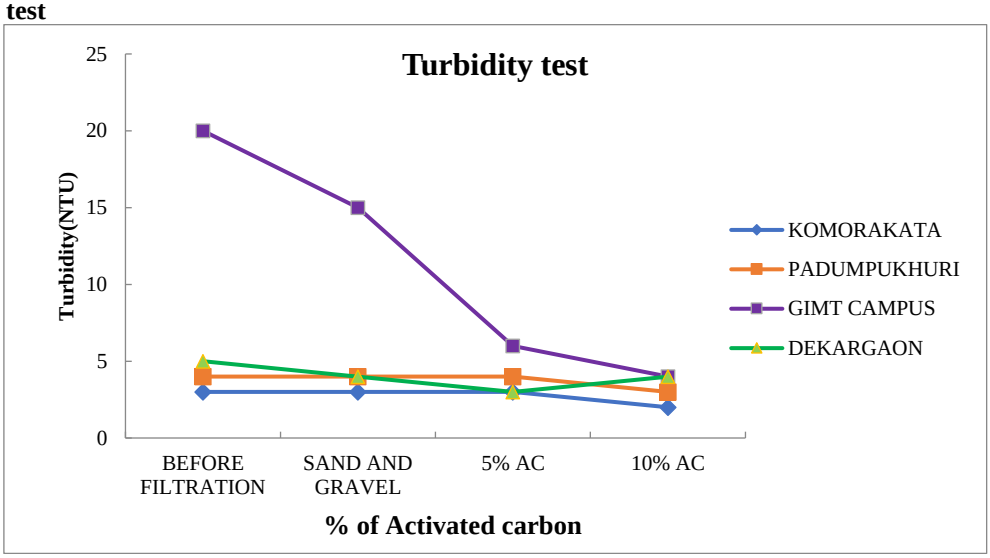

Fig 13: Turbidity variation with different raw and filtered water

From this graph we can see that before filtration, turbidity the water sample collected from GIMT above the permissible limits. Filtering with 10% AC (rice husk) will give the best results because all the samples have turbidity with in permissible limits. Sand and gravel also reduces the turbidity level to some extent.

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viii. Fluoride Test

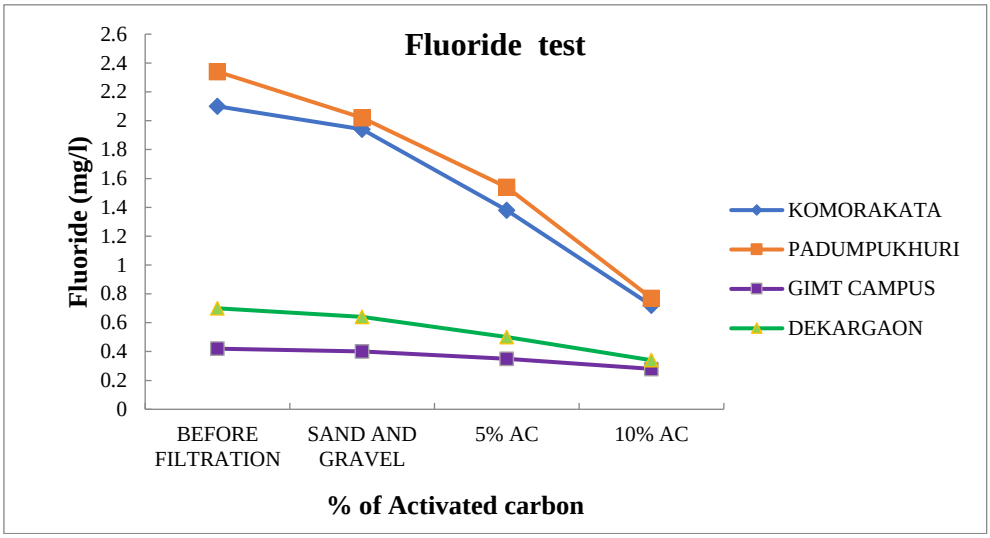

Fig 14: Fluoride concentration variation with different raw and filtered water

From this graph we can see that before filtration, fluoride concentration the water sample collected from Komorakata and Padumpukhuri are above the permissible limits. Filtering with 5% AC (from rice husk) will give the best results because all the samples have fluoride concentration with in permissible limits, with 10% addition of AC with fluoride concentration of Dekargaon and GIMT, Tezpur drop below the minimum permissible concentration.

V. CONCLUSION

During our project we have collected water samples from Padumpukhuri, Komorakata, Dekargaon and GIMT, Tezpur campus. We have done Acidity, Alkalinity, Fluoride, Hardness, Iron, P^H, Total Solids and Turbidity test. After that the collected samples allowed to pass through proto type filter using activated carbon of 5% and 10% of rice husk and coconut shell as absorbent. We have shown a comparative study of different proportion of Activated Carbon on water parameter and came to the conclusion that

Before filtration the samples of GIMT Tezpur had more concentration of total solids, turbidity, hardness, iron then desirable and permissible limits. The sample collected from Dekargaon also has higher concentration of iron than permissible limits. The samples of both Komorakata and Padumpukhuri had higher concentration of fluoride than the permissible limit set by BIS.

The activated carbons which we had used, successfully act as adsorbent and give all the respective parameter within the range. As the % of activated carbon increases the adsorbing capacity also increases.

Normally used Sand Gravel house hold filter remove Hardness, Total solids and Turbidity to some extent. It is not suitable for removing of Fluoride, Alkalinity and Iron.

a. Scope for further study

Though this is a time bound project, we have to summarize our work in short. But in future different works can be done relating to this project. Such as Heavy metal contamination such as chromium, mercury, arsenic, zinc etc can be checked. Another natural waste product such as corn curbs, nut shell and sugarcane ash can be used as activated carbon. If this filter work for removing of all harming parameters (heavy metals) present in water, then this can be proposed for household filter at low cost

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