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PERFORMANCE EVALUATION OF A SLOW SAND FILTER BY REPLACING SAND WITH DIFFERENT FILTER MEDIUMS

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ABSTRACT

This paper presents how the addition of different filter mediums to a water purification system will enhance the water quality generated. In this research, four different mediums namely activated carbon, activated alumina, white silica sand, and red mud are used to make different combinations of filters. The experiments were performed on distinct kinds of combinations of filters. The wastewater samples were collected from the Toilet and Bathroom respectively and various water quality parameters were analysed by performing tests on water samples before filtration and after filtration. The adsorption of activated carbon, activated alumina, white silica sand, red mud for water purification significantly improved the various water quality parameters. The most efficient filter model was the combination of all four filter mediums including sand and gravel.

Keywords: Filtration, Water Quality Parameters, Activated Carbon, Activated Alumina, White Silica Sand, Red Mud.

I. INTRODUCTION

Activated carbon filtration is one of several techniques employed in water treatment to eliminate impurities such as organic compounds because it may also remove odour causing contaminants. It is frequently employed to make drinking water more acceptable. It is commonly used in potable water purposes. Adsorption is how carbon filters eliminate pollutants.

Organic substances connect or stick to the surfaces of a carbon filter since water and pollution are also both polar in nature that attracted one another. Carbon filters have a greater surface area and are very porous, which makes them effective in eliminating undesirable tastes, odors, and other contaminants from water.

When water passes across a carbon filter, it acts like a parking area, having pores for contaminants to enter. The tiny openings are measured in microns. The lower the micron, the finer the filtering. Contaminants have additional opportunity to park or attach to the carbon due of the lower flowing rate and pressure. The lengthier water is in connection with a carbon filter's surfaces, the more efficient is the filtration.

II. OBJECTIVE OF THE STUDY

- To know the performance of different filter mediums on the quality of water.
- To determine the most efficient combination of filter for the removal of impurities.

III. METHODOLOGY

In this research we prepared 5 different models made from activated carbon, white silica sand, red mud, activated alumina and to study the efficiency of filters to select the best combination of material. The major goal of this study was to investigate the effectiveness of different materials on various water quality parameters.

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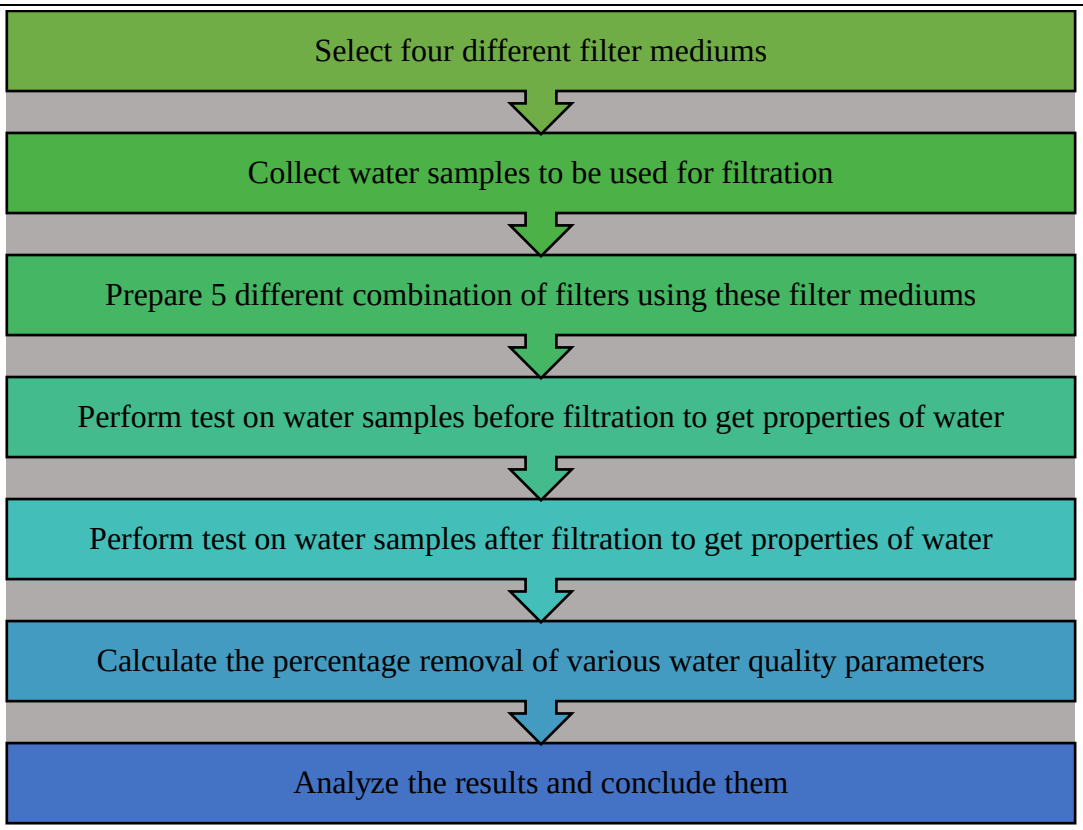

Fig 1: Flow Chart to Complete the Research Work

Mix Formation

Table 1: Different Combination of material for prepare Filter

Material in Layer	Model-1	Model-2	Model-3	Model-4	Model-5
Layer 1	Activated Carbon	Activated Alumina	Activated Carbon	Activated Carbon	Activated Carbon
Layer 2	White Silica Sand	White Silica Sand	Activated Alumina	Activated Alumina	Activated Alumina
Layer 3	Red Mud	Red Mud	White Silica Sand	Red Mud	White Silica Sand
Layer 4		-	-	-	Red Mud

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Parameters studied for Analysis

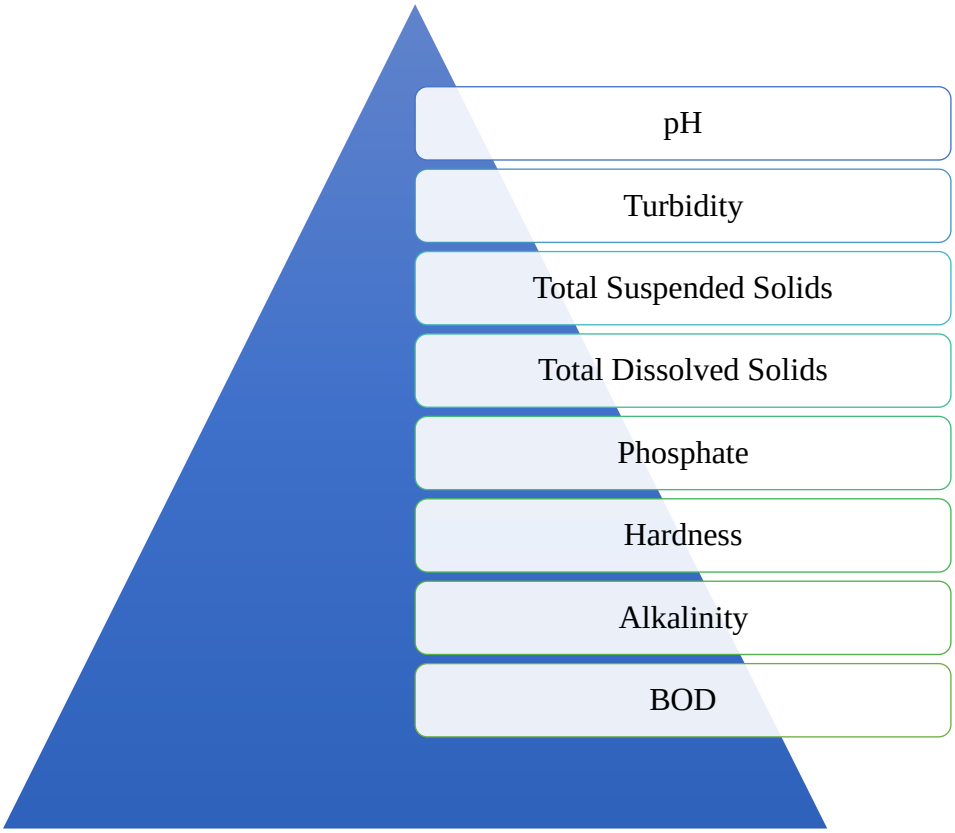

Fig 2: Flow Chart of Water Quality Parameters Analysed

IV. RESULT & DISCUSSION

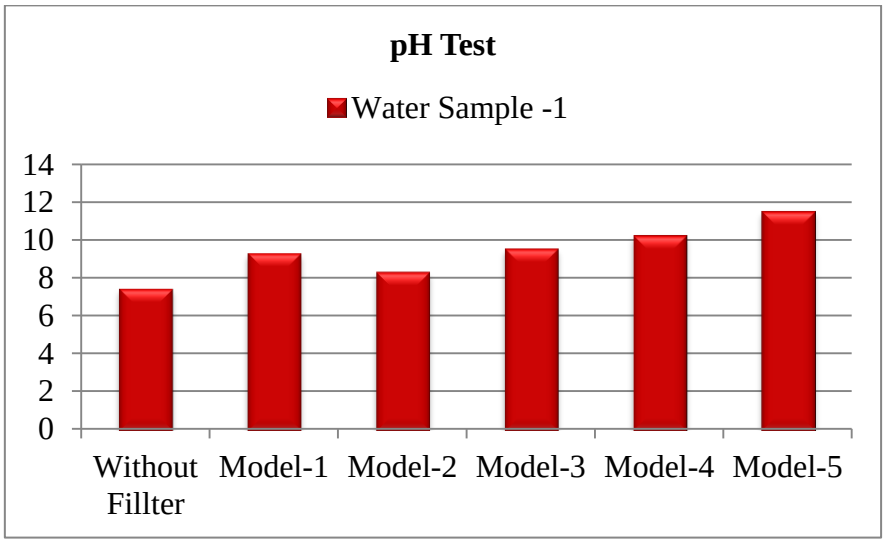

Fig 3: pH Test value of collected Water sample-1

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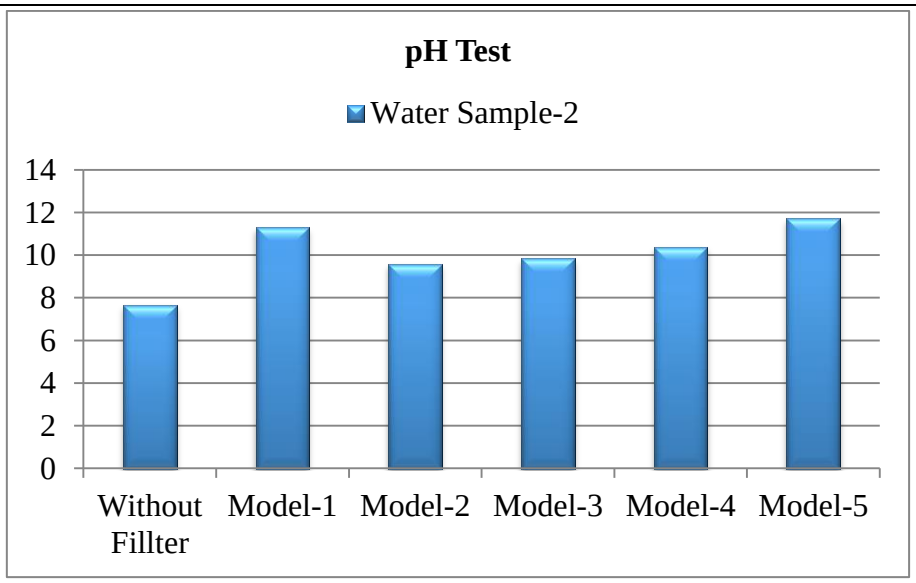

Fig 4: PH Test value of collected Water sample-2

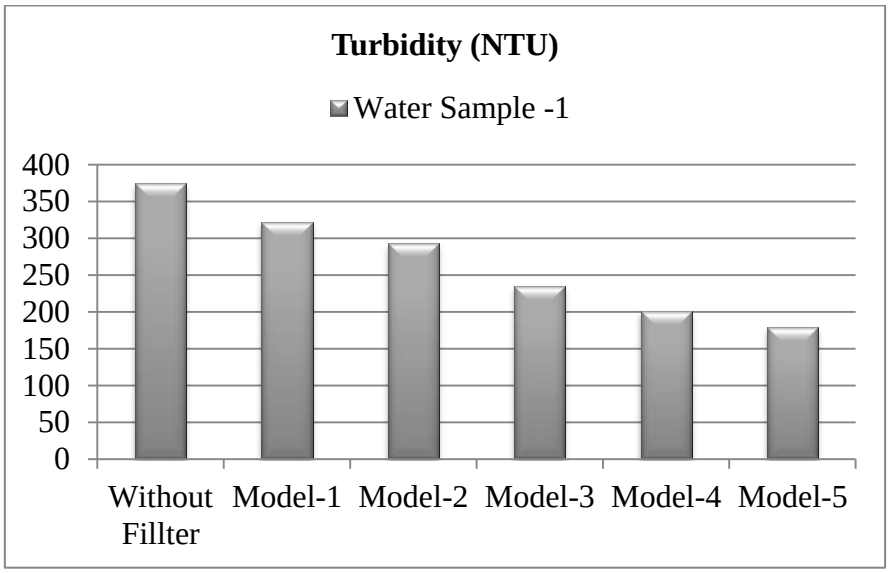

Fig 5: Turbidity Test value of collected Water sample-1

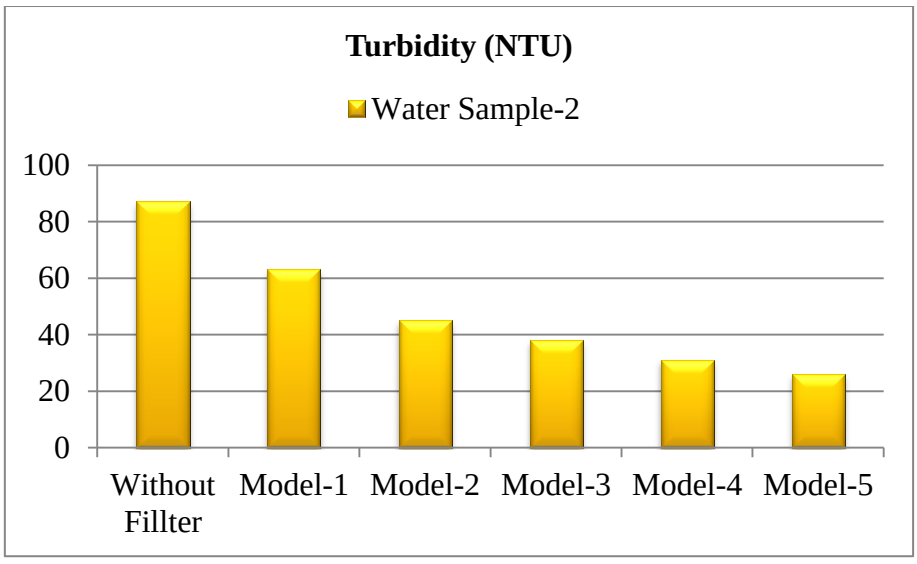

Fig 6: Turbidity Test value of collected Water sample-2

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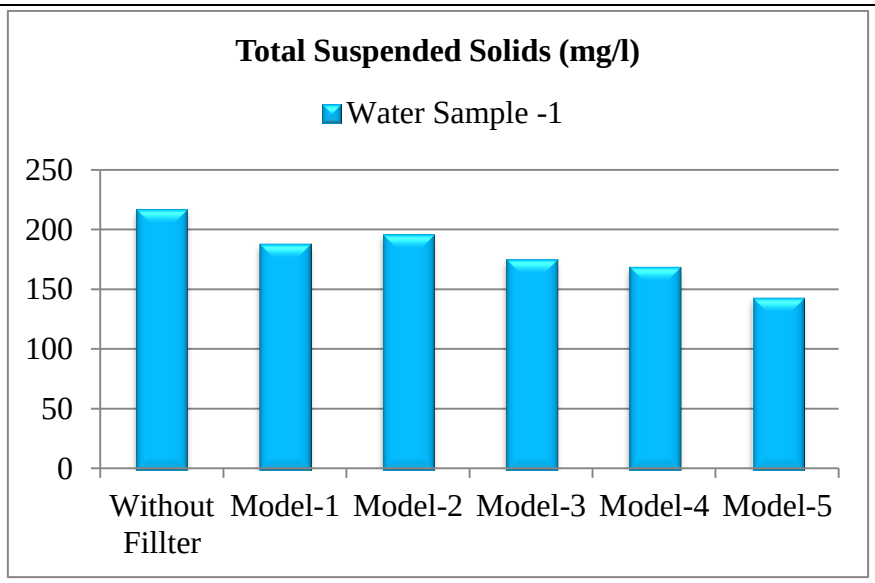

Fig 7: Total Suspended Solids Test value of collected Water sample-1

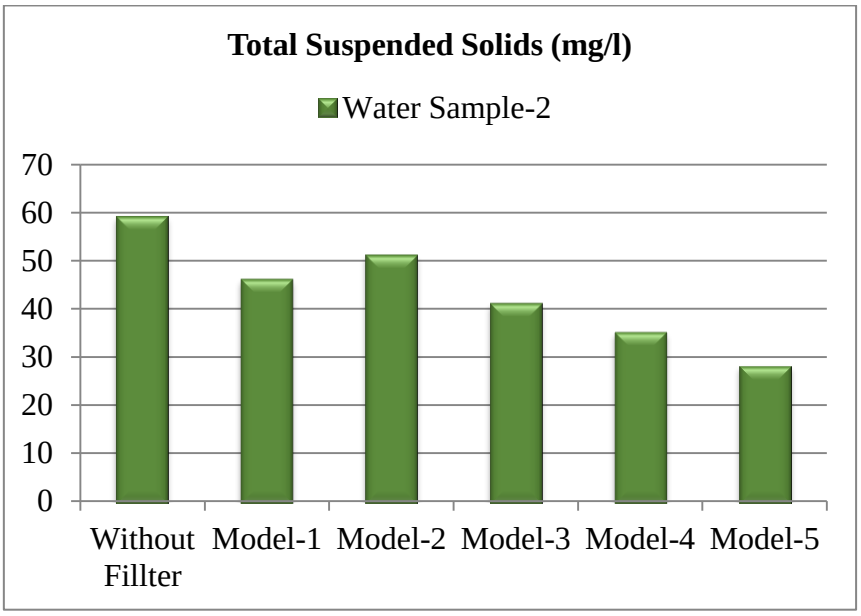

Fig 8: Total Suspended Solids Test value of collected Water sample-2

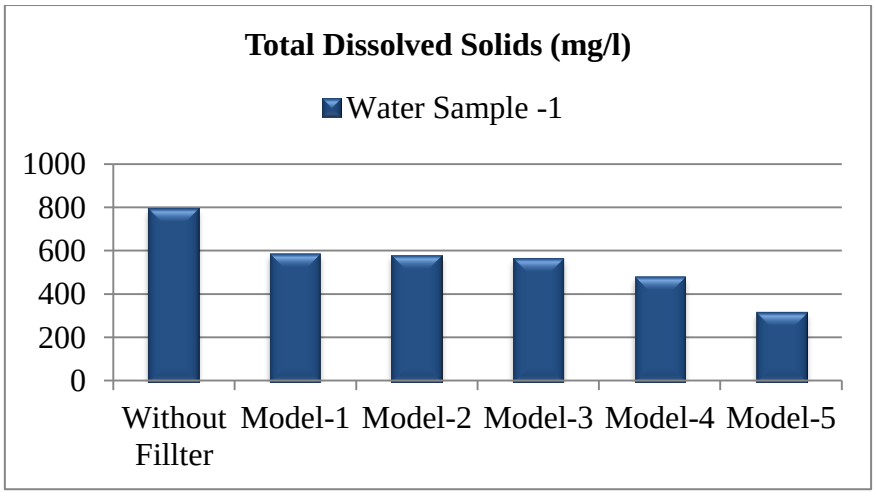

Fig 9: Total Dissolved Solids Test value of collected Water sample-1

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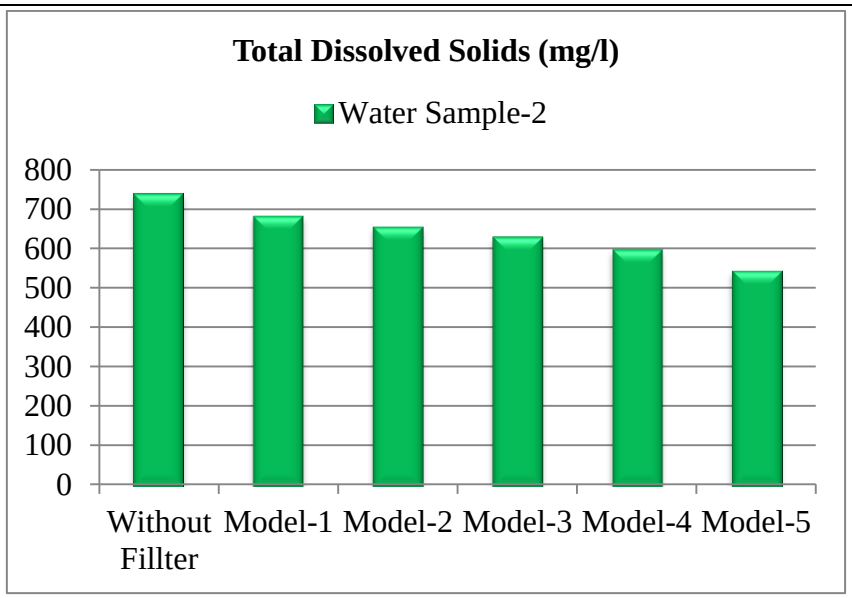

Fig 10: Total Dissolved Solids Test value of collected Water sample-2

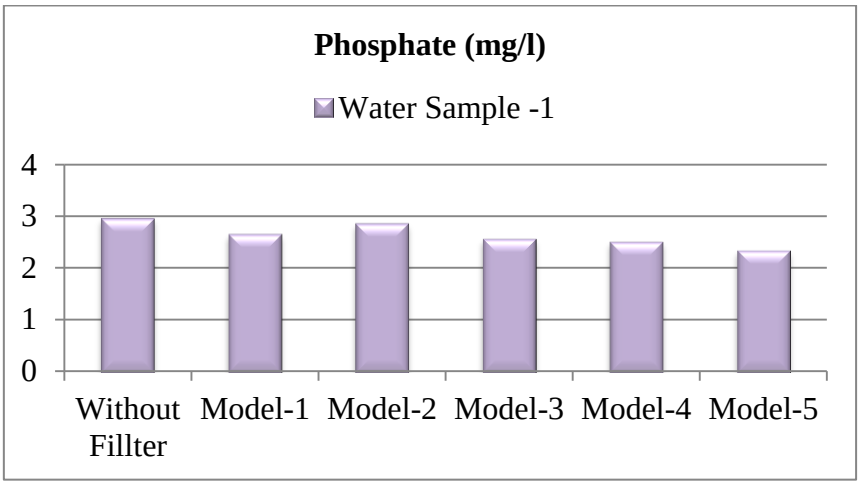

Fig 11: Phosphate Test value of collected Water sample-1

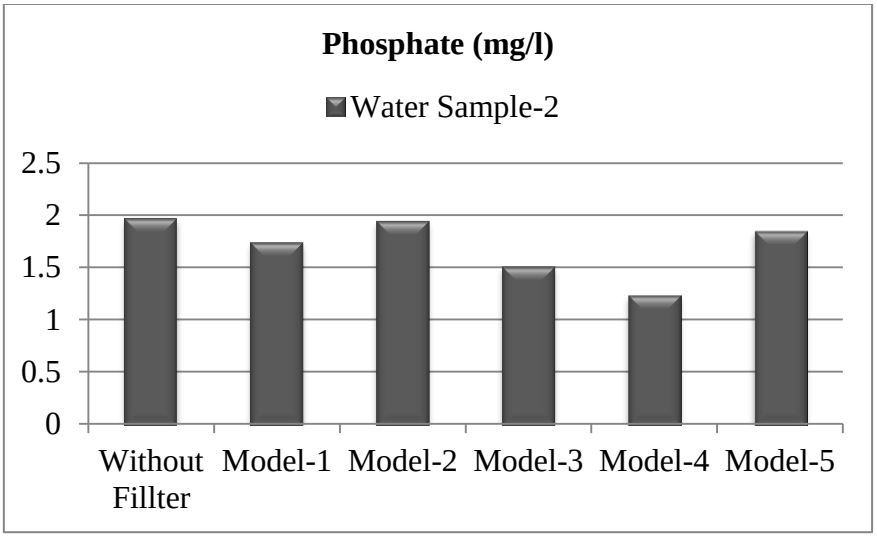

Fig 12: Phosphate Test value of collected Water sample-2

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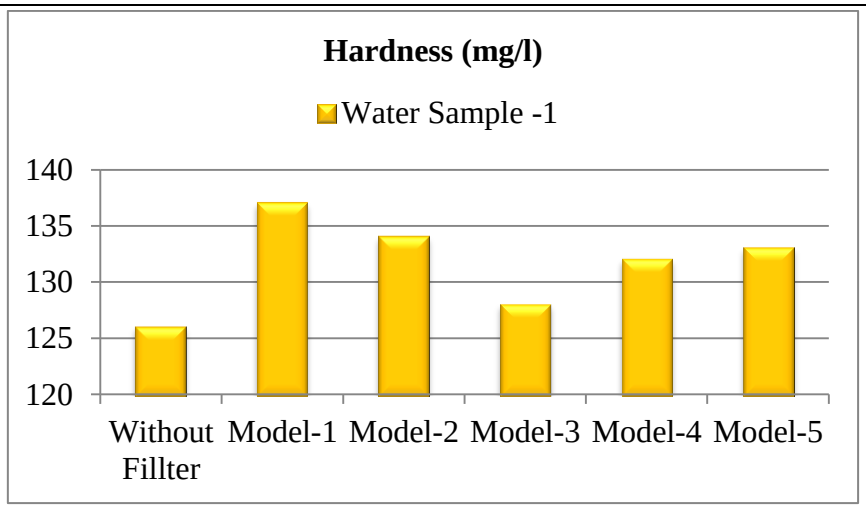

Fig 13: Hardness Test value of collected Water sample-1

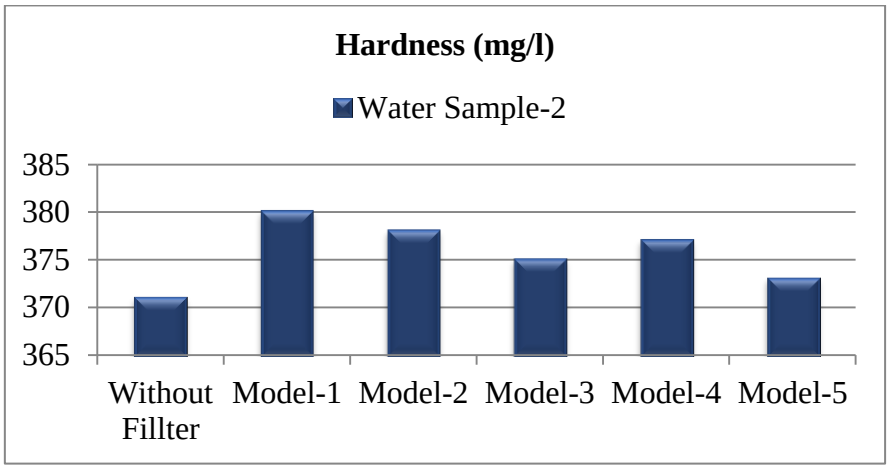

Fig 14: Hardness Test value of collected Water sample-2

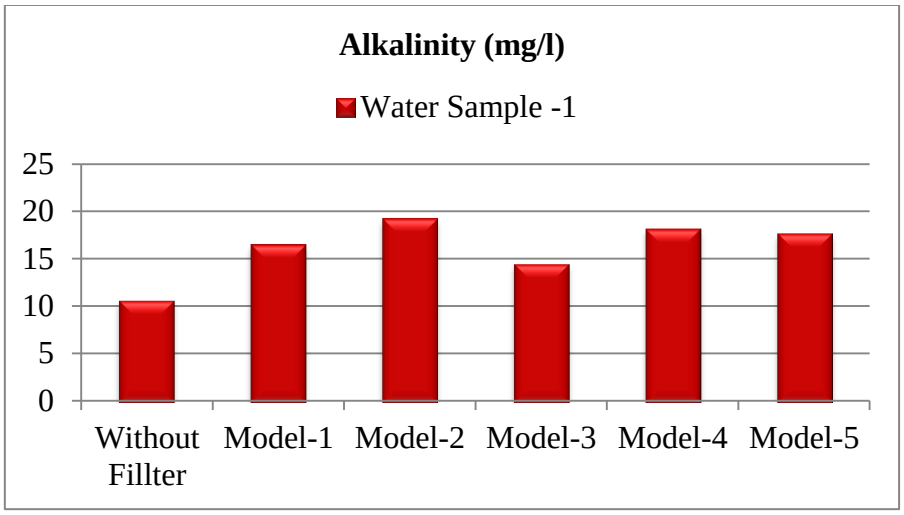

Fig 15: Alkalinity Test value of collected Water sample-1

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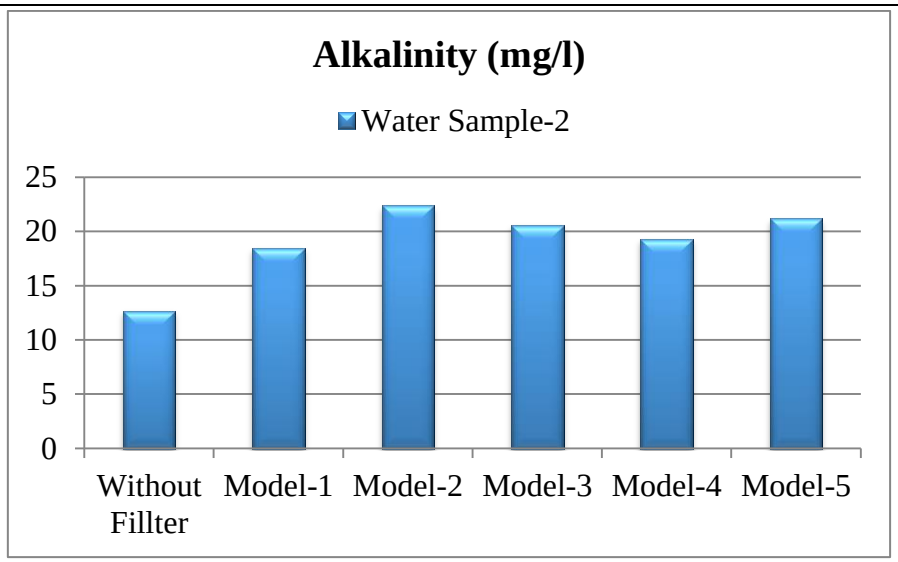

Fig 16: Alkalinity Test value of collected Water sample-2

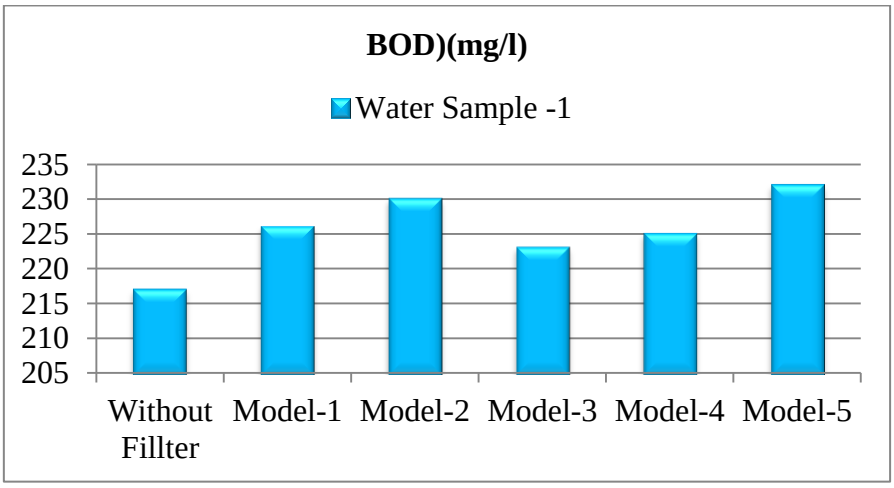

Fig 17: BOD Test value of collected Water sample-1

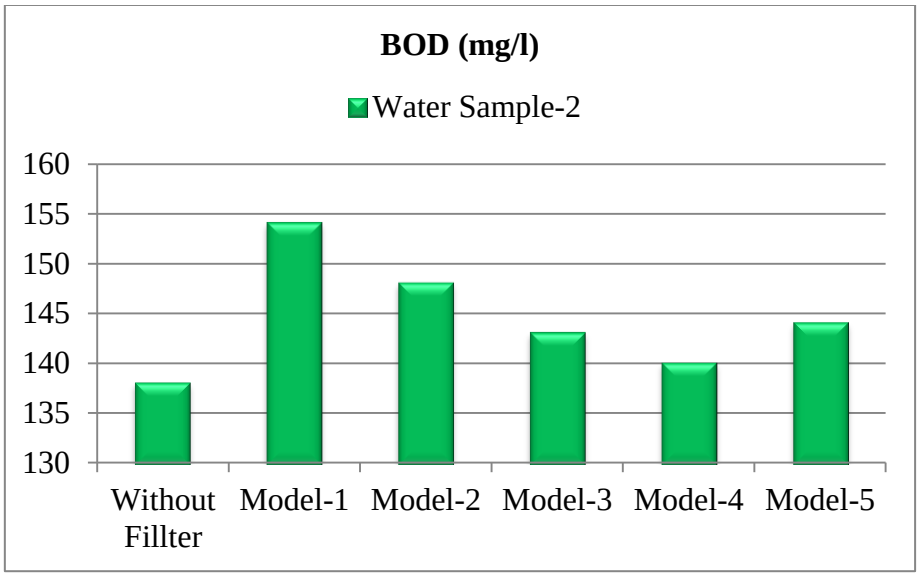

Fig 18: BOD Test value of collected Water sample-2

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Table 2: Percentage Changes of Parameters by Different Models with Water Sample-1

Parameters	Model-1	Model-2	Model-3	Model-4	Model-5
pH	25.40695	12.00488	28.62181	38.06294	12.51719
Turbidity	13.9037	21.6578	37.1658	46.5241	52.139
TSS	13.4259	9.72222	19.4444	22.2222	34.2593
TDS	26.2958	27.1808	28.9507	39.5702	60.3034
Phosphate	10.4025	3.44475	13.5061	15.3479	21.1801
Hardness	8.730159	6.349206	1.587302	4.761905	5.555556
Alkalinity	56.25119	82.44894	36.33327	71.81714	66.99752
BOD	4.147465	5.990783	2.764977	3.686636	3.111111

Table 3: Percentage Changes of Parameters by Different Models with Water Sample -2

Parameters	Model-1	Model-2	Model-3	Model-4	Model-5
pH	47.51662	25.02933	28.23621	35.49733	12.86319
Turbidity	27.5862	48.2759	56.3218	64.3678	70.1149
TSS	22.0339	13.5593	30.5085	40.678	52.5424
TDS	7.72358	11.5176	14.9051	19.2412	26.5583
Phosphate	11.8792	1.4849	23.5535	37.6344	6.298
Hardness	2.425876	1.886792	1.078167	1.617251	0.539084
Alkalinity	45.75777	76.47847	62.37975	52.21574	67.38685
BOD	11.5942	7.246377	3.623188	1.449275	2.857143

V. CONCLUSION

Activated Carbon

Activated Carbon pH is between 9.5 - 11 that makes water more alkaline. It can purify the water by reducing its acidic dirt. Activated carbon reduces water turbidity by removing organic waste. Activated carbon is a media that have capability of removing dirt particles from Suspended Solids. Activated carbon can also remove copper particles from water and increase its purity. Activated carbon in “granular” form can remove iron from water. Activated carbon in “granular” form can also be used for removing Phosphate because it is a major pollutant of water and carbon have high adsorption ability. High quality activated carbon filters can remove chlorine up to 95%. As an experimental work Activated Carbon can remove chromium from polluted water as it has ability to absorb Cr (ions) from polluted waste.

Activated Alumina

Generally activated alumina is used for removing Fluoride. It increases pH significantly. Activated alumina reduces water turbidity by removing fluoride. Activated alumina can be used to remove maximum part of fluoride. Activated alumina absorb contaminants instead of filtering them so it has no reaction on elements except fluoride. No significant effect on iron, phosphate, Chlorine, Ammonia, Chromium was observed.

White Silica Sand

Generally white silica sand pH is closer to 7.0 which means it is neutral in pure form so it can neutralize acidic elements and maintain the water level and purify it. White silica sand effects turbidity by reducing acidity of dirt and reduces its impurities. White silica sand can be used for suspended solid particles filtration. White silica sand can filter mostly dissolved impurities. White silica sand mostly used in industrial solid waste filtration. No reaction on copper and ammonia. Active silica sand used as phosphoric acid removing agent can neutralize the phosphate acidic properties.

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Red Mud

Red mud is highly alkaline. Its pH is between 10.5-12.5 that can be reducing acidity. As an alkaline source it can be used for removing acidic turbidity. Red mud reduce acidity and surface solid into the lower part. It reduces acidity of dissolved materials. Red mud can be used in copper reduction. Red mud increases iron level because it has already 30-50% of iron oxide. Red mud can reduce phosphate by adsorption. Red mud works as a catalyst and react with ammonia, after that ammonia convert into nitrogen & hydrogen. Red mud also neutralize Chromium by adsorption.

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