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Efficiency of Clay Filters in Removal of Impurities from Waste Water

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ABSTRACT

Work presented is a preliminary investigation of water purification using clay filters. This work was carried out to determine the efficiency of clay pots (as a filter) in removing water impurities. Filters and the related parts were fabricated and its efficiency in removing EC, TDS, TSS, hardness, BOD, COD, and some ions like Ca, Mg, Na, K, chloride, sulphate, Oil and grease was measured by passing water through the clay filters. The clay filters showed excellent efficiency in removal of TSS, BOD, COD, Oil and grease, sodium and potassium and negligible potential to remove hardness, EC, TDS, chloride and sulphate of water.

Keywords: *Water treatment, Clay filters, domestic waste water.*

INTRODUCTION

Water is a precious natural resource used for domestic, industrial and agricultural purposes. Estimation of water quality is an important criteria for evaluating the suitability of water for drinking and industries. The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. Natural water contains some types of impurities whose nature and amount vary with source of water. Metals for example, are introduced in to aquatic system through several ways which include, weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere and from several human activities, including mining, processing and the use of metal based materials.

Surface water sources like shallow wells, rivers, lakes are potential sources of contaminations due to discharge of domestic and industrial waste. In contrast, contaminants are less likely to occur in deeper ground water reservoirs because contaminants get filtered while travelling greater depths to reach the water [11]. Contaminated water sources affect the health and economic status of the populations [6]. Even if no sources of anthropogenic contamination exist, there is potential for natural levels of heavy metals and chemicals to be harmful to human health. Based on the reports of World Health Organization (WHO), nearly 85 percent out of 1.5 billion population of the world has no access to healthy and uncontaminated water. Inexpensive and appropriate technologies including Point of Use (POU) and Point of Entry (POE) are more considered [3]. Application of appropriate technology in the consumption and the entry points may significantly help water provision for small communities through considering a suitable and healthy quality for drinking water [15]. One of the methods of water purification in this category is the use of ceramic filters [14]. These filters may be produced with different materials and in various forms; however, the most common ceramic filters in the world are diatomaceous filters, which are supplied in candle, plate and vase forms. These ceramic filters have become conventional in some parts of the world, such as India and Nepal [10]. In this work, the efficiency of removal water impurities by clay filters was studied.

MATERIALS AND METHODS

The soil sample is collected from Kathora Village of Amravati district (India) from sampling sites. Samples were powdered using pestle and mortar and sieve analysis was carried out using AIMIL Sieve shaker. Soil samples having particle size in the range of 2.36- 2.00 mm, 2.00-1.00 mm, and 1.00 mm-600µ, 600µ-425µ and ingredients like saw dust, rice husk and wheat husk were used for making round shape porous pellets. Pellets were dried & baked in muffle furnace at 750°C for 30 minute to form clay filter. These filters were soaked in distilled water for 24 hrs. and then washed thoroughly with 0.1 N HCl and several times by distilled water before use.

The domestic waste water samples from locality Shegaon naka, Rathi nagar, Gadge nagar and Rahatgaon of Amravati city was collected in prewashed (with detergent, dil. HNO_3 and doubly distilled water,) polythene bottle. Before filling the water samples the bottle was rinsed with the water sample. In the present work, waste water sample and water samples after filtering through baked filters were studied as a part of treatment of waste water with respect to pH, Electrical conductivity, TSS, BOD, COD, Oil and grease, Total hardness, TDS, and ions like Ca, Mg, Na, K, Chloride, and Sulphate content. Standard [2] methods were used for the analysis of samples. Chemicals used were of AR/GR grade and obtained from Qualigen /E-Merck/Hi-media. For pH and conductivity measurement digital pH meter (Model Eq-610) and digital conductivity meter (Model Eq-660A) Equiptronics make were used.

RESULTS AND DISCUSSION

Efficiency of clay in removing pH, Electrical conductivity, total dissolved solids, total suspended solids, hardness, biological oxygen demand, Chemical oxygen demand, and some ions like Ca, Mg, Na, K, chloride, sulphate, Oil and grease contents of waste sample before treatment and after passing through clay filters were carried out and results are given in tables 1,2,3,4.

The clay filters ≤ 2.36 mm have shown excellent efficiency in removal of total suspended solids. 100% removal of total suspended solids was found in original filter as well as saw dust blended filter. In case of rice husk blended filter there is 86% removal of total suspended solids and in case of wheat husk blended filter the removal is 84%. Similarly BOD removal in original filter is 62%, in saw dust blended filter 53 %, rice husk blended filter 45 % and in wheat husk blended filter removal was 56 %. Similarly COD removal in original filter is 44%, in saw dust blended filter 41 %, in rice husk blended filter 34 % and in wheat husk blended filter removal was found to be 30 %. Similarly Oil and grease was removed by original filter completely and there is incomplete removal of oil and grease by other blended filters. Thus the results indicate that the original filter ≤ 2.36 mm clay, showed excellent characteristics of TSS removal and moderate efficiency of BOD, COD, oil and grease removal . Thus the blending didn't show any measurable outcome. Waste water when passed through ≤ 2.36 mm clay filter pH of water sample was increased marginally. There is an decrease in EC by about 1 to 2 % which is to be ascribed to negligible decrease in Ca^{2+}. Similarly other ions like Mg^{++}, Cl^-, SO_4^{--} Na^+, K^+ show negligible removal by original as well as blended filters.

The clay filter ≤ 2.00 mm have shown excellent efficiency in removal of total suspended solids. 100% removal of total suspended solids was found in original filter, saw dust blended filter as well as rice husk blended filter. In case of wheat husk blended filter the removal is 90%. Similarly BOD removal in original filter is 73%, in saw dust blended filter 66 %, in rice husk blended filter 62 % and in wheat husk blended filter removal was 57%. Similarly COD removal in original filter is 52%, in saw dust blended filter 48 %, in rice husk blended filter 44% and in wheat husk blended filter removal was found to be 41%. Similarly Oil and grease was removed by original filter, saw dust blended filter and rice husk blended filter completely and there is incomplete removal of oil and grease by wheat husk blended filter. Thus the results indicate that the original filter ≤ 2.00 mm clay showed excellent characteristics of TSS removal and moderate efficiency of BOD, COD, oil and grease removal. Results also show that the blending didn't show any positive outcome. Waste water when passed through ≤ 2.00 mm clay filter pH of water sample was increased marginally. There is an decrease in EC by about 1 to 2 % which is to be ascribed to negligible decrease in Ca^{2+}. Similarly other ions like Mg^{++}, Cl^-, SO_4^{--} Na^+, K^+ show negligible removal by original as well as blended filters.

The clay filter ≤ 1.00 mm has shown excellent efficiency in removal of total suspended solids. 100% removal of total suspended solids was found in original filter, saw dust blended filter as well as rice husk blended filter. In case of wheat husk blended filter the removal is 93%. Similarly BOD removal in original filter is 80%, in saw dust blended filter 72%, In rice husk blended filter 70% and in wheat husk blended filter removal was 61 %. Similarly COD removal in original filter is 56%, in saw dust blended filter 53 %, in rice husk blended filter 51 % and in wheat husk blended filter removal was found to be 44 %. Similarly Oil and grease was removed by original filter, saw dust blended filter and rice husk blended filter completely and there is incomplete removal of oil and grease by wheat husk blended filter. Thus the results indicate that the original filter ≤ 1.00 mm clay showed excellent characteristics of TSS removal and moderate efficiency of BOD, COD, oil and grease removal. In this case also the blending didn't show any positive outcome. Waste water when passed through ≤ 1.00 mm clay filter pH of water sample was increased marginally. There is a decrease in EC by about 1 to 2 % which is be ascribed to negligible decrease in Ca $^{2+}$. Similarly other ions like like Mg^{++}, Cl^{-}, SO_4 $^{--}$ Na^{+}, K^{+} show negligible removal by original as well as blended filters.

Excellent efficiency in removal of total suspended solids was also found for ≤ 600 µ 100% removal of total suspended solids was found in original filter, saw dust blended filter , rice husk blended filter, and wheat husk blended filter. Similarly BOD removal in original filter is 84%, in saw dust blended filter 78%, in rice husk blended filter 76 % and in wheat husk blended filter removal was 73 %. Similarly COD removal in original filter is 64%, in saw dust blended filter 57%, in rice husk blended filter 55 % and in wheat husk blended filter removal was found to be 51%. Similarly Oil and grease was removed by original filter, saw dust blended filter and rice husk blended filter completely and there is incomplete removal of oil and grease by wheat husk blended filter. Thus the results indicate that the original filter ≤ 600 µ clay showed excellent characteristics of TSS removal and moderate efficiency of BOD, COD, oil and grease removal. Results also show that the blending didn't show any positive outcome. Waste water when passed through ≤ 600 µ clay filter pH of water sample was increased marginally. There is a decrease in EC,which is to be ascribed to negligible decrease in Ca $^{2+}$. Similarly other ions like like Mg^{++}, Cl^{-}, SO_4 $^{--}$ Na^{+}, K^{+} show negligible removal by original as well as blended filters.

Thus out of all the filters having particle size ≤ 2.36 mm, ≤ 2.00 mm, ≤ 1.00 mm and ≤ 600 µ original clay filters have shown excellent characteristics of removal of TSS and Oil and grease, fairly good tendency in removal of BOD and COD as compared to blended filters.

The pH of water provides vital information in many types of geochemical equilibrium or solubility calculations. It is linked with carbon-dioxide, carbonate and bicarbonate equilibrium. The combination of CO_2 with water forms carbonic acid which affect the pH of water [9]. The use of ash or charcoal has been found to facilitate removal of iron by making the water alkaline, which subsequently precipitates iron as goethite or ferrihydrate (Houben,2003). A study on removal of iron from ground water by ash [4] has reported the decrease in iron content almost to 50% and simultaneous increase of pH of the sample. However they found decrease in total suspended solids, biological oxygen demand, chemical oxygen demand, Oil and grease, metal ions like Na and K.

For the first time in this work, clay filters were used as a filter. Other workers [1][9][13] showed that clay pot (Ceramic filter) had an excellent efficiency for removing of turbidity and microbial inhibitors.

Table 1 : After filtration through ≤ 2.36 mm clay filter

SN	PARAMETER (All in Mg/lit Except pH & EC)	Before Filtration	Domestic Sewage water filtered through clay Filter (Black soil ≤ 2.36mm sieve)			
			Original Sieved soil	Sieved soil + Saw dust	Sieved soil + Rice husk	Sieved soil +Wheat husk
1	pH	7.35	7.40	7.37	7.37	7.35
2	TSS	138	Nil	Nil	10	22
3	BOD(27°C at 3Days)	37	14	17.5	20.2	22.6
4	COD	172.0	96.0	102.0	114.6	121.0
5	OIL & GREASE	8	Nil	4	6	4
6	EC (µS/cm)	960	958	953	951	954
7	Total Hardness	346	342	337	332	341
8	TDS	657	653	654	650	652
9	Calcium	58.6	54	52.4	49.8	51.5
10	Magnesium	48.4	47.7	48.3	47.9	48.2
11	Chloride	167	167	167	164	158
12	Sulphate	141	139	140	136	140
13	Sodium	42.6	41.3	41.0	41.0	41.8
14	Potassium	9.5	8.7	8.6	9.2	9.4

Table 2 : After filtration through ≤ 2.00 mm clay particle filter

SN	PARAMETER (All in Mg/lit Except pH & EC)	Before Filtration	Domestic Sewage water filtered through clay Filter (Black soil ≤ 2.00 mm sieve)			
			Original Sieved soil	Sieved soil + Saw dust	Sieved soil + Rice husk	Sieved soil +Wheat husk
1	pH	7.35	7.40	7.38	7.38	7.37
2	TSS	138	Nil	Nil	Nil	14
3	BOD(27°C at 3Days)	37.0	10.0	12.7	13.8	16.0
4	COD	172	82	90	97	102
5	OIL & GREASE	8	Nil	Nil	Nil	4
6	EC (μS/cm)	960	957	954	951	954
7	Total Hardness	346	342	340	335	344
8	TDS	657	650	654	649	648
9	Calcium	58.6	53.8	53.4	51.4	50.7
10	Magnesium	48.4	48.2	48.0	47.8	47.9
11	Chloride	167	167	166	167	165
12	Sulphate	141	140	138	139	140
13	Sodium	42.6	41.6	41.0	41.2	41.9
14	Potassium	9.5	8.75	8.6	9.1	9.3

Table 3 : After filtration through ≤ 1.00 mm clay filter

SN	PARAMETER (All in Mg/lit Except pH & EC)	Before Filtration	Domestic Sewage water filtered through clay Filter (Black soil ≤ 1.00 mm sieve)			
			Original Sieved soil	Sieved soil + Saw dust	Sieved soil + Rice husk	Sieved soil +Wheat husk
1	pH	7.35	7.42	7.40	7.40	7.37
2	TSS	138	Nil	Nil	Nil	10
3	BOD(27°C at 3Days)	37.0	7.5	10.5	11.2	14.5
4	COD	172.0	76.4	80.0	84.0	96.0
5	OIL & GREASE	8	Nil	Nil	Nil	Nil
6	EC (μS/cm)	960	952	958	956	952
7	Total Hardness	346	331	338	334	339
8	TDS	657	645	643	638	643
9	Calcium	58.6	54.8	54.3	52.7	52.4
10	Magnesium	48.4	46.7	47.4	45.3	46.3
11	Chloride	167	165	164	162	166
12	Sulphate	141	141	138	132	140
13	Sodium	42.6	40.8	41.0	41.0	41.1
14	Potassium	9.5	8.6	8.6	9.0	9.1

Table 4 : After filtration through ≤ 600 μ clay filter

SN	PARAMETER (All in Mg/lit Except pH & EC)	Before Filtration	Domestic Sewage water filtered through clay Filter (Black soil ≤ 600 μ sieve)			
			Original Sieved soil	Sieved soil + Saw dust	Sieved soil + Rice husk	Sieved soil +Wheat husk
1	pH	7.35	7.45	7.42	7.40	7.40
2	TSS	138	Nil	Nil	Nil	Nil
3	BOD(27°C at 3Days)	37.0	6.0	8.2	8.7	10.0
4	COD	172.0	62.7	74.0	76.8	84.0
5	OIL & GREASE	8	Nil	Nil	Nil	Nil
6	EC (μS/cm)	960	956	952	947	954
7	Total Hardness	346	345	340	337	340
8	TDS	657	644	647	640	649
9	Calcium	58.6	56.0	55.8	53.2	54.3
10	Magnesium	48.4	47.0	44.9	45.6	45.3
11	Chloride	167	163	166.4	158	165.4
12	Sulphate	141	139.5	137.7	132.4	141.3
13	Sodium	42.6	40.6	41.5	41.3	41.8
14	Potassium	9.5	8.65	8.61	8.9	9.15

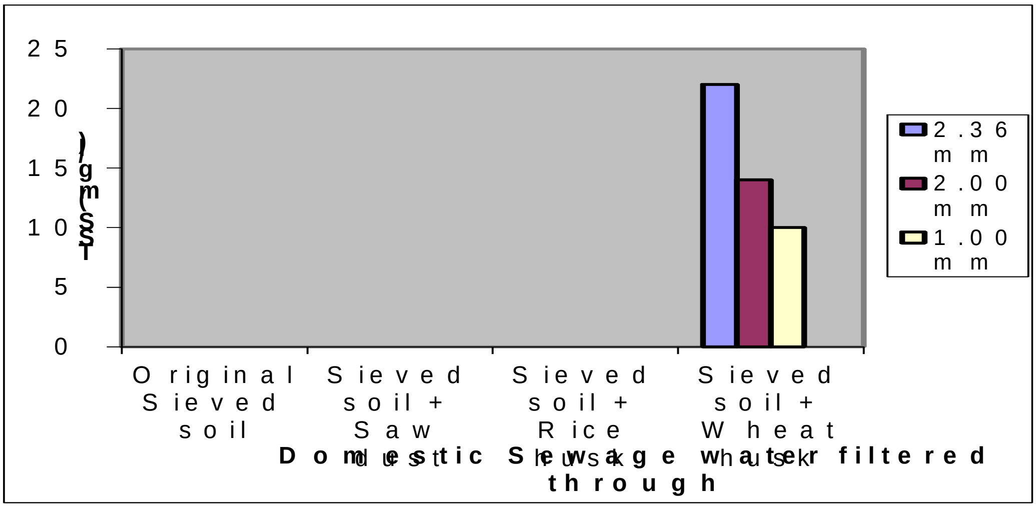

Figure 1 : Variation in TSS

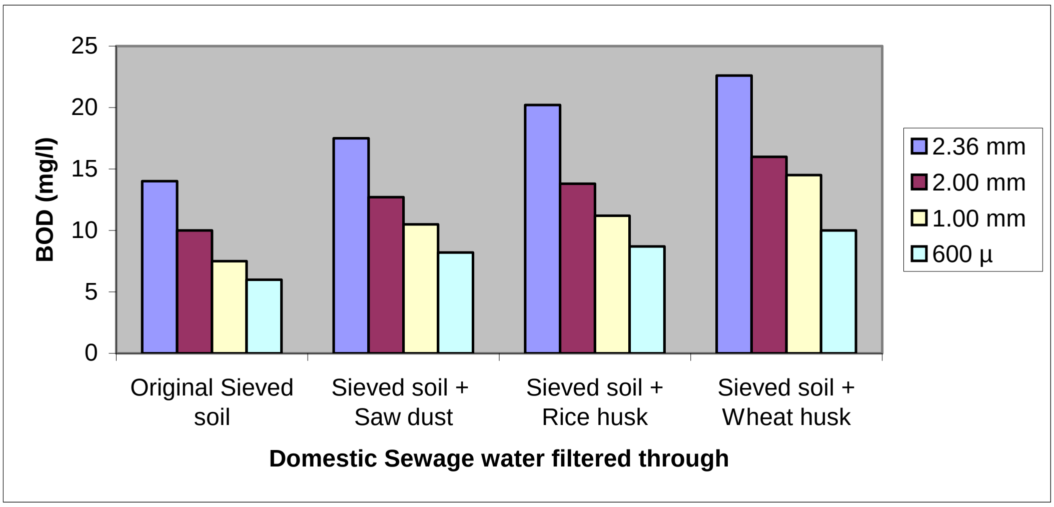

Figure 2 : Variation in BOD

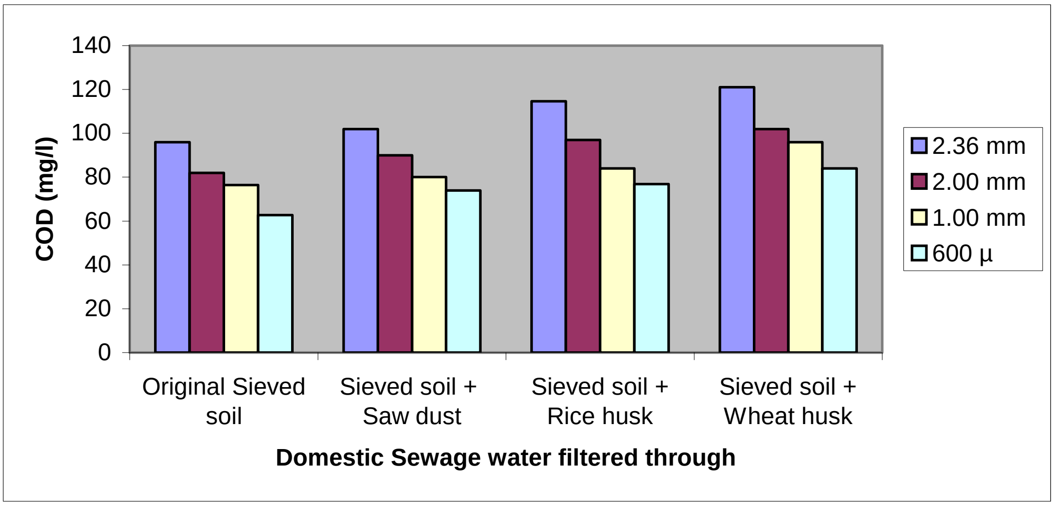

Figure 3 : Variation in COD

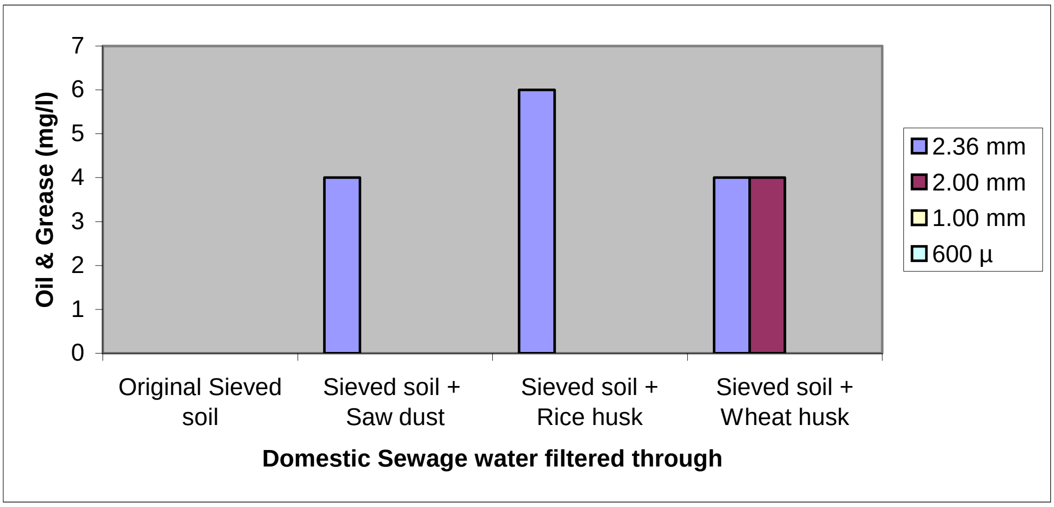

Figure 4 : Variation in oil & grease

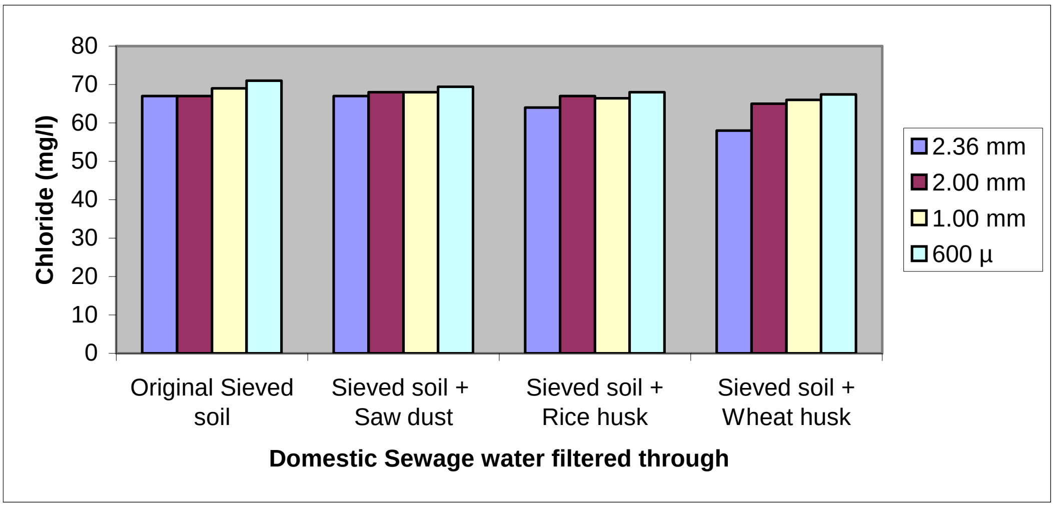

Figure 5 : Variation in chloride

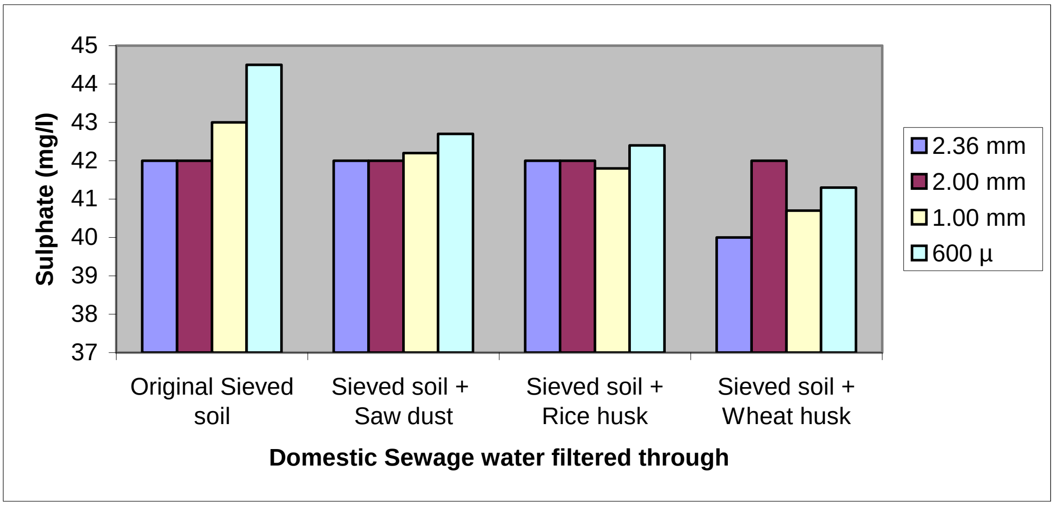

Figure 6 : Variation in sulphate

CONCLUSION

Clay filters after baking at appropriate temperature shows the capability of pollution control by way of removal of dissolved as well as suspended impurities. It needs further study for process optimization.

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