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ADSORPTION STUDIES USING LATERITE MATERIAL TO REDUCE POLLUTION FROM MARIGOLD PROCESSING UNIT

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ABSTRACT

In present scenario many industries use marigold flower as raw material in manufacturing of paints, cosmetics, perfumes, medicines etc.., the waste produced from marigold processing unit is in liquid form, which possess problems with excess BOD, COD, pH, Chlorides, Turbidity and Total solids. The treatment facilities available in the existing unit does not meet the disposal standards.The raw wastes from marigold processing unit was collected and analyzed for initial characteristics. The experiment was carried out using the process of adsorption in which laterite is used as adsorbent. The Whole study of adsorption characteristics of above pollution parameters are done in column study. to see the performance evaluation by varying rate of flow for constant depth of adsorbent, constant rate of flow for varying depth of adsorbent and comparison of the result of after treatment and before treatment is done. The efficiency of BOD, COD, pH, Chlorides, Turbidity and Total solids removal was found to be dependent on various parameters like flow rate(l/m), depth of adsorbent, contact area and contact period and by knowing the initial and final concentration, the percentage of removal was calculated. The results obtained were positive, quite encouraging and interesting.

Keywords: Marigold waste, Laterite and adsorption.

I. INTRODUCTION

Due to rapid increase in industrialization, there is a major impact on the environment. In order to reduce rapid degradation, it is necessary to adopt developed technologies. Pollution refers to contamination of the environment by harmful and waste materials, which brings about a significant change in the quality of the surrounding atmosphere. Water pollution signifies contamination of water bodies, which make them unfit for drinking and other uses. Although, 70% of the Earth is covered by water, the water of the seas and the oceans is saline and hence, cannot be used for drinking, agriculture and industrial uses. Only the water bodies like lakes, ponds, rivers, reservoirs and streams provide us with fresh water. The Marigold processing unit in Hassan industrial area is “OMNICON INDUSTRIES LTD”, which processes Marigold in producing dehydrated powder which is used for variety of purposes.. The waste generated from Marigold processing unit is in liquid form, which possess problems with excess BOD, COD, pH, Chlorides, Turbidity and Total solids. The treatment facilities available in this unit don’t meet the disposal standards

BOD is amount of organic matter that can be oxidized by microbes by utilizing oxygen as their source of survival. BOD in Marigold processing unit is mainly constituted because of waste generated from processing of Marigold flowers used as raw material. Such waste is highly organic in nature. If not properly treated and disposed, it will create lot of problems on receiving bodies. If this waste is disposed on water, results in the death of aquatic animals as a result of lowering in DO levels, as the DO value of 4ppm is necessary for survival of fishes and aquatic animals. As most of the industries dispose their waste normally in nearby water bodies, if the same water is used for drinking purposes it results in health hazards to residents who are living nearby. Large BOD means large amount of organic matter, if not properly treated and disposed, may create following problems like Organic shock loading on waste water treatment plant and deadly effect on aquatic life when disposed in water bodies. COD is always larger than BOD which in turn induces more pollution effects.

Turbidity is present in waste water coming out from Marigold processing unit because of organic wastes of flowers after processing which may be in dissolved, suspended and in colloidal form which causes the waste water unsightly. Color creates visual nuisance. More turbid waste enhances unsightly condition. Initially odour nuisance is tolerable as time proceeds, bad smell may pollute environment.

pH of waste water from marigold processing unit are due to acids and chemicals used during processing of Marigold flowers and these chemicals impart acidity or basicity to the waste.

Chlorides present in waste water of Marigold processing unit is due to chemicals used in the processing of Marigold flowers if not properly removed and disposed in water bodies nearby rivers causing the eye irritations for swimmers and also affects aquatic life. This waste is generally rich in hlorides, if not properly removed to meet disposal standards, will create undesirable effect on receiving bodies.

Total solids either dissolved or in suspended form usually organic as well as inorganic in nature. If this present in excess causes the water unsuitable for domestic purpose

With these points in view, an efficient alternate method is developed to remove these physical and chemical characteristics from wastewater using adsorption and for this technique Laterite is used as an adsorbent.

Adsorption is a process that uses special solids (called adsorbent) to remove substances from either gaseous or liquid mixtures. The term adsorption was first coined in the late 19th century, but the process itself was not widely used until the 1940s and 50s when activated carbon was first used for municipal water treatment. It is different from absorption, in which a substance diffuses into a liquid or solid to form a solution. The term adsorption encompasses both processes, while adsorption is the reverse process. Adsorption is operative in most natural physical, biological, and chemical systems, and is widely used in industrial applications such as activated charcoal, synthetic resins and water purification. Adsorption, ion exchange and chromatography are sorption process in which certain adsorptive are selectively transferred from the fluid phase to the surface of insoluble, rigid particles suspended in a vessel or packed in a column. Atom or molecules of solid surface behave as surface molecules of a liquid. These are not surrounded all sides by atoms or molecules of their kind and hence posses unbalanced attractive residual forces similar to valiancy forces. These forces attack the molecules of the adsorbent that comes in contact with the solid. Due to adsorption, the residual forces decreases and, therefore the surface energy gets decreased considerably. This energy is lost in the form of heat energy. Thus adsorption is always accompanied by evolution of heat. Adsorption is effective for purifications. Adsorption is also used for recovery of certain constituents (solvents from air), preventing pollution, purifying materials that will react, and so on.

The term laterite was first introduced by Buchanan (1807) while on a journey through Malabar and Kanara in India described it as ferruginous, viesicular, Unstratified and porous material with yellow orches due to high iron content. The freshly dug material was soft enough to be readily cut into brick blocks but it rapidly hardens on exposure to air and became remarkably resistant to the weathering effect of climate. This material was locally used as brick for building and became remarkably resistant to the weathering effect of climate. This material was locally used as brick for building and hence called 'laterite' from the Latin word 'later means brick. Laterite is a type of soil, red in color, which is mainly found in the tropics. Aquaristic, travelers will always notice it occurring in the vicinity of tropical water. Where as laterite is considered as an infertile soil for the purposes of agriculture, it is of elementary importance for bodies of water and thus also for submerse growing plants. Under reduction conditions, which are in the absence of oxygen, bivalent iron is dissolved from laterite in ground water. Such seepage spots close to water courses are also referred to as 'nutrient sources' because analysis have shown high contents of nutrients suitable for aquatic plants present in the seepage water.

II. MATERIALS AND METHODS

The experiment was carried out using the process of adsorption in which laterite material is used as adsorbent. The study was done by passing the wastewater in a straight path. Flow rate(l/m), varying depth, contact area and contact period are considered and efficiency of percentage removal was observed. The column was of polyvinyl material and the first phase of the study was done for waste sample from Marigold processing unit using laterite of grain size passing 6.3mm sieve and retained on 4.75mm sieve and second phase was done for a same sample using grain size passing 4.75mm sieve and retained on 2.36mm sieve. The analysis also includes the depth of the filter media of 0.25m, 0.5m and 1m . various parameters such as wastewater flow rate(l/m),varying depth, contact area and contact period are considered and efficiency of percentage removal was observed. The experimental setup is shown in figure(1).

Figure:

Figure 1: Photographic view of experimental setup

Experimental Procedure:

The experiment was conducted in different stages by considering two parameters at a time. The Flow rate of waste water was taken as common parameter in all stages as shown in table 1

Tables:

Table 1. Different Stages of experiment and parameters considered

STAGE	PARAMETERS
1	Grain size of 4.75mm retained and flow rate variation
2	Grain size of 2.36mm retained and flow rate variation

Figure:

Figure(2)4.75mm retained grain size

Figure(3) 2.36mm retained grain size

The adsorbent was selected with a grain size of 4.75mm retained and 2.36mm retained. The raw wastewater is collected and stored in a plastic tank and its initial characteristics are found which are shown in table(2). It was allowed to pass through the pvc pipe containing a particular laterite grain size and depths of 0.25m, 0.5m and 1m. variation in flow rate was made, during different trails. After stabilization of flow, samples of wastewater are collected. In stage I, laterite of grain size 4.75mm retained as shown in figure(2) was taken in a column at 0.25m depth for different flow rates and repeated the same for 0.5m and 1m depth. In stage II, laterite of grain size 2.36mm retained as shown in figure(3) was taken in a column at o.25m depth for different flow rates and repeated the same for 0.5m and 1m depth. The filter effluent water was analyzed for the different parameters

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such as COD, BOD, pH, Turbidity, Chlorides and Total solids in the laboratory by using standard methods. Then the efficiency of removal was determined by using following formula.

Formulae:

$$\text{Efficiency}(\%) = \frac{(\text{initial} - \text{final})*100}{\text{Initial}} \quad (1)$$

Tables:

Table(2) Initial characteristics of marigold Waste

Sl.no	Parameters	Raw effluent characteristics
1.	PH	4.75
2.	Turbidity	1340 NTU
3.	B.O.D	39200 mg/l
4.	C.O.D	78300 mg/l
5.	Total solids	13560 mg/l
6.	chlorides	3428mg/l

III. RESULTS AND DISCUSSIONS

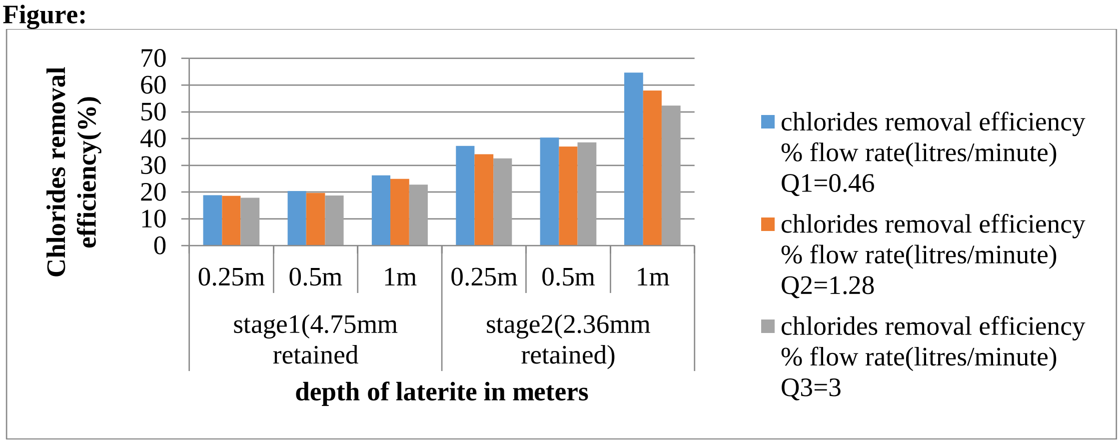
The performance evaluation was done by varying the depth of adsorbent for a given size in stage 1 and the flow rate variation with respect to each depth was done and samples collected were analyzed for various parameters.

Tables:

Table(3) Percent removal of chlorides for different depth and flow rates.

Stage	depth of filling laterite in meters	chlorides removal efficiency %		
		flow rate(liters/minute)		
		Q1=0.46	Q2=1.28	Q3=3
Stage1 (4.75mm retained	0.25m	18.85	18.56	17.83
	0.5m	20.43	19.64	18.74
	1m	26.3	24.94	22.8
Stage2 (2.36mm retained)	0.25m	37.24	34.19	32.61
	0.5m	40.41	37.02	38.6
	1m	64.61	58.01	52.37

Figure:



Figure(4)Removal efficiency of chlorides

It was observed that in stage 1, for given grain size, Chlorides removal efficiency decreased with increased flow rate. This shows that an adsorption process depends on contact time. It was also observed that with the increase in depth of laterite, removal efficiency also increases. It can be inferred that, as the contact area increases removal efficiency also increases. In stage II, Efficiency of removal decreased with increased flow rate.

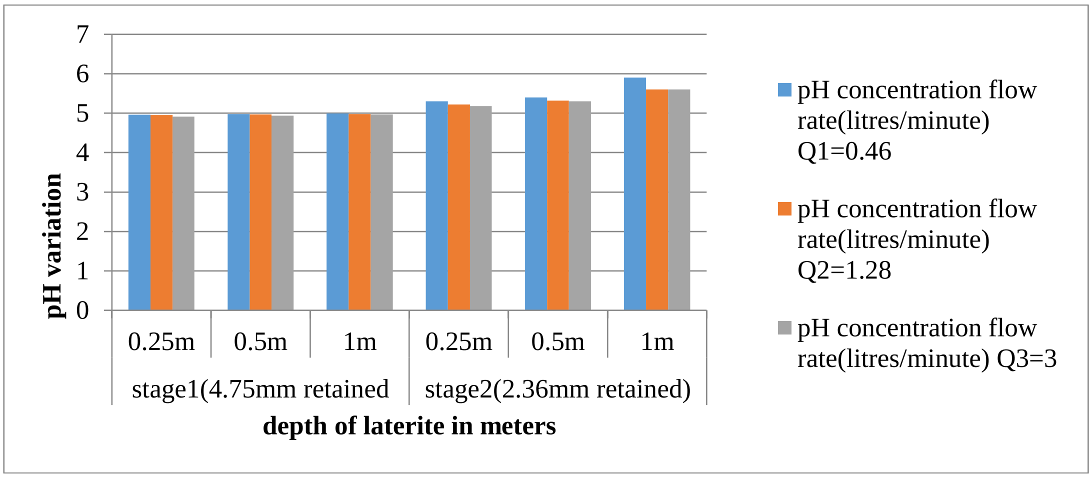
However an efficiency of 64.61% could be seen for slower flow rate and for medium flow rate the removal efficiency achieved is 58.01% and it is comparable with the efficiency of increased flow rate of 52.37%. This shows that, The increased flow rate decreases the contact time, thus efficiency also decreases. For the larger grain size of 1m depth of laterite removal efficiency is 26.3% and it is comparable with the smaller grain size of removal efficiency of 64.61% that means removal efficiency increased three times and this means that, as the surface area increased removal efficiency also increased. Figure(4) shows various chlorides removal efficiencies in different stages. It was also observed that in two stages, the efficiency increased with increased in depth of laterite.

Tables:

Table 4. pH variation for different depth and flow rates

Stage	depth of laterite in meters	pH concentration		
		flow rate(liters/minute)		
		Q1=0.46	Q2=1.28	Q3=3
stage1(4.75mm retained	0.25m	4.96	4.95	4.91
	0.5m	4.98	4.97	4.94
	1m	4.99	4.98	4.97
stage2(2.36mm retained)	0.25m	5.3	5.22	5.18
	0.5m	5.4	5.32	5.3
	1m	5.9	5.6	5.6

Figure:



Figure(5). PH variations with different depths of adsorbent.

The results obtained as shown in figure(5), there is a substantial increase in pH value with respect to contact time for a given flow rate. Thus as the flow rate increases, the contact time decreases as the tendency of acidic pH towards neutral pH decreases.

Tables:

Table(5) percent removal of Turbidity for different depths and flow rates

Stage	depth of laterite in meters	Turbidity removal efficiency (%)		
		flow rate(liters/minute)		
		Q1=0.46	Q2=1.28	Q3=3
stage1(4.75mm retained	0.25m	25	20	17.5
	0.5m	32.5	26.47	20
	1m	35	32.5	27.5
stage2(2.36mm retained)	0.25m	32.5	22.5	20
	0.5m	35	32.5	30
	1m	40	35	32.5

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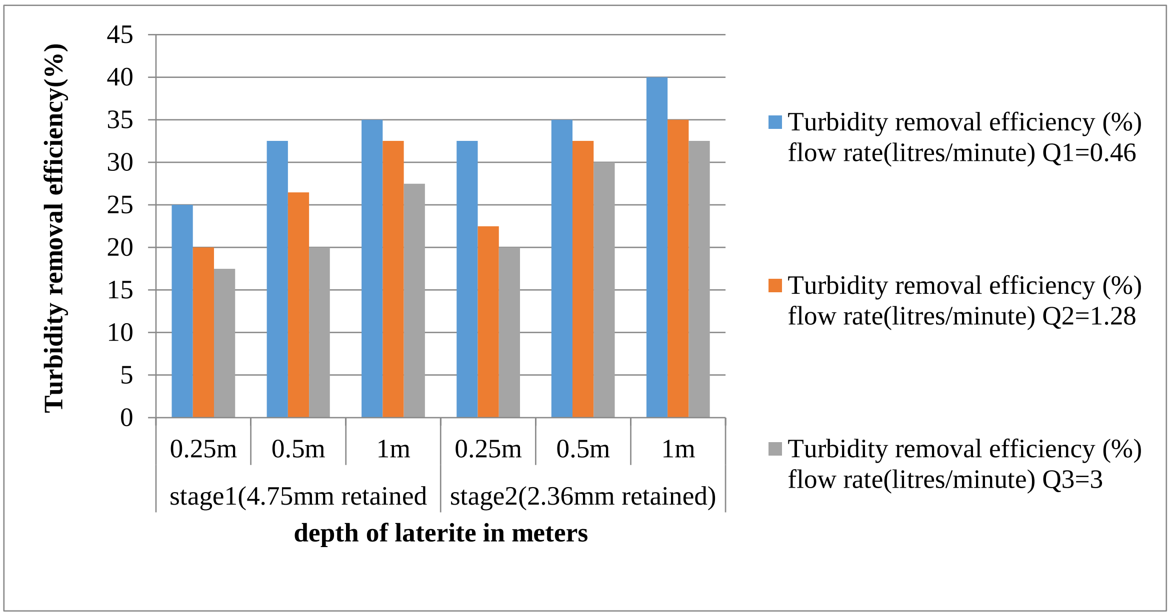
Figure:



Figure(6). Removal efficiency of turbidity

It was observed that, In stage I of 1m depth of laterite efficiency of removal was 35%.In stage II, for the same depth of laterite, efficiency of removal was 40% for the slower flow rate. And for the medium flow rate It was observed that, In stage I of 1m depth of laterite efficiency of removal was 32.5%. where as In stage II, of 1m depth of laterite efficiency of removal was 35%. for the faster flow rate It was observed that , In stage I of 1m depth of laterite, efficiency of removal was 27.5%.In stage II, of 1m depth of laterite efficiency of removal was 32.5%. this shows that from stage I to stage II , surface area increased and the removal efficiency also increased. It also shows as the contact time deceases removal efficiency also decreases. It was also observed that removal efficiency increased with increase in depth of laterite that means contact area increased .as shown in Figure(6) where Turbidity removal efficiencies in different stages is plotted.

Tables:

Table(6). percent removal of Total solids for different depths and flow rates

stage	depth of laterite in meters	Total solids removal efficiency (%)		
		flow rate(litres/minute)		
		Q1=0.46	Q2=1.28	Q3=3
stage1(4.75mm retained	0.25m	28.23	22.89	15.19
	0.5m	46.36	45.33	40.86
	1m	47.28	46.36	43.22
stage2(2.36mm retained)	0.25m	47.48	45.94	44.5
	0.5m	49.94	48.92	44.35
	1m	70.22	65.7	59.18

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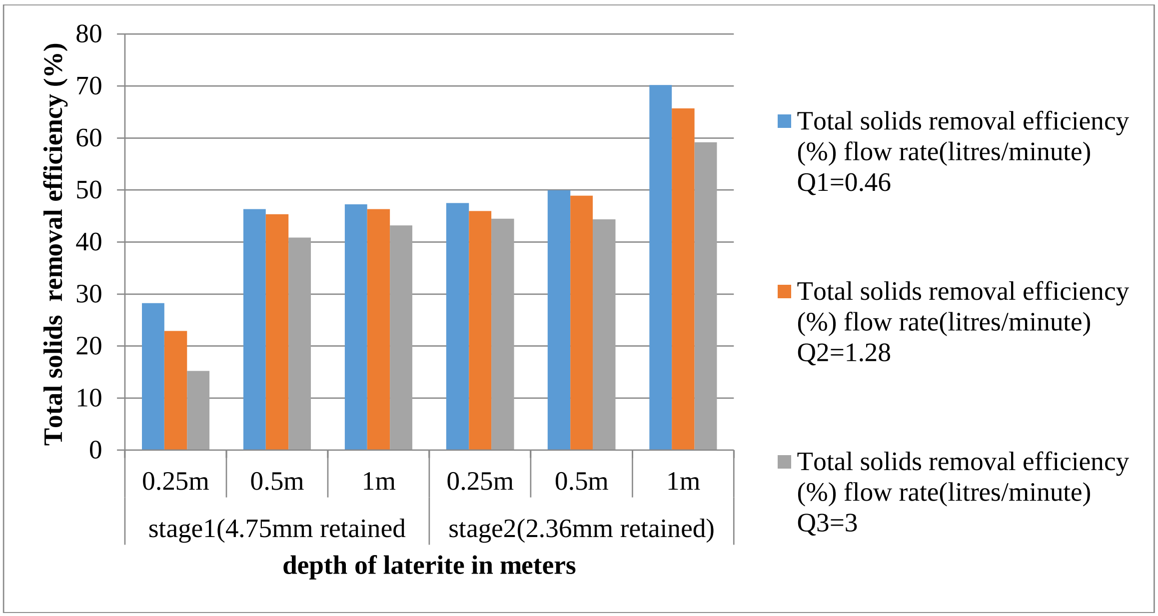
Figure:



Figure(7). Removal efficiency of total solids

It was observed that, In stage I of 1m depth of laterite, efficiency of removal was 47.28%.In stage II, of 1m depth of laterite efficiency of removal was 70.22% for the slower flow rate. And for the medium flow rate It was observed that , In stage I of 1m depth of laterite, efficiency of removal was 46.36%.In stage II, of 1m depth of laterite, efficiency of removal was 65.7% .for the faster flow rate It was observed that , In stage I of 1m depth of laterite efficiency of removal was 43.22%.In stage II, of 1m depth of laterite efficiency of removal was 59.18%. This shows that from satge I to stage II , surface area increased and the removal efficiency also increased. It also shows as the contact time deceases removal efficiency also decreases. It was also observed that removal efficiency increased with increases in depth of laterite that means contact area and contact time increase will have higher removal efficiencies. Figure(7)shows various total solids removal efficiencies in different stages.

Tables:

Table 7. BOD removal efficiency for various depths and flow rates

stage	depth of laterite in meters	BOD removal efficiency (%)		
		flow rate(litres/minute)		
		Q1=0.46	Q2=1.28	Q3=3
stage1(4.75mm retained)	0.25m	27.65	21.02	14.38
	0.5m	39.82	35.4	28.21
	1m	44.8	43.14	39.82
stage2(2.36mm retained)	0.25m	38.71	38.16	27.65
	0.5m	44.8	43.14	39.82
	1m	71.91	65.84	62.72

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Figure:

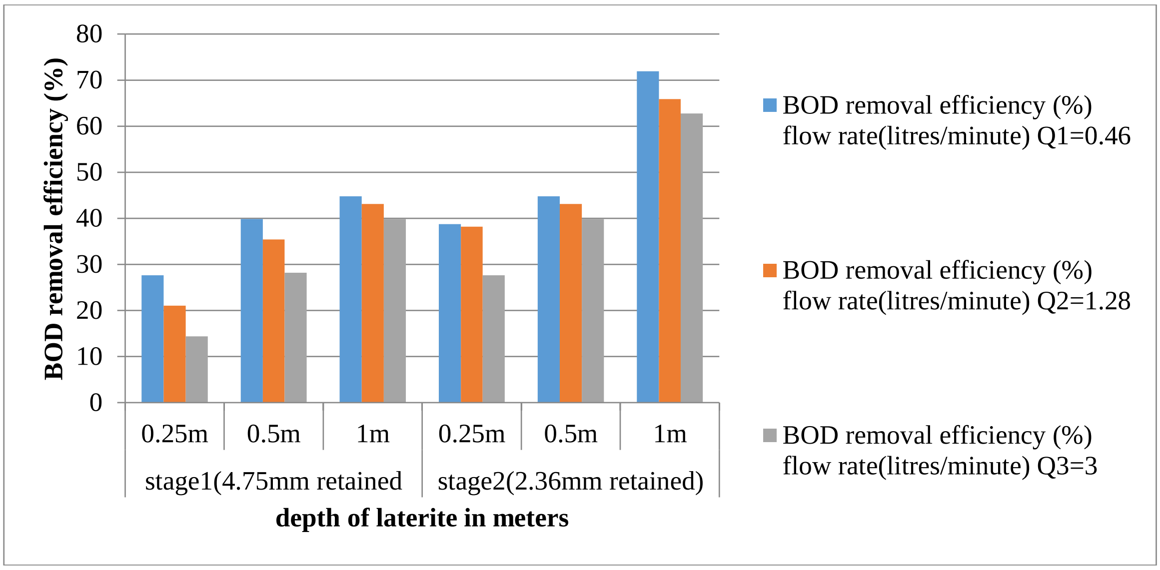

Figure 8. Plot of Removal efficiency of BOD

It was observed that , In stage I of 1m depth of laterite, efficiency of removal was 44.8%.In stage II, of 1m depth of laterite efficiency of removal was 71.91% for the slower flow rate. And for the medium flow rate It was observed that , In stage I of 1m depth of laterite, efficiency of removal was 43.14%.In stage II, of 1m depth of laterite efficiency of removal was 65.84% .For the faster flow rate It was observed that , In stage I of 1m depth of laterite, efficiency of removal was 39.82%.In stage II, of 1m depth of laterite efficiency of removal was 62.72% increased nearly twice, this shows that from stage I to stage II , as surface area increased and the removal efficiency also increased. It also shows as the contact time decreases removal efficiency also decreases . It was also observed that removal efficiency increased with increased in depth of laterite that means contact area increased .Figure(8)shows various BOD removal efficiencies in different stages.

Tables:

Table 8. COD removal efficiency for various depths and flow rates

stage	depth of laterite in meters	COD removal efficiency (%) flow rate(litres/minute)		
		Q1=0.46	Q2=1.28	Q3=3
stage1(4.75mm retained	0.25m	25.14	18.37	13.59
	0.5m	32.61	26.09	21.74
	1m	40.22	38.04	36.96
stage2(2.36mm retained)	0.25m	39.34	36.3	31.9
	0.5m	55.76	55.32	53.26
	1m	65.62	59.78	56.52

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Figure:

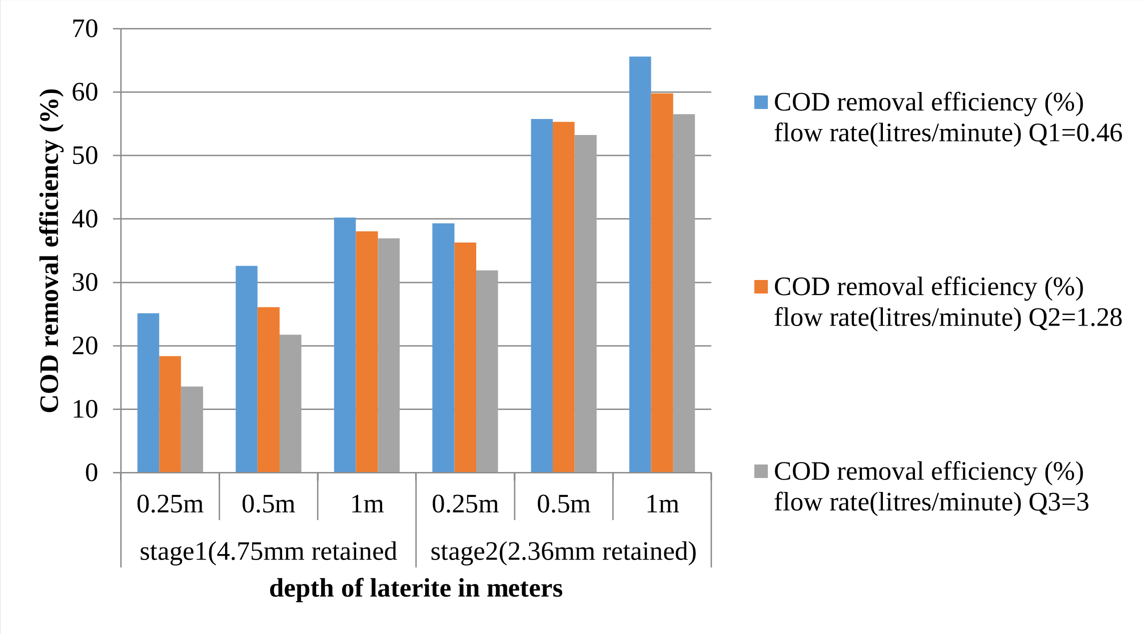

Figure 9. Plot of Removal efficiency of COD

It was observed that , In stage I of 1m depth of laterite, efficiency of removal was 40.22%.In stage II, of 1m depth of laterite efficiency of removal was 65.62% for the slower flow rate. And for the medium flow rate It was observed that, In stage I of 1m depth of laterite, efficiency of removal was 38.04%.In stage II, of 1m depth of laterite efficiency of removal was 59.78% .for the faster flow rate It was observed that , In stage I of 1m depth of laterite, efficiency of removal was 36.96%.In stage II, of 1m depth of laterite, efficiency of removal was 56.52% and this shows that from stage I to stage II , surface area increased and the removal efficiency also increased. It also shows as the contact time deceases removal efficiency also decreased. It was also observed that removal efficiency increased with increased in depth of laterite that means contact area and contact time increases. Figure(9) shows various COD removal efficiencies in different stages.

It was observed that in stage 1,for the grain size 4.75mm Retained, the characteristics such as PH, Turbidity, BOD, COD, Chlorides and Total solids efficiency decreased with the increase in flow rate, Thus Adsorption process depends on time of contact and as depth increases removal efficiency also increases. In stage II, for the grain size of 2.36mm retained, removal efficiency of all the above characteristics decreased with increased flow rate. And also as the time of contact and contact area increased there was substantial increase in performance.

IV. CONCLUSION

Based on the experimental data, It is quite evident that laterite is a powerful adsorbing medium, and for smaller grain sizes and slower flow rates, the contact period with adsorbent increases and thus efficiency of removal increases. In addition as the depth of column increased efficiency also increased. Thus optimum results may be obtained for slower flow rates, smaller grain sizes and higher column depth. Since laterite is comparitively cheap and easily available, expenses and maintenance incurred are very low as compared to other system. Hence this method cab be conveniently employed in the Marigold processing unit and may be adopted as pretreatment very low as compared to other system. Hence this method can be conveniently employed in the Marigold processing unit and may be adopted as pretreatment unit in biological treatment plants. However further investigations may be necessary on performance of adsorbent for its reuse potential.

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