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Treatment of Effluent from Granite Cutting Plant by Using Natural Adsorbents like Rice Husk Carbon and Saw Dust Carbon

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Abstract:- Granite cutting plant is one such industry that releases polluting and turbid effluent. The residue from all these processes is discharged with water as an effluent. The effluent mainly contains many solids that harm the environment. Hence it requires treatment techniques before disposal. Several conventional methods are available for removal of contaminants like coagulation, adsorption, polyelectrolyte methods and biological methods. Most of them are cost prohibitive. The reduction of solids concentration in the effluent before disposal by using the techniques, coagulation followed by adsorption using natural adsorbents, like rice husk carbon and saw dust carbon, in contrast to the usage of activated carbon as it is costly. From a local Granite cutting plant near Anantapur, the effluent is collected and its physico-chemical characteristics are estimated and found to be pH(7.5), TS(4240mg/l), TSS(21560mg/l), TDS(12373mg/l).Effluent obtained is subjected to coagulation by potash alum followed by adsorption using saw dust carbon and rice husk carbon. Percentage removal of solids for a contact time of 40 minutes and adsorbent dosage of 0.1g/ml is maintained. The percentage removal of solids based on time variation are TSS=50%, TDS=57% for rice husk carbon; TSS=62%, TDS=60% for saw dust carbon. Percentage removal of solids for a contact time of 25 minutes and adsorbent dosage of 0.25g/ml, the percentage removal of solids based on concentration variation are TSS=68%, TDS=50% for rice husk carbon; TSS=72%, TDS=52% for saw dust carbon. A comparison of the characteristics of effluent treated by rice husk carbon and saw dust carbon revealed that saw dust carbon ensured better removal of solids. However no variation in pH is observed.

Keywords:- coagulation, Adsorption, TSS, TDS, TS, physico-chemical.

I. INTRODUCTION

Waste water treatment by adsorption and coagulation analysis was done by. S. K. Waghmare. The paper revealed that effluent from paper industry can be treated by coagulation followed by adsorption through natural adsorbents, saw dust carbon and rice husk carbon. As this appeared cost effective and efficient, we tried to adopt this to treat granite industry effluent. This was the basic idea behind our project [1].

Fahiminia M, Ardani R, Hashemi S, Alizadeh M. Wastewater Treatment of Stone Cutting Industries by Coagulation Process. Arch Hyg Sci 2013;2(1):16-22.,a study of this paper reveals that, Use of coagulation process for treatment of wastewater created by stone cutting industries causes increase in settling speed for suspended solids and return of water to production line without turbidity and it also causes reduction in consumption of polishing emery and segments. The objective from using coagulation and flocculation in treatment of the wastewater caused from stone cutting industries is to remove colloidal material existing in Wastewater. Also, the nutritive materials existing in wastewater might be removed during this process. Arslan EI *et al*. conducted a study in Turkey under the title of "physicochemical treatment of marble waste water and recycling of sludge".The first section of their study was related to use of coagulation and flocculation processes. They investigate several parameters, including turbidity, total solids (TS), suspended solids (SS) and chemical oxygen demand (COD) in Cutting, faience and equalization processes.[2]

Another study was conducted cutting by Nasserdine K et al. in Hebron to improve the quality of output effluent from stone industries by coagulation process. In this research, the existing methods of wastewater treatment were investigated and Jar Test was used for optimizing water recycling and studying possibility of treatment (11). In application of physicochemical treatment in effluent by coagulation and flocculation processes, a large amount of sludge might be created which shall be removed during further processes[2]

Determination of flocculation characteristics of natural stone powder suspensions in the presence of different polymers by Hande K. BASARAN, Tuba TASDEMIR Mining Engineering Department, Eskisehir Osmangazi University, 26480, Eskisehir, Turkey reveals that marble factories use large amounts of water during the cutting, washing and polishing processes. Water is used as a coolant during cutting of marble blocks. The cutting of a block, for instance, produces approximately 25–40% of the weight of the block as fine particles

(Onenc, 2001). The particles in the wastewater are generally treated by simple solid– liquid separation. The inefficiency of the employed techniques results in the presence of fine particles in recycled water, which cause polishing problems during processing. In addition, the suspended particles in recycled water may also result in pipe clogging.[3]

The purpose of the flocculation process is to form aggregates or flocs from finely dispersed particles in the presence of natural or synthetic polymeric substances (flocculants). There are many types of polymeric flocculants used in various solid liquid separation processes. The polymers are characterized by their ionic nature: cationic, anionic and non-ionic. The flocculants bring together coagulated particles into larger aggregates and settle them. The polymer bridging and charge neutralization are the commonly encountered mechanisms in flocculation. Bridging flocculation occurs as a result of adsorption of individual polymer chains onto several particles simultaneously, forming molecular bridges between the adjoining particles in a floc. The charge neutralization becomes a major mechanism for polyelectrolyte, where significant particle surface sites with charge opposite to that of the ionic polymer functional groups are present. The flocculants are known to adsorb on particle surface through hydrogen bonding, ion binding, electrostatic interactions, chemical bonding, hydrophobic interactions and Vander Waals forces (Somasundaran and Das, 1998; Hogg, 2000; Mpofu et al., 20)

The use of sawdust as by product adsorbent of organic pollutant from wastewater: adsorption of phenol Larous. S1 , Meniai A-H1 , Locally available sawdust, a very low cost and promising material was tested experimentally as an adsorbent, after carbonization, for the removal of phenol from industrial waste waters for a safe disposal. The experiments were performed batchwise to remove phenol from synthesized aqueous solutions. The equilibrium adsorption level was determined as a function of the solution pH, temperature, contact time, adsorbent dose and the initial adsorbate concentration. Adsorption isotherms of phenol on adsorbents were determined and correlated with the usual isotherm equations such as Langmuir and Freundlich. The optimum conditions for the removal of phenol were worked out along with the kinetics of the process[4]

Abatement of toxic heavy metals from highway runoff using sawdust as adsorbent Kishor Kumar Singh1*, Upasana Singh and Abhimanyu Yadav,The possible use of sawdust as biosorbent has been successfully utilised to remove heavy metal ions from highway runoff. It is noted that increase in Pb2+ concentration and pH, caused the increase in adsorption capacity of sawdust. In relation to this, a decrease in sawdust dose results in a higher metal loading on the sawdust. The adsorption isotherms of heavy metals fit the Langmuir or Freundlich model reasonably well. The order of heavy metal adsorption is Pb2+ > Cu2+ > Zn2+.[5]

Adsorption of methylene blue dye using low cost adsorbent of sawdust: Batch and continuous studies Hadeel Ali Al-Husseiny Babylon University, College of Engineering, Civil Eng. Dept ,The feasibility of sawdust as low cost adsorbent to remove methylene blue from aqueous solutions was investigated through batch and column studies. Batch experiments were carried out with treated sawdust and commercial activated carbon to compare the adsorption behavior of them in terms of their adsorption capacities with the initial concentration of 100 mg/L and solution pH of 5. Equilibrium data were fitted to Langmuir and Freundlich isotherm models. The equilibrium data were best represented by the Langmuir isotherm model, with maximum monolayer adsorption capacity of 30.11 mg/g for sawdust while 39.09 mg/g by using activated carbon. In column experiments, fixed bed adsorption of methylene blue was performed on sawdust columns and the breakthrough curves were determined by varying bed depth, flow rate and influent concentration.[6]

Removal of Heavy Metals Using Rice Husk: A Review Sneh Lata1 and S.R. Samadder2 1Department of Environmental Science & Engineering, Indian School of Mines, Dhanbad-826004, India. 2Department of Environmental Science & Engineering, Indian School of Mines, Dhanbad-826004, India, Rice husk (RH) is a low cost (agricultural by-product) bio-adsorbent which has been studied intensively for the removal of various heavy metals and metalloids (such as Pb, Cd, Zn, Ni and As) from both groundwater and surface water. The present study is focused on critical review of previous and current available information on potential of treated and untreated rice husk for the removal of heavy metals and metalloids (arsenic). Various studies on adsorption efficiency of rice husk considering the parameters contact time, adsorbent dose (rice husk), initial concentration of heavy metals, pH, and temperature have been evaluated by many researchers. The present study analyzed those studies and compiled the adsorption efficiency of rice husk and concluded that treated rice husk gave comparatively better adsorption efficiency of heavy metals with compared to that of untreated rice 166 Sneh Lata & S.R. Samadder husk. The treated rice husk can be implemented on large scale industrial applications after field studies.[7]

II. EXPERIMENTAL PROCEDURE

In this project, the effluent from a local granite cutting plant was obtained and is coagulated using saw dust and rice husk carbon adsorbents prepared from unused saw dust and rice husk. The following materials were used in this project.

Collection of effluent: Effluent from a local granite cutting plant located near Bellary by-pass road Anantapur was collected.

2.1 Characterisation of effluent

Appearance: The effluent was full of solids and appeared very turbid.

2.1.1. Decantation

The effluent obtained is taken in a large beaker and is left undisturbed for one hour .then all the settleable solids got settled at the bottom. Leaving a relatively clearer liquid on the top and it is extracted. Then the physico chemical characteristics of the effluent like pH, TSS, TS and TDS were estimated.

2.1.2. Estimation of physico chemical characteristics: P^H of the effluent is determined using P^H strips and is found to be 7.5.Concentration of total solids present in the effluent is estimated to be 4,240mg/L.concentration of total suspended solids in the effluent was estimated to be 21,560mg/L.Concentration of total dissolved solids in the effluent was estimated to be 12,373mg/L.

2.1.3. Coagulation

The effluent is allowed to coagulate by the addition of potash alum at the adsorbent dosage of 10g/100ml and allowed to coagulate over night. Then the effluent is filtered from the coagulated solids and is subjected to further treatment.

2.1.4. Preparation of adsorbents

2.1.4.1. Rice husk carbon: Preparation

Rice husk was obtained from rice mill and washed with distilled water for 2 times and dried completely in an oven (hot air oven).

- Heat supply was kept under control to prevent burning and charring of rice husk.
- The dried rice husk was soaked in 0.6M citric acid, obtained by dissolving 126g of citric acid monohydrate ($C_6H_8O_7.H_2O$) in 1 liter of distilled water.

Soaking time = 90 minutes

- Then the soaked husk is filtered and thoroughly washed with distilled water.
- Before soaking, the rice husk is sieved with 40 & 50 mesh and the retained mass was passed of the soaking.
- This ensures that the size of rice husk is approximately 420µm.
- Now the wet rice husk was dried in a hot air oven for 1 hour at a temperature of 100^0c.
- The dried rice husk was used as an adsorbent.

2.1.4.2. Saw dust carbon: Preparation

- Saw dust was collected from our college's Mechanical Work shop.
- It was first washed with hot distilled water for two times.
- Then the saw dust was dried in sun for four hours and then over night at room temperature.
- Now the saw dust was carbonized by heating in a hot air oven at a temperature of 100^0c for one & half hour.
- A color change from light yellow to black was observed after carbonization.
- This was used as adsorbent

2.1.5. Adsorption of coagulated effluent

The coagulated effluent is brought into contact with rice husk carbon and saw dust carbon individually for a known time during which the solids in the effluent get adsorbed by the adsorbent, there by leaving the effluent relatively pure.

2.1.6. Effect of adsorbent dosage on the percentage removal of solids: Four beakers were taken. To each beaker, 50 ml of coagulated effluent is added. To the first beaker 5.0g of adsorbent is added. To the second beaker 7.5g, 10.0g to the third beaker and 12.5g to the fourth beaker is added. Contact time is maintained constant for each beaker at 25minutes.Then the effluent was filtered from the suspension of adsorbent and effluent. Then the physico-chemical characteristics of treated effluent from each beaker are estimated .Effect of adsorbent dosage on percentage removal of solids was studied using both rice husk carbon and saw dust carbon.

2.1.7. Effect of contact time on the percentage removal of solids

- Four beakers were taken.
- To each beaker, 50ml of effluent and 5.0g of adsorbent was added.
- Time of contact for effluent and adsorbent in the first beaker is maintained 10min.

- 20min in the second beaker, 30min in the third beaker and 40min in the fourth beaker.
- After allowing sufficient time of contact, the effluent was filtered from the suspension of adsorbent and effluent.
- Then the physico-chemical characteristics of treated effluent from each beaker are estimated.
- Effect of time of contact on percentage removal of solids was studied using both rice husk carbon and saw dust carbon.

III. RESULTS AND DISCUSSION

3.1. Effect of different parameters on adsorption efficiency for rice husk carbon

3.1.1 Effect of contact time on % removal of TDS for rice husk carbon:

The effect of contact time on %removal of TDS at an adsorbent dosage of 0.1g/ml was studied and the values are tabulated in the table 3.1 below and the graph is shown in fig.3.1.

Table 3.1 Effect of contact time

Time	Adsorption % efficiency rice husk
10	36.25
20	37.29
30	39.81
40	58.02
50	66.23
60	74.44

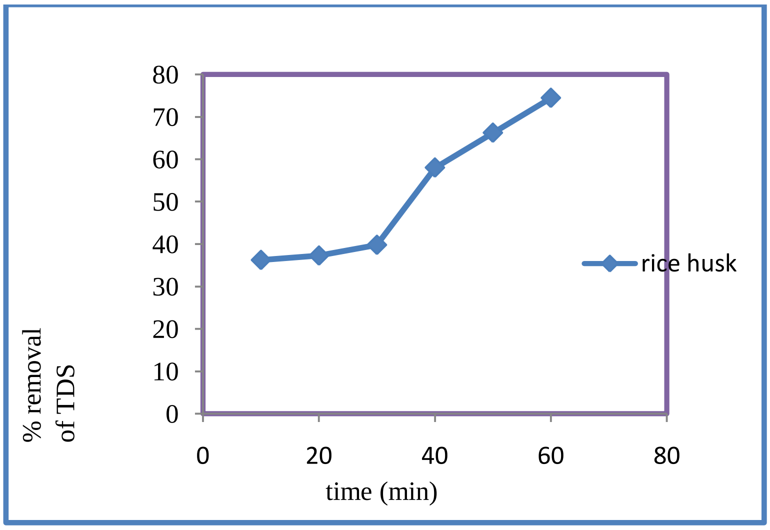


Figure 3.1 Effect of contact time on % removal of TDS by rice husk carbon at an adsorbent dosage of 0.1g/ml.

From the above graph we infer that the % removal of TDS increases with the increase in the contact time. The adsorption efficiency has increased from 36% at a contact time of10 mins to 58% at a contact time of 40 mins. The changes in the % removal can be attributed to the increased time of contact which increases the time available for the solids to get adsorbed by rice husk carbon.

3.1.2 Effect of contact time on % removal of TSS by rice husk carbon

The effect of contact time on %removal of TSS at an adsorbent dosage of 0.1g/ml was studied and the values are tabulated in the table 3.2 below and the graph is shown in fig.3.2

Table 3.2 Effect of contact time

Time	Adsorption % efficiency rice husk
10	20.97
20	35.76
30	41.49
40	50.37
50	59.25
60	77.01

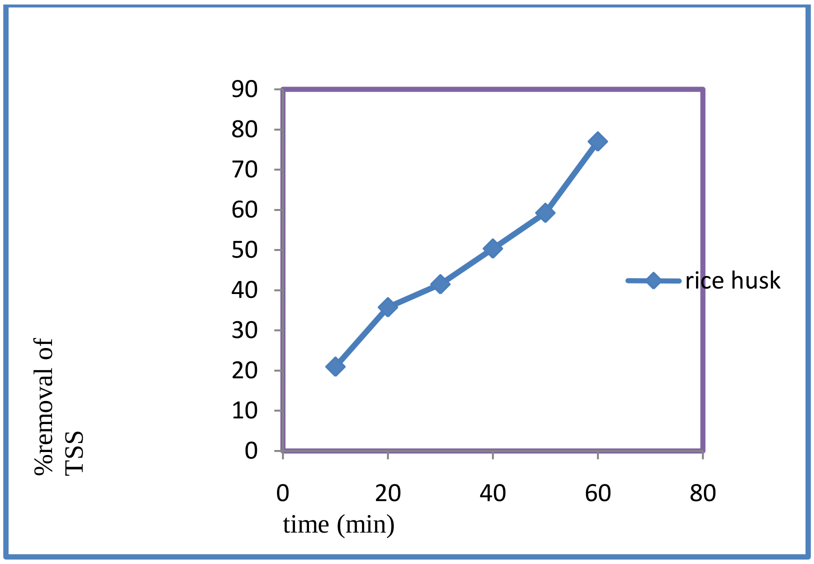


Figure 3.2 Effect of contact time on % removal of TSS by rice husk carbon at an Adsorbent dosage of 0.1g/ml.

From the graph it is observed that % removal of TSS increases with the increase in the contact time. The adsorption efficiency has increased from 21% at a contact time of 10 mins to 50% at a contact time of 40 mins.

3.1.3 Effect of adsorbent dosage on %removal of TDS by rice husk carbon

The effect of adsorbent dosage on % removal of TDS by rice husk carbon was studied at a constant contact time of 25 mins. Volume of effluent taken was 50 ml.The values are tabulated in the table 3.3 below and graph is shown in the figure 3.3

Table 3.3 Effect of adsorbent dosage

Amount	Adsorption % efficiency rice husk
5	34.94
7.5	42.2
10	48.57
12.5	50.76

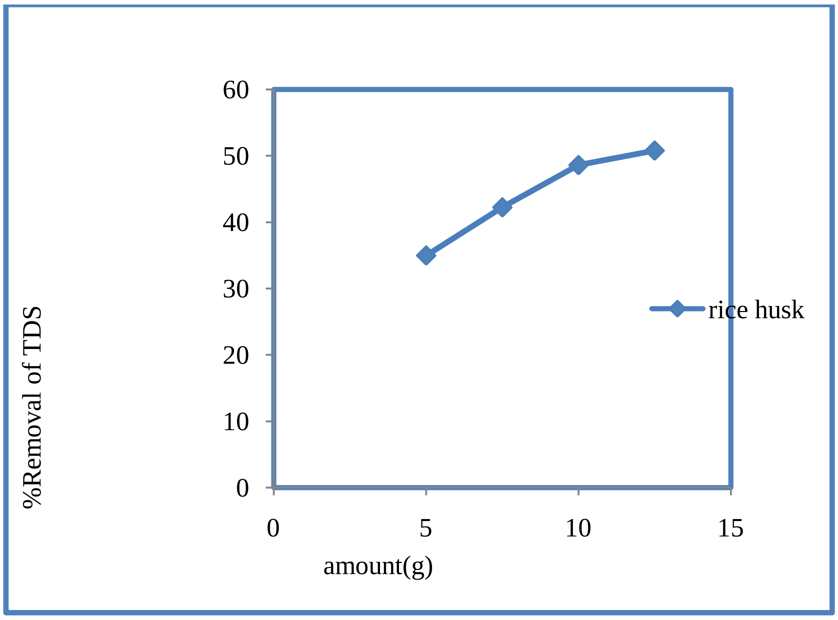


Figure 3.3 Effect of adsorbent dosage on % removal of TDS at a constant contact time of 25 mins. And effluent volume of 50 ml

From the graph it is observed that the % removal of TDS increased with increase in the amount of adsorbent at a constant effluent volume of 50 ml and contact time 25 mins. The change can be attributed to the fact that at higher doses of adsorbent more adsorbent surface and pore volume would be available for the adsorption interaction and these results in higher removal.

3.1.4 Effect of adsorbent dosage on %removal of TSS by rice husk carbon

The effect of adsorbent dosage on % removal of TSS by rice husk carbon was studied at a constant contact time of 25 mins. Volume of effluent taken was 50 ml.The values are tabulated in the table 3.4 below and graph is shown in the figure 3.4

Table 3.4 Effect of adsorbent dosage

Amount	Adsorption %efficiency rice husk
5	37.66
7.5	54.49
10	61.59
12.5	68.08

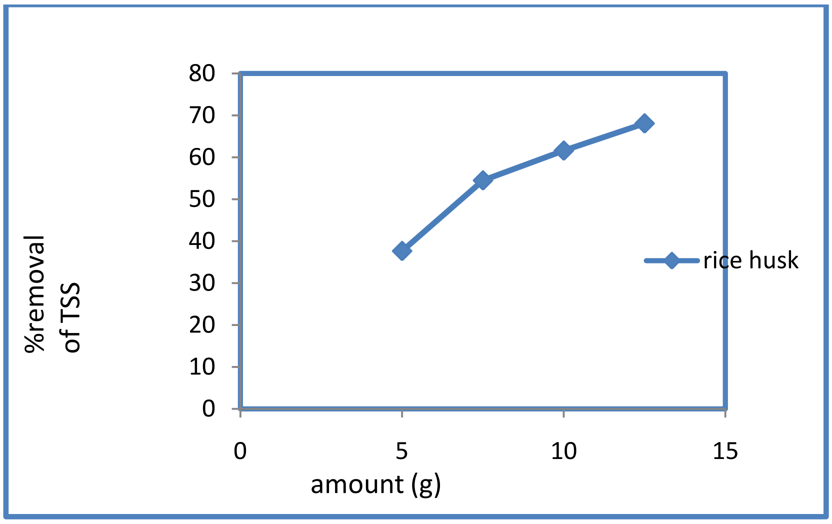
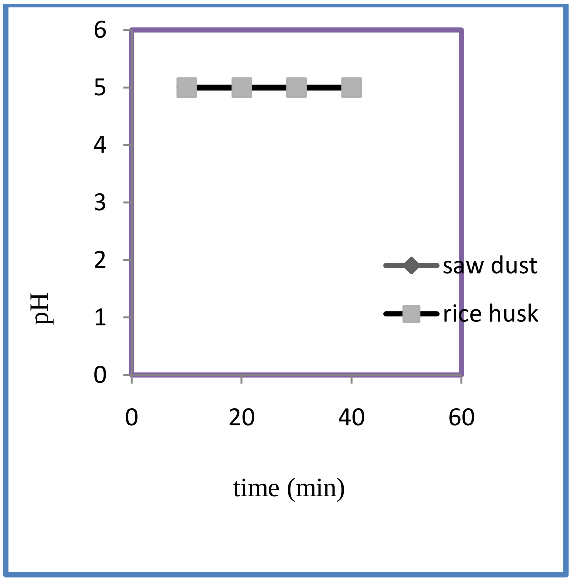


Figure 3.4 Effect of adsorbent dosage on % removal of TSS at a constant contact time of 25 mins. And effluent volume of 50 ml

From the graph it is observed that the % removal of TDS increased with increase in the amount of adsorbent at a constant effluent volume of 50 ml and contact time 25 mins. The change can be attributed to the fact that at higher doses of adsorbent more adsorbent surface and pore volume would be available for the adsorption interaction and these results in higher removal.

3.1.5 Effect on pH

Both adsorbent dosage and contact time didn't have any effect on the pH of the effluent it remained constant at the value of 5.0.



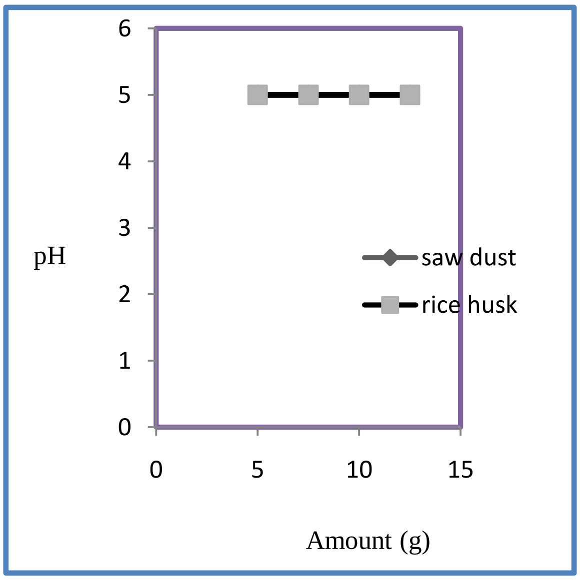


Figure 3.5 Effect of contact time on pH of effluent Figure 3.6 Effect of adsorbent dosage on pH of effluent

3.2 Effects of different parameters and adsorption efficiency for saw dust carbon

3.2.1 Effect of contact time on % removal of TDS for saw dust carbon:

The effect of contact time on %removal of TDS at an adsorbent dosage of 0.1g/ml was studied and the values are tabulated in the table 3.7 below and the graph is shown in fig.3.7

Table 3.7 Effect of contact time

Time	Adsorption %efficiency saw dust
10	36.57
20	38.83
30	40.83
40	60.78
50	72.73
60	83.34

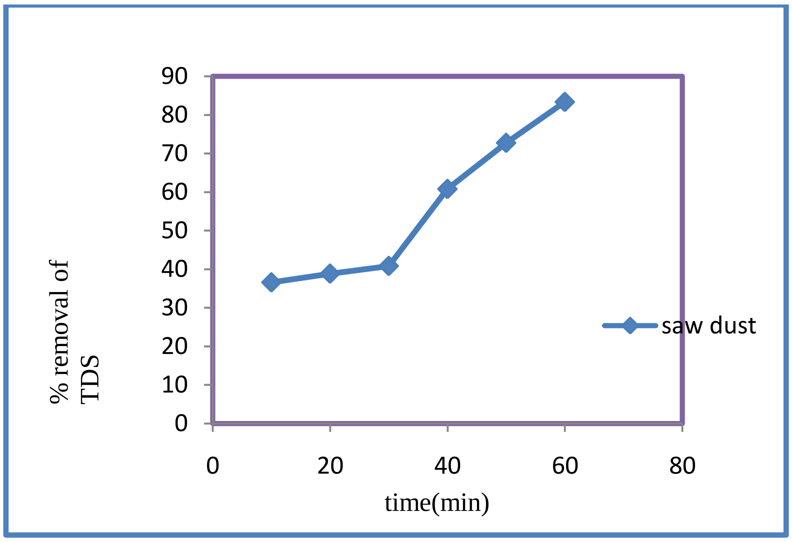


Figure 3.7 Effect of contact time on % removal of TDS by saw dust carbon at an adsorbent Dosage of 0.1g/ml.

From the above graph we infer that the % removal of TDS increases with the increase in the contact time. The adsorption efficiency has increased from 36% at a contact time of10 mins to 61% at a contact time of 40 mins .The changes in the % removal can be attributed to the increased time of contact which increases the time available for the solids to get adsorbed by saw dust carbon.

3.2.2 The effect of contact time on %removal of TSS for saw dust carbon

The effect of contact time on %removal of TSS at an adsorbent dosage of 0.1g/ml was studied and the values are tabulated in the table 3.8 below and the graph is shown in fig.3.8

Table 3.8 Effect of contact time

Time	Adsorption %efficiency sawdust
10	28.01
20	43.04
30	50.23
40	62.38
50	70.35
60	78.32

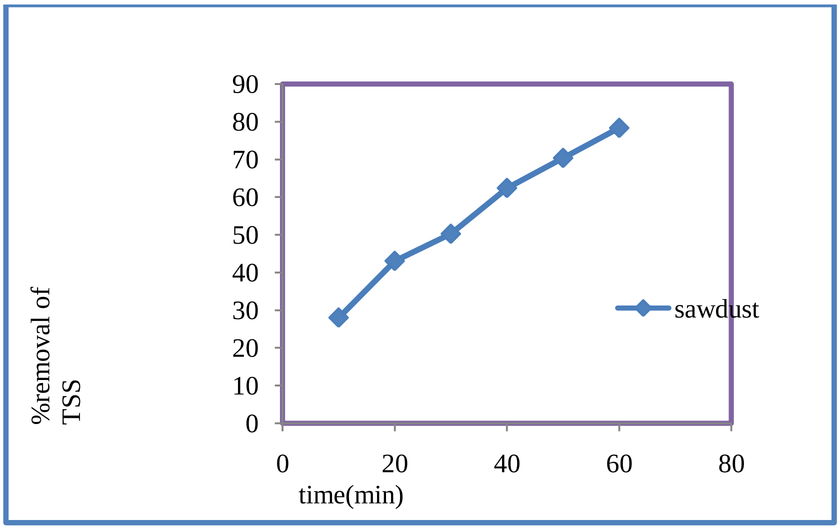


Figure 3.8 Effect of contact time on % removal of TSS by saw dust carbon at an adsorbent Dosage of 0.1g/ml.

From the above graph we infer that the % removal of TSS increases with the increase in the contact time. The adsorption efficiency has increased from 28% at a contact time of 10 mins to 62% at a contact time of 40 mins. The changes in the % removal can be attributed to the increased time of contact which increases the time available for the solids to get adsorbed by saw dust carbon.

3.2.3 Effect of adsorbent dosage on %removal of TDS by saw dust carbon

The effect of adsorbent dosage on % removal of TDS by saw dust carbon was studied at a constant contact time of 25 mins. Volume of effluent taken was 50 ml.The values are tabulated in the table 3.9 below and graph is shown in the figure 3.9

Table 3.9 Effect of adsorbent dosage

Amount	Adsorption %efficiency saw dust
5	39.58
7.5	45.63
10	49.92
12.5	51.99

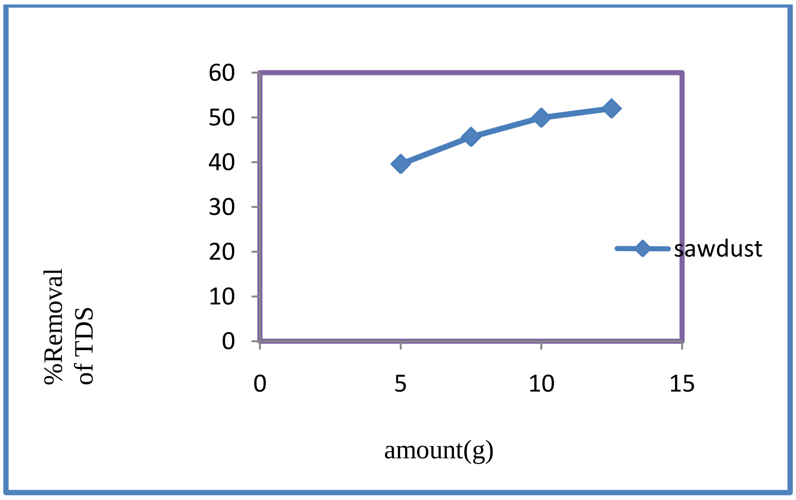


Figure 3.9 Effect of adsorbent dosage on % removal of TDS at a constant contact time of 25 mins. And effluent volume of 50 ml

From the graph it is observed that the % removal of TDS increased with increase in the amount of adsorbent at a constant effluent volume of 50 ml and contact time 25 mins. The change can be attributed to the fact that at higher doses of adsorbent more adsorbent surface and pore volume would be available for the adsorption interaction and this results in higher removal.

3.2.4 Effect of adsorbent dosage on %removal of TSS by saw dust carbon

The effect of adsorbent dosage on % removal of TSS by saw dust carbon was studied at a constant contact time of 25 mins. Volume of effluent taken was 50 ml.The values are tabulated in the table 3.10 below and graph is shown in the figure 3.10.

Table 3.10 Effect of adsorbent dosage

Amount	Adsorption %efficiency sawdust
5	44.85
7.5	58.67
10	66.09
12.5	71.91

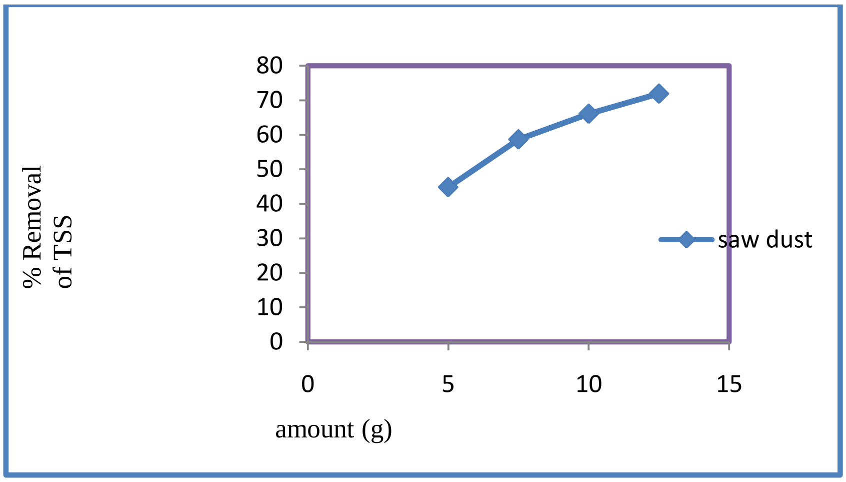


Figure 3.10 Effect of adsorbent dosage on % removal of TSS at a constant contact time of 25 mins. And effluent volume of 50 ml

From the graph it is observed that the % removal of TDS increased with increase in the amount of adsorbent at a constant effluent volume of 50 ml and contact time 25 mins. The change can be attributed to the fact that at higher doses of adsorbent more adsorbent surface and pore volume would be available for the adsorption interaction and these results in higher removal.

3.2.5 .Effect on pH

Both adsorbent dosage and contact time didn’t have any effect on the pH of the effluent it remained constant at the value of 5.0. as shown in the figure 3.11

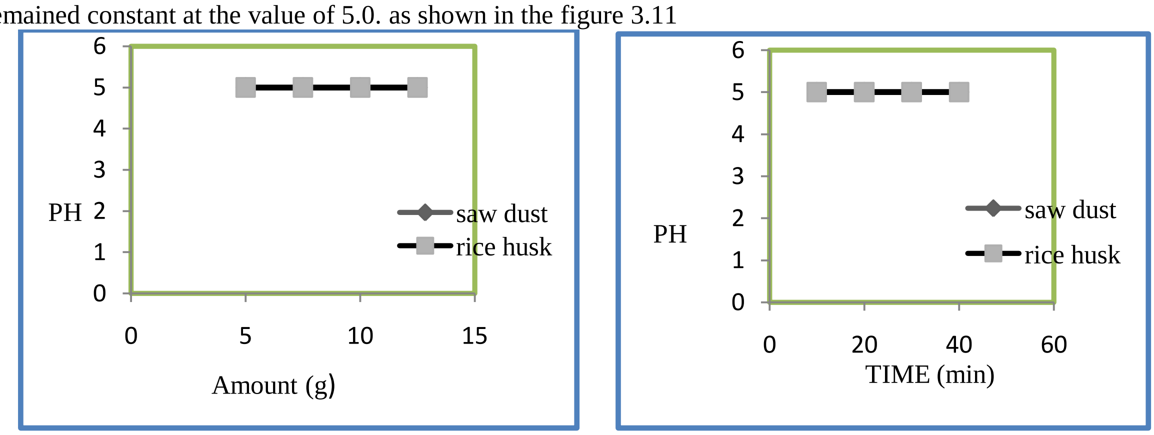


Figure 3.11

3.3 Comparison on % removal of TDS by rice husk carbon and saw dust carbon

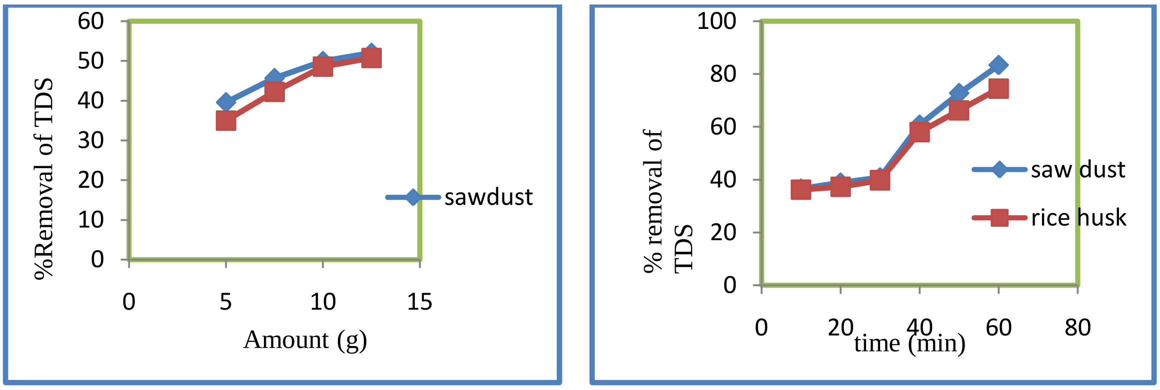


Figure 3.12

From the above graphs we infer that saw dust carbon is a better adsorbent when compared with the rice husk carbon.

3.4 Comparison on % removal of TSS by rice husk carbon and saw dust carbon

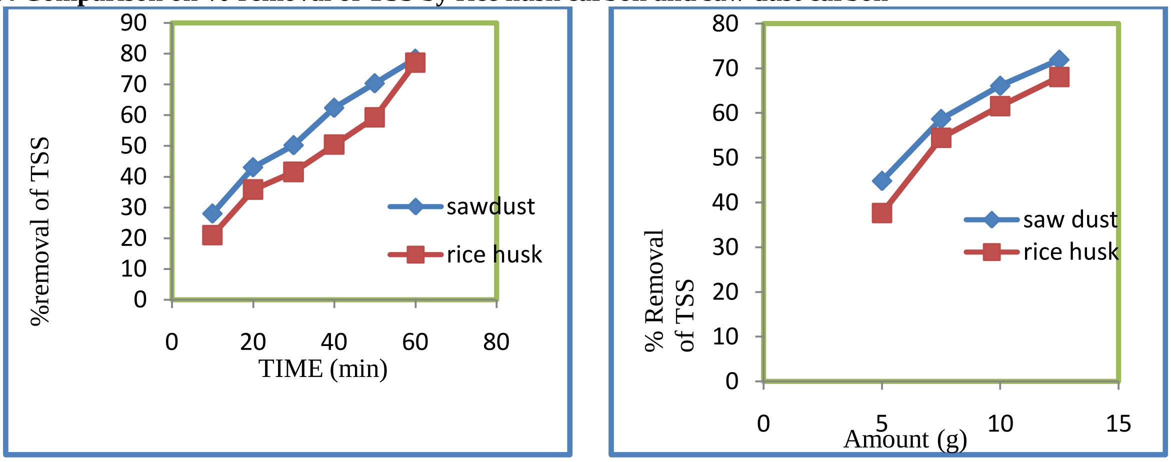


Figure 3.13

From the above graphs we infer that saw dust carbon is a better adsorbent when compared with the rice husk carbon.

IV. CONCLUSIONS

The utilization of waste materials such as saw dust and rice husk for preparation of adsorbents such as saw dust carbon and rice husk carbon was investigated along with the treatment of effluent from a local granite cutting plant through coagulation followed by adsorption through rice husk carbon and saw dust carbon.

The following conclusions could be drawn from our investigation:

- Both saw dust carbon and rice husk carbon acted as better adsorbents for the removal of solids present in the effluent from granite cutting plant.
- Coagulation also resulted in better removal of solids along with a decrease in pH from 7.5 to 5.0
- Even during adsorption, pH of the effluent didn't alter.
- An increase in adsorbent dosage resulted in an increase in the percentage removal of solids from the effluent for both saw dust carbon and rice husk carbon.
- An increase in time of contact of effluent and adsorbent during adsorption resulted in an increase in the percentage removal of solids.
- However saw dust carbon had shown a better percentage of removal of solids at an adsorbent dosage of 0.1g/ml and at contact time of 40 minutes based on contact time variation than rice husk carbon. Percentage removal of solids was found to be TSS= 62% and TDS= 60% for saw dust carbon and TSS= 50% and TDS= 57% for rice husk carbon.
- Thus saw dust carbon appeared more efficient than rice husk carbon.

- However , as both the adsorbents used in this project are made from natural and unused materials ,they are cost effective and eco friendly relative to the commercially available adsorbents.

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