Studies on Treatment of Wastewater by using Low Cost Natural Adsorbents

Divya shree s[1], Dr. K M Sham Sundar[2]

[1]PG Student, Dept. of Civil Engineering, UBDT College of Engineering, Davanagere, Karnataka, India
[2]Professor, Dept. of Civil Engineering, UBDT College of Engineering, Davanagere, Karnataka, India

---

Abstract - *Sugar industry effluent carries a higher concentration of contaminants. This causes pollution of water and soil, if discharged without proper treatment. These contaminants reduce the water quality, thus makes the water unfit for aquatic life and domestic purposes. The wastewater is characterized by its colour, and pH, high BOD, low DO level, COD, Chlorides, TS, SS, high amount of TDS, Sulphate, and Oil & Grease. The initial concentrations of these parameters are 5.35, 530mg/L, 2.0mg/L, 790mg/L, 45mg/L, 2100mg/L, 770mg/L, 1750mg/L, 62mg/L, 89mg/L respectively. The study was carried out for the treatment of wastewater by using pomegranate peel and chickpea shells as adsorbents. After treatment of effluent the pH, and DO were increased, and the COD, BOD, Chlorides, TS, SS, TDS, Sulphate, and Oil & Grease are reduced to a percentage of 70%, 90%, 38%, 17%,22%, 29%, 49%, 87% by using pomegranate peel and 49%, 55%, 32%, 12%, 14%, 24%, 42%,79% by using chickpea shells as adsorbents at varying depth. It is concluded that the removal efficiency increases with increasing the depth of the adsorbents.*

***Key Words*: Sugar Industry Wastewater, Adsorbents, Pomegranate Peel, Chickpea Shells, Filtration.**

1. INTRODUCTION

Water is an essential constituent of all living organisms. Water has a most useful and significant role in the natural cycle in this relation. Just 3% of the water is available on earth as fresh water. Enormous amounts of fresh water must be used in the production cycle to be used in Industry. Hence, the fresh water consumption is equal to the wastewater discharge as an effluent. Unmanaged quantities of organic wastes from the factories towns, and agricultural sectors are decomposed in the atmosphere, this resulting in pollution of soil, water, and air on a wide scale. It leads to significant public health issues and deterioration of the environment. Unfortunately, most of the sugar industries in developing countries release wastewater without adequate treatment due to the lack of knowledge, and financial support to spend on the treatment of wastewater. Through this context, the present study highlighted that concentration of pollutants in the effluent of sugar industry. Wastewater discharged from sugar industry creates contamination issue in both marine and terrestrial environments if released without treatment.

1.1 Scope of the Work

Sugar Mills untreated effluents highly contains pH, TDS, TS, TSS, BOD, COD, Chlorides, Sulphate, Oil & Grease and lower DO levels, which are causes of degrading of water bodies. They are also unacceptable, and must not be discharged into irrigation and drainage systems. Untreated effluents from Sugar Mills not only degrade the surface water body, fertile soil, but pollute groundwater as well. This is also suggested that wastewater should not be released into the irrigation and drainage network without treatment, which results in unsafe water quality for marine life and ecological habitat. The treated wastewater of Sugar factories will dilute with fresh water that could be suitable for irrigation and utilizing again for industrial processing.

1.2 Objectives of the Study

1. To determine the initial and final characteristics of wastewater.
2. Feasibility studies of pomegranate peel and chickpea shells as an adsorbent for the treatment of wastewater.
3. Study on removal efficiency of various parameters by using natural adsorbents.
4. To compare the adsorbents (pomegranate peel and chickpea shells) in the treatment of wastewater by plotting graphs.

2. CHARACTERISTICS OF EFFLUENTS

Individual and combined effluent characteristics vary between mill to mill, and from time to time. All effluents excluding the overflow of spray pond are acidic and colored posters with unpleasant odour, high BOD and suspended solid. It also has a high content of oil and grease. The characteristics of a typical sugar mill's effluents are given in the table below.

Table -1: General Characteristics of Sugar Mill Effluent.

Sl.No	Parameters	Range (mg/l)	BIS standards (mg/l)
1	pH	6.5-8.8	6.5-9.0
2	DO	0-2.0	4-6
3	BOD	300-2,200	50

4	COD	1360-2,000	250
5	Chlorides	18-40	600
6	TS	870-1950	2700
7	TDS	400-1650	2100
8	SS	220-790	600
9	Sulphate	40-70	100
10	Oil & Grease	60-100	10

3. EXPERIMENTAL SETUP

The study was carried out in bio-filtration kit at environmental laboratory. The bio- filtration kit contains a layer of sand and gravel. It has provisions at its bottom to collect the filtered water that opens out through an outlet. The lower most layers are composed of 20mm size gravel aggregates and above that there is a layer of gravel of size 10mm and top layer consists of sand of size less than 1.18mm. These layers of gravel fill up to a depth of 10cm, each 5cm depth. On top of that there is sand layer for about 5cm. The topmost layer consists of adsorbent materials at varying depth of 5cm, 10cm, and 15 cm. Schematic diagram used for the experiment is shown in Figure 1.

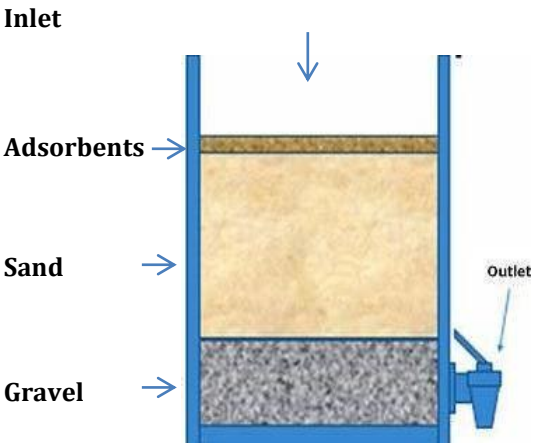

Fig -1: Schematic Diagram of bio-filtration kit used for the Experiment.

The inflow was provided using plastic bucket containing wastewater from sugar industry, kept on an elevated platform just near the bio-filtration kit. The plastic bucket had tap at the bottom. It consisted of 0.5 inch pipe with water trickling holes that enable uniform wastewater distribution on the top surface of the filtering unit. Sugar industry wastewater from the influent tank flows gravitationally through the pipes. The wastewater percolated down through different layers in the bed of bio-filters passing through the adsorbents placed on top and sand and gravels. The water is collected at the bottom of the kit. This treated wastewater from the kit was collected and analyzed for pH, Oil & Grease, TDS, TS, TSS, Chloride, sulphates, D.O, BOD and COD.

4. METHODOLOGY

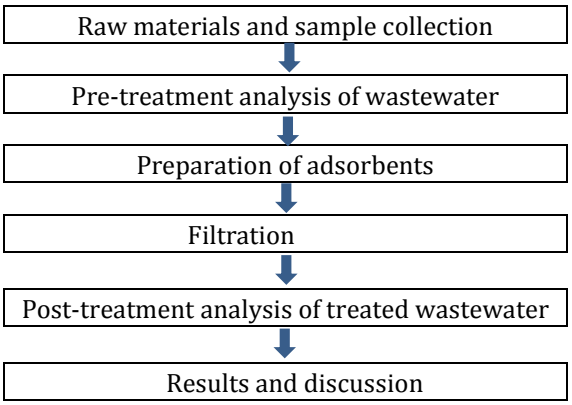

Fig -2: Flow Chat of Methodology.

5. MATERIALS USED AND PREPARATION OF ADSORBENTS

Different adsorption media used are listed below and are locally collected at a very low cost.

5.1 Gravel

Fig -3: Coarse Aggregates

Gravels are placed at the bottom of the filtering unit in two layers. The gravels which pass through 20mm IS sieve and 10mm IS sieve is placed below sand layers. Gravels used in filters are sieved washed thoroughly and are oven dried for about 24 hours and then these materials are placed into the filter.

5.2 Sand

Fig -4: Sand

Filtration sand is sieved, washed and oven dried for 24 hours and is placed in one layer. The sand which passes through 1.18mm IS sieve is placed over the gravel layers.

5.3 Preparation of adsorbents

5.3.1 Pomegranate Peel

Pomegranate Peels were collected from a nearby juice seller as a waste product. After the peels were collected they were washed thoroughly in distilled water. The washed materials are then cut into very small pieces and are allowed to dry naturally under the sunlight for 7 days. The moisture content was fully lost from it. The color change was noticed from red to brownish black. After it was fully dried pomegranate peels were crushed into powder using domestic mixer and passed through IS sieve size of 0.15mm.

Fig -5: Pomegranate Peels Collected from The Fruit Shop.

5.3.2 Chickpea shell

Chickpea shells were collected from a household as a waste product. After the shells were collected they were washed thoroughly in distilled water. The washed materials are then cut into very small pieces and are allowed to dry naturally under the sunlight for 7 days. The moisture content was fully lost from it. The color change was noticed from green to yellow. After it was fully dried shells were crushed into powder using domestic mixer and passed through IS sieve size of 0.15mm.

Fig -6: Chickpea Shells Collected from The Household.

6. RESULTS AND DISCUSSIONS

6.1 pH

Table -2: pH Values Before and After Filtration.

Adsorbents used in Depth (cm)	Influent (mg/L)	Pomegranate peel	Chickpea shells
		Effluent (mg/L)	Effluent (mg/L)
5	530	320	470
10	530	160	390
15	530	48	240

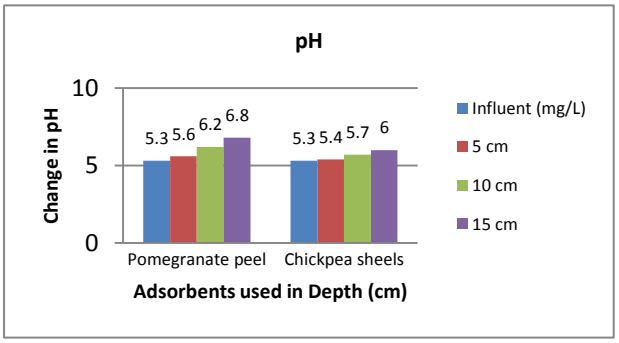

Chart -1: Variation in pH Before and After Filtration.

Pomegranate peel is effective in increasing pH upto 6.8 when compared to chickpea shells.

6.2 Dissolved Oxygen (DO)

Table -3: DO Values Before and After Filtration.

Adsorbents used in Depth (cm)	Influent (mg/L)	Pomegranate peel	Chickpea shells
		Effluent (mg/L)	Effluent (mg/L)
5	2	2.6	2.2
10	2	3.3	2.8
15	2	4.6	3.7

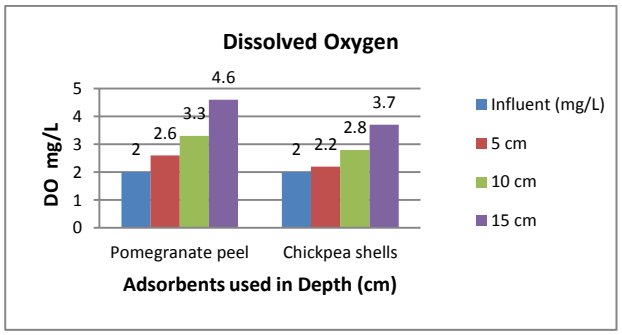

Chart -2: Variation in DO Before and After Filtration.

Pomegranate peel is effective in increasing DO upto 2.5 to 5% when compared to chickpea shells.

6.3 Biological oxygen demand (BOD)

Table -4: BOD Values Before and After Filtration.

Adsorbents used in Depth (cm)	Influent (mg/L)	Pomegranate peel	Chickpea shells
		Effluent (mg/L)	Effluent (mg/L)
5	5.3	5.6	5.4
10	5.3	6.2	5.7
15	5.3	6.8	6.0

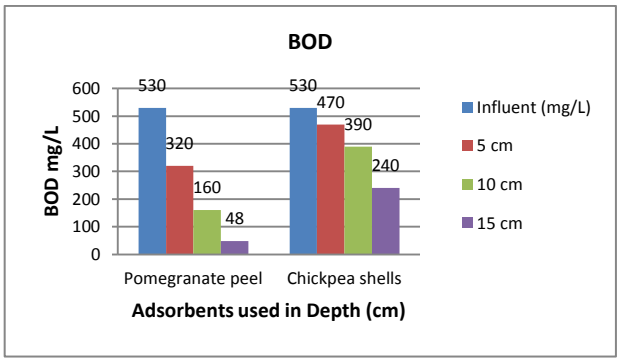

Chart -3: Variation in BOD Before and After Filtration.

Pomegranate Peel is effective in removing BOD upto 39 to 91% when compared to chickpea shells.

6.4 Chemical Oxygen Demand (COD)

Table -5: COD Values Before and After Filtration.

Adsorbents used in Depth (cm)	Influent (mg/L)	Pomegranate peel	Chickpea shells
		Effluent (mg/L)	Effluent (mg/L)
5	790	560	655
10	790	380	530
15	790	240	410

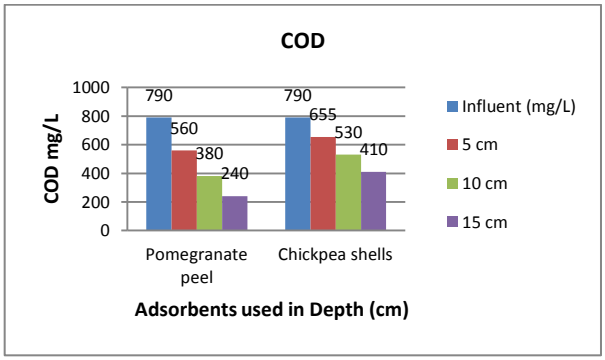

Chart -4: Variation in COD Before and After Filtration.

Pomegranate Peel is effective in removing COD upto 29 to 70% when compared to chickpea shells.

Chlorides

Table -6: Chlorides Values Before and After Filtration.

Adsorbents used in Depth (cm)	Influent (mg/L)	Pomegranate peel	Chickpea shells
		Effluent (mg/L)	Effluent (mg/L)
5	45	40	41
10	45	32	37
15	45	28	31

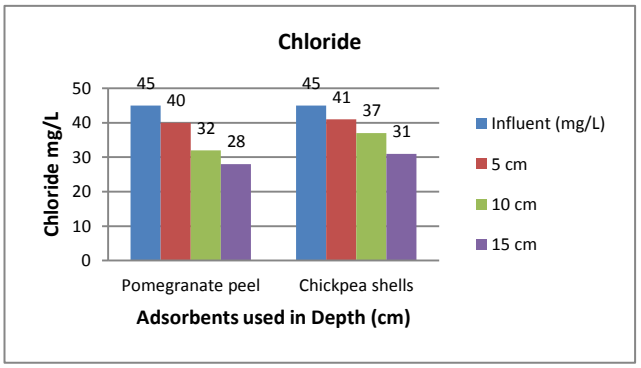

Chart -5: Variation in Chlorides Before and After Filtration.

Pomegranate Peel is effective in removing Chlorides upto 11 to 38% when compared to chickpea shells.

6.5 Total solids (TS)

Table -7: Total Solids Values Before and After Filtration.

Adsorbents used in Depth (cm)	Influent (mg/L)	Pomegranate peel	Chickpea shells
		Effluent (mg/L)	Effluent (mg/L)
5	2100	1960	1985
10	2100	1820	1905
15	2100	1745	1853

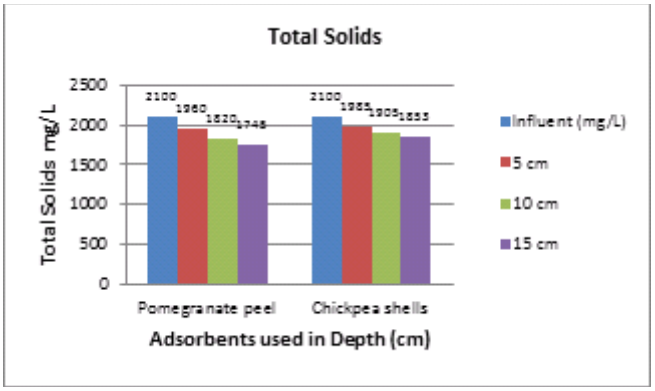

Chart -6: Variation in Total Solids Before and After Filtration.

Pomegranate peel is effective in removing TS upto 6 to 17% when compared to chickpea shells.

6.6 Suspended Solids (SS)

Table -8: SS Values Before and After Filtration.

Adsorbents used in Depth (cm)	Influent (mg/L)	Pomegranate peel	Chickpea shells
		Effluent (mg/L)	Effluent (mg/L)
5	770	715	730
10	770	635	675
15	770	550	592

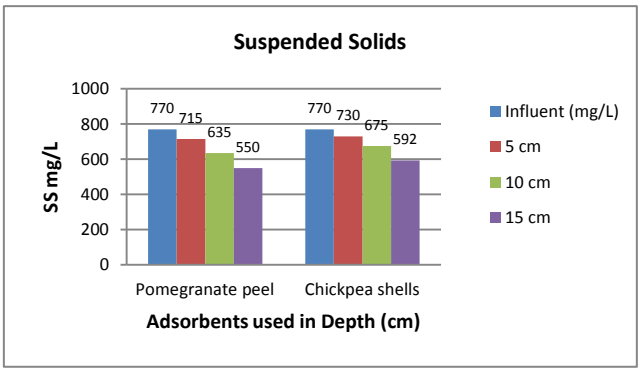

Chart -7: Variation in SS Before and After Filtration.

Pomegranate Peel is effective in removing SS upto 11 to 49% when compared to chickpea shells.

6.7 Total Dissolved Solids (TDS)

Table -9: TDS Values Before and After Filtration.

Adsorbents used in Depth (cm)	Influent (mg/L)	Pomegranate peel	Chickpea shells
		Effluent (mg/L)	Effluent (mg/L)
5	1750	1645	1685
10	1750	1520	1600
15	1750	1375	1510

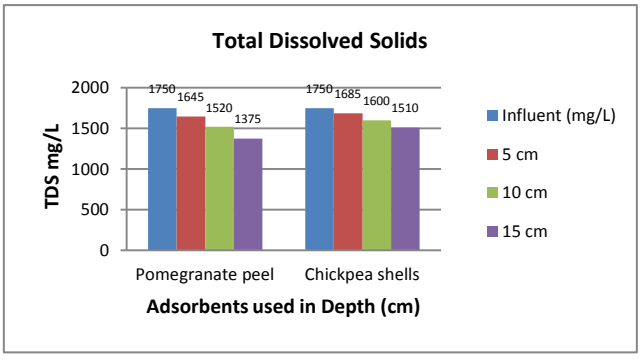

Chart -8: Variation in TDS Before and After Filtration.

Pomegranate Peel is effective in removing TDS upto 7 to 29% when compared to chickpea shells.

6.8 Sulphate

Table -10: Sulphate Values Before and After Filtration.

Adsorbents used in Depth (cm)	Influent (mg/L)	Pomegranate peel	Chickpea shells
		Effluent (mg/L)	Effluent (mg/L)
5	62	55	58
10	62	47	40
15	62	32	36

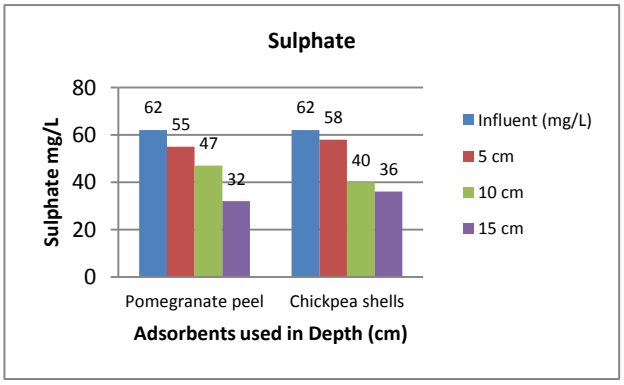

Chart -9: Variation in Sulphate Before and After Filtration.

Pomegranate Peel is effective in removing Sulphate upto 11 to 49% when compared to chickpea shells.

6.10 Oil & Grease

Table -11: Oil & Grease Values Before and After Filtration.

Adsorbents used in Depth (cm)	Influent (mg/L)	Pomegranate peel	Chickpea shells
		Effluent (mg/L)	Effluent (mg/L)
5	89	50	65
10	89	35	47
15	89	12	19

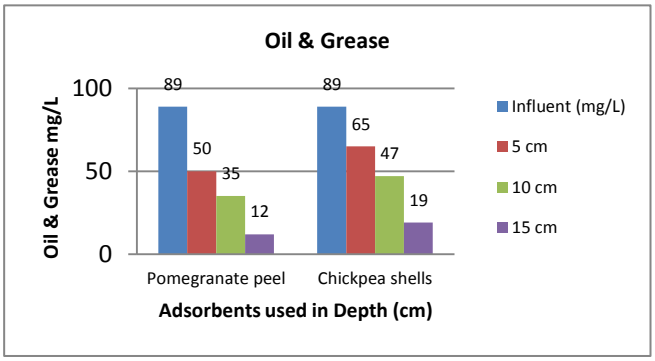

Chart -10: Variation in Oil & Grease Before and After Filtration.

Pomegranate peel is effective in removing Oil & Grease upto 43 to 87% when compared to chickpea shells.

7. CONCLUSIONS

- In the present study, the effect of absorbents used in contaminants reduction in wastewater such as pomegranate peel and chickpea shells is observed by developing a Bio-filter model and passing the wastewater through the model.
- From the results, it is observed that there is substantial reduction in pH, DO, BOD, COD, Chlorides, Total Solids, Suspended Solids, Total Dissolved Solids, Sulphates, and oil & grease after subjecting to filter.
- Initial concentrations of pH, DO, BOD, COD, Chlorides, TS, SS, TDS, Sulphate and Oil & Grease are 5.35, 2.0mg/L, 530mg/L, 790mg/L, 45mg/L, 2100mg/L, 770mg/L, 1750mg/L, 62mg/L, 89mg/L respectively. After treatment of effluent the removal efficiency of pH, DO, BOD, COD, Chlorides, TS, SS, TDS, Sulphate and Oil & Grease are reduced to 7, 5mg/l, 90%, 70%, 38%, 17%,22%, 29%, 49%, 87% by using pomegranate peel and 6, 4mg/L, 55%, 49%, 32%, 12%, 14%, 24%, 42%,79% by using chickpea shells as adsorbents at varying depth.
- The present study also revealed that the adsorption increases with the increase of height of the adsorbent used in the bio-filtration model.
- It is concluded that the removal efficiency of pomegranate peel is greater than the chickpea shells. Hence it can be successfully used as adsorbents for the treatment of wastewater.
- The wastewater after treatment is fit for irrigation purposes, gardening, washing, cleaning and various other domestic purposes. Here the natural adsorbents proved to be more effective in wastewater treatment. The results proved that the low cost adsorbents such as pomegranate peel and chickpea shells can be fruitfully used for treatment of wastewater before discharging into water bodies.

ACKNOWLEDGEMENT

It is with deep sense of gratitude, I acknowledge the help and encouragement of my guide, HOD and staff of department of civil engineering for guiding and suggesting me in carrying out this research work.

REFERENCES

[1] Abdul Latif Qureshi, Ali Asghar Mahessar, et.al., (2015) "Impact of Releasing Wastewater of Sugar Industries into Drainage System", International Journal of Environmental Science and Development, 6(5).

[2] Chidanand Patil, Mugdha Ghorpade, Manika Hugar (2015) "Performance and Evaluation of Sugar Industry Effluent Treatment Plant", 2(2): 2393-8374.

[3] Kolhe A.S., Sarode A.G., Ingale S.R. "Study of Effluent from Sugar Cane Industry", ISSN: 0974-2832.

[4] Punit Limbani, Metali shah (2018) "Impact of Sugar Industry Effluent on Nearby Water Body", International Journal Trend in Scientific Research and Development, 2(2): 2456-6470

[5] Sanket.D.Awasare, Harshavardhan.U.Bhosale, et.al., (2015) "Effluent Treatment Plant of Sugar Wastewater", International Journal of Scientific Research in Science and Technology, 1(5): 2395-6011.

[6] Shiva Kumar.D, Srikantaswamy.S (2015) "Evaluation of Effluent Quality of a Sugar Industry by using Physico-Chemical Parameters", International Journal of Advanced Research in Engineering and Applied Sciences, 4(1): 2278-6252.

[7] Neethu.P, M.A Chinnamma, (2017) "Natural Adsorbents for Agricultural Waste Water Treatment", International Journal of Advanced Engineering, Management and Science, 3(4), ISSN: 2454-1311.