TREATMENT OF WASTE WATER USING NATURAL ADSORBENTS

Guruprashanth N[1], Soundarya H M[2], Nayana H M[3], Sharath D S[4], Pavan M[5]
Department of Civil Engineering
Jain Institute of Technology, Davanagere
Karnataka, India

Abstract: **This abstract summarizes the treatment of wastewater using natural adsorbents. Wastewater treatment is a crucial process to remove pollutants before discharge into the environment. Traditional methods often involve chemical and energy-intensive processes. However, the utilization of natural adsorbents has gained attention due to their effectiveness, low cost, and environmentally friendly nature. Pollutants are drawn to and attached to the surface of the adsorbent material during the adsorption process. The adsorbent's surface area, porosity, chemical makeup, and surface functional groups are all factors that affect adsorption capability. Additionally, pH, temperature, contact time, and initial pollutant concentration significantly influence the adsorption efficiency.**

I. INTRODUCTION

Earth is referred to as the "Blue Planet" because water covers 71% of its surface. There is a finite amount of water. It's likely that the water that people drink today came from a woolly mammoth at one point in time and perhaps trickled down its back. Water that existed on Earth billions of years ago is still present now because the Earth is a closed system, meaning that very little substance, including water, ever departs or enters the atmosphere. But through the hydrologic cycle, the Earth purifies and replenishes the water supply. Even though there is a lot of water on the earth, just a little amount (about 0.3 percent) of it can be used by humans. The remaining 99.7% of matter is suspended in the air, on the ground, in the ice caps, and in the oceans. Even yet, a large portion of the 0.3% that is usable is inaccessible. Rivers provide the vast majority of the water that people utilize. Surface water refers to the visible bodies of water. In actuality, aquifer moisture is where the majority of fresh water is kept. A river can continue to flow even in the absence of precipitation because groundwater can feed the streams. Both surface and groundwater are useful to humans.

1.1 The quantity of water on Earth

1. Ocean water: 97.2 %
2. Ice and other glaciers: 2.15 %
3. Groundwater: 0.61 %
4. Lakes with fresh water: 0.009 %
5. Intracoastal water: 0.008 %
6. 0.005% of soil moisture
7. Environment: 0.001 %
8. Rivers: 0.01 %

1.2 Wastewater

Wastewater is the liquid that remains after fresh water has been applied to various tasks and procedures. This water may be used for domestic, commercial, or agricultural purposes. In daily life, wastewater is nothing more than sewage, which is domestic or municipal wastewater produced by people. A study found that household water in the world is not securely treated in 44% of cases, which can lead to a variety of water-related ailments like cholera, schistomiasis, and other disorders. The significant population and economic expansion, particularly in the numerous nations in Africa that lack management systems for treating the wastewater, puts individuals from low- and lower-middle income countries at a higher risk of exposure to contaminants and poorly cleaned water.

1.3 Industrial Wastewater

Due to governmental regulations, industries have been forced to reduce wastewater or treat it before discharging it into water bodies over the past few years which results in growth of global population, economic growth, and rapid globalisation and industrialization. Some industries have even begun recycling wastewater. The waste water that is emptied into bodies of water like lakes, rivers, etc. Waste water which is discharge contains the toxic materials, pollutants, which may results in the loss of environment, biodiversity and affects the human health, the water borne diseases can significantly higher chances of occurring by this.In all the industries responsible for the wastewater, textile industries are accountable for the serious pollution issues because mainly these contains the undesirable dye effluents. A combination of metals, dyes, and other contaminants are found in these effluents released by the textile industry. These dyes can be natural dyes and processed dyes, processed dyes can be produced easily and these are economical so these leads to the more usage of the synthetic dyes. These effluents of dyes are normally high in pH, suspended solids, COD and BOD.

1.4 Wastewater Distribution

Of the 16,662.5 MLD of generated wastewater, only 4037.2 MLD (or 24%) is treated before discharge; the remaining 12,626.30 MLD is disposed of without treatment. Twenty-seven cities only have primary treatment facilities, whereas only forty-nine cities have both primary and secondary care facilities. The complex organic compounds in wastewater are broken down into simpler, stable, and odorless components throughout the sewage treatment process, either physiochemical (physical treatment) or biologically (biological treatment).

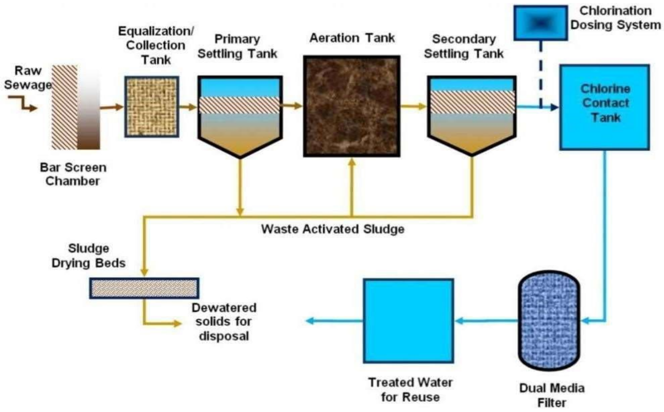

Fig- 1.1: Flow Chart of Sewage Treatment Plant

Bar screening chamber: The first step in wastewater treatment is screening, which is used to get rid of big floating material like wood, plastic bags, and other things.

Grit chamber: In grit chambers, which are tanks with flow-slowing features, materials like sand, coffee grinds, and eggshells will settle out in the water.

Skimming tank: In skimming tank the flowing matters like oil, fat, grease etc are removed and allowed to pass through the partition walls.

Primary treatment unit (or) Sedimentary tank: Sedimentary tanks are constructed to remove suspended particles.

Primary clarifier: A tank provided before secondary treatment unit.

Secondary clarifier: A tank provided after secondary treatment unit.

Secondary unit:

- Trickling filters and the activated sludge process are the two main secondary treatment techniques used.
- The secondary stage of treatment is primarily aimed to remove organic waste in sewage by use of bacteria.

Final disposal with chlorination

- After secondary treatment, an effluent is disinfected with chlorine compounds to destroy/kill parasites, bacteria and viruses.
- After disinfection of water, it can be safely disposed into surrounding water bodies.

Advantages of wastewater treatment

- Initial cost is low.
- More amount of BOD removed..
- Effortless procedure.
- Less operation cost.
- Sludge generation is Less.
- High water solubility.
- Toxic to pathogens.
- Low cost and readily available.
- Available in domestic to industrial scale.
- Simple operating system.

Disadvantages of wastewater treatment

- Rotating arms will block at early stage.
- More odour generation.
- Area Required is more.
- Difficult to handle in cold climate.
- Monitoring of sludge concentration is difficult.
- Chlorine gas is challenging to manage owing to its danger.

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II OBJECTIVES

- To study the Characteristics of industrial wastewater.
- The analysis of the effects of changing the dosage of the adsorbent on the adsorption process.
- To investigate the contact time, initial pH of metal ion concentration, and percentage of metal ion elimination.
- Preparation of natural absorbents like Orange peel, Banana peel, Areca nut, Coconut shell.
- By using natural absorbents to decrease the metal ion content in distilled wastewater.
- Fixing varied dosages of natural absorbents for the elimination of pH, turbidity, and total dissolved solids in industrial waste water treatment.
- Determination of optimum dosage of absorbents.

III MATERIALS AND METHODOLOGY

Materials

Materials used for Absorption are:

- Orange peel
- Sugarcane bagasse
- Caesalpinia bonduc
- Coconut shell

Collection of Distilled water for preparing wastewater using Heavy metal ions:

Water that has been heated until it turns into vapour and then condenses back into liquid is known as distilled water. Water impurities that do not boil at or below the boiling point of water stay in the original container. Water that has been filtered in this way is called distilled water.

Fig- 3.1: Distilled Water

Collection of Natural Absorbents:

The natural Absorbents used for study are. Orange peel powder, Banana peel powder, Areca nut powder, Coconut shell powder. These Absorbents are the good adsorption properties and economic in cost. Usually Orange, and Banana peels are collected from local fruit stall. Then Areca nut is collected from Areca trees near our surrounding and Coconut shell is collected from local market.

Fig- 3.2: Orange peel

Fig- 3.3: Sugarcane Bassage

Fig- 3.4: Caesalpinia Bonduc

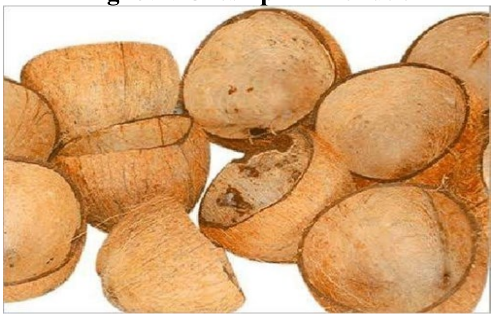

Fig- 3.5: Coconut shell

Preparation of Natural Absorbents:

Orange peel powder:

Orange peels were procured from the neighbourhood Rasapriya Juice shop in Davangere, and after being thoroughly cleaned with tap water to get rid of colloidal particles, they were analysed. Orange peels were exposed to sunshine for a week before being sliced into little pieces by hand, crushed into a fine powder, and sieved. Natural absorbents serve as a low-cost absorbent agent in the wastewater treatment plant's absorption process, making them an essential economic and environmentally favourable product.

Fig- 3.6: Orange peel powder

Coconut shell powder:

The most adaptable component of the coconut, the organic shell, is used to make coconut shell flour. Due to its exceptional durability characteristics, high toughness, and abrasion resistant capabilities, it is suitable for long-term service. The chemical makeup of the shell is comparable to that of hard woods, although having a lower cellulose concentration and greater lignin content. The chemical composition of the shell is comparable to that of hard woods, however it contains more lignin and less cellulose. In order to turn dry coconut shells into charcoal, carbonization involves heating the materials in an oxygen-free environment. A furnace or kiln is often used for this operation. Place the shells in the furnace and raise the temperature gradually to about 932–1652 degrees Fahrenheit (500–900 degrees Celsius). By doing this, volatile components are removed, and carbon-rich charcoal is left behind.

Fig- 3.7 Coconut shell powder

Caesalpinia bonduc powder:

Caesalpinia bonduc is collected from Amaravathi Halappa ayurvedic medicine shop near old BSC, and after that cleaned repeatedly with tap water to get rid of the colloidal particles. The Caesalpinia bonduc plant was sun-dried for a week before being manually chopped into small pieces, ground into a fine powder, and sieved.

Fig- 3.8: Caesalpinia bonduc powder

Sugarcane bagasse powder:

In order to get rid of colloidal particles, sugarcane bagasse is collected from the neighbourhood juice stand next to Hadadi Road in Davanagere. By hand cutters, sugarcane bagasse was cut into little pieces after being sun-dried for a week. Later, it was crushed into a fine powder and sieved. It is a significant financial and ecologically beneficial product since natural absorbents contribute to the creation of an inexpensive absorbent agent in the wastewater treatment plant's absorption process.

Fig- 3.9: Sugarcane bagasse powder

Reagents used for preparing wastewater sample:

- Barium
- Lead
- Nickel

Collection of Heavy metal ions:

Barium, Lead, and Nickel, were collected from the Scientific supplies near Chetana hotel at Davangere.

Barium: An inorganic substance with the formula $BaCl_2$ is barium chloride. It is one of the most prevalent barium salts that dissolve in water. Like the majority of other water-soluble barium salts, it burns with a yellow-green hue and is a white powder. It is also extremely poisonous.

Fig- 3.10: Barium chloride

Lead: Lead(II) nitrate is an inorganic compound with the chemical formula Pb(NO3)2. It often takes the form of a colourless crystal or white powder, unlike the bulk of other lead(II) salts, and is soluble in water.

Fig- 3.11: Lead nitrate

Nickel: Nickel nitrate is any of the hydrates of the inorganic substance Ni(NO3)2. The term "nickel nitrate" often refers to nickel(II) nitrate hexahydrate because it is unusual to find the anhydrous form. There are two ways to write this species' formula.: $Ni(NO_3)_2\ 6H_2O$ and, more specifically, $[Ni\ (H_2O)_6]\ (NO_3)_2$.

Fig- 3.12: Nickel nitrate

Methodology

Batch Studies

Batch studies involves following steps

- Analysis of Samples
- Weighing and adding of coagulants

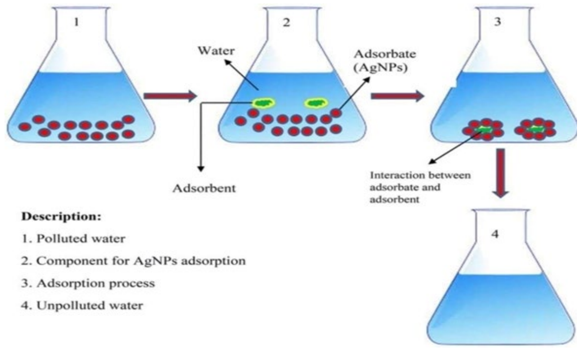

Fig- 3.13: Batch studies

Analysis of Samples:

The samples were analyzed before and after treatment for various parameters such as Turbidity, Total dissolved solids, pH.

Weighing and adding of Absorbents:

Fig- 3.14: Weighing balance

Testes Conducted for Wastewater Samples:

- pH
- Total dissolved solids
- Turbidity

pH Test:

Fig- 3.15: pH Meter

- After preparing the waste water sample, pH test was conducted. Usually, the pH of the sample is determined using pH meter. Firstly, prepare the buffer solution of pH 3.5 and 7.
- Insert the electrode in buffer solution of pH 3.5.
- Then switch on the power supply and standardize the pH meter using calibrating knob.
- Clean the electrodes using tissue paper, again dip the electrode in the buffer solution of pH 7.
- Note the reading. If it is 7, the instrument is calibrated. If not, again calibration is done.
- A waste water sample is taken in a beaker & the temperature knob is adjusted to room temperature.
- The electrode is washed with distilled water & dipped in the unknown sample.
- The reading in the dial indicates the pH of 5 sample. This procedure is repeated for different absorbent samples.

TOTAL DISSOLVED SOLID TEST:

Fig- 3.16: TDS and EC meter

- A TDS metre is a small, handheld instrument used to measure the total dissolved solids in water because dissolved ionised particles, such as salts and minerals, affect the conductivity of a solution.
- Using a TDS metre, determine the total dissolved solids (TDS) content of industrial waste water.
- Connect the instrument to 230v, 50HZ power supply. Connect the conductivity electrode to the socket provided at the back of the instrument.
- Then standardize the instrument using the known conductivity solution by using check knob in the instrument.
- After standardizing the equipment replace the known solution by the wastewater sample and select the knob to check position.
- Set the range know for different ranges until it gives stable values. The TDS meter displays the TDS value of that sample in ppm.

IV RESULT AND DICUSSION

Table- 4.1: Study of absorbents for different dosages: Effects of natural absorbents on wastewater for Orange peel powder

Sl. No	Parameters	Initial values	After treatment of orange peel powder sample (gm/L)				
			0.2	0.4	0.6	0.8	1.0
1	pH	6.61	6.62	6.55	6.38	6.35	6.3
2	Turbidity (NTU)	92.6	111.2	131.2	125.5	113.6	107.3
3	TDS(mg/l)	5.42	5.02	5.68	5.87	5.72	5.72

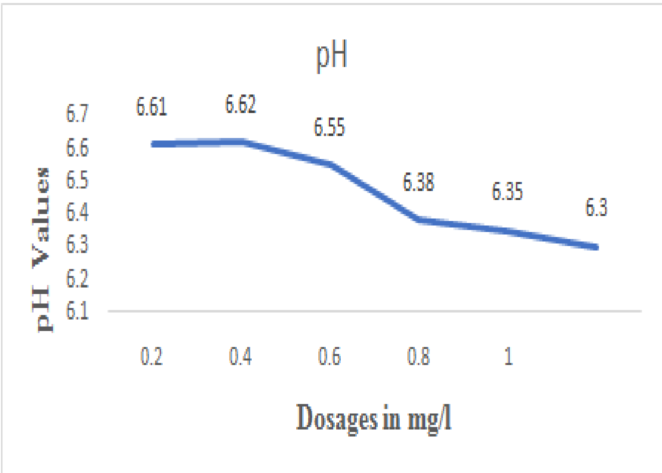

Fig- 4.1: pH TEST

pH reduction by different dosages of orange peel powder

By using orange peel powder for absorption pH of the waste water is reduced from 6.62 to, 6.55, 6.38, 6.35 and 6.3 for dosage of 0.2 gm/L, 0.4 gm/L, 0.6 gm/L, 0.8 gm/L and 10gm/L respectively.

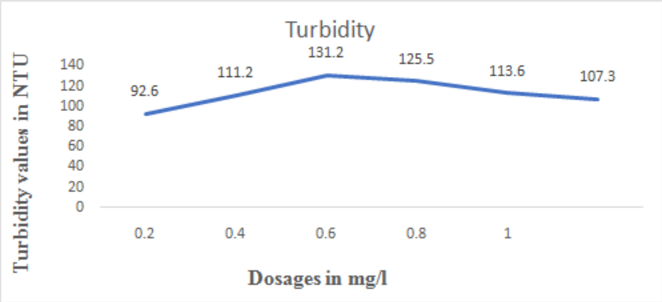

Fig- 4.2: Turbidity Test

Turbidity reduction by different dosages of orange peel powder Turbidity of the wastewater was reduced by 111.2, 131.2, 125.5, 113.6 and 107.3 NTU for 0.2, 0.4, 0.6, 0.8 and 1.0 gm/l of absorbent dosage. From the above chart we can observe that maximum removal of turbidity obtained from 0.4 gm/L of dosage.

TDS TEST:

TDS of wastewater treated by orange peel powder for different dosages of 0.2 gm/L, 0.4 gm/L, 0.6 gm/L and 0.8 gm/L, percentage reduction of TDS is 5.02, 5.68, 5.87, 5.72 and 5.95 respectively.

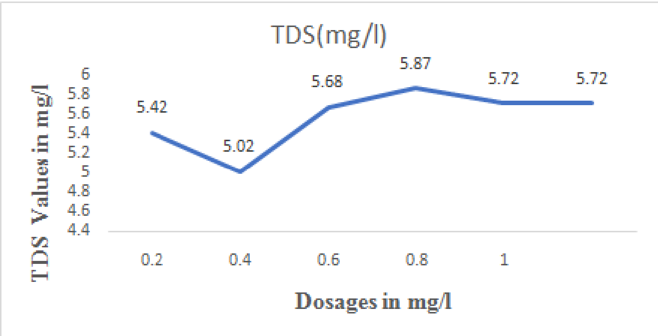

Fig- 4.3: Removal of TDS different dosage of orange peel powder

Coconut shell powder:

The effects of the dosage of coconut shell adsorbent were evaluated for parameters both before and after waste water treatment for coconut shell powder.

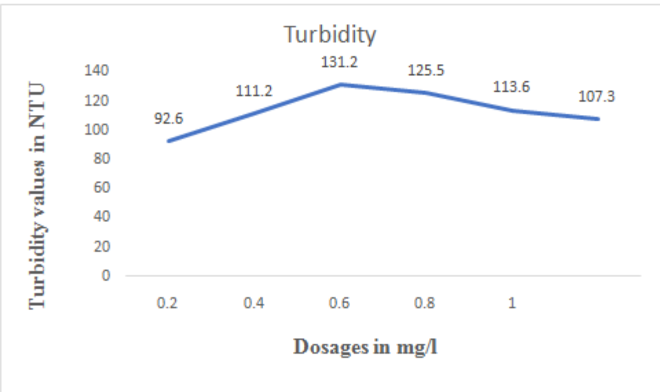

Fig- 4.4: Turbidity reduction by different dosages of Coconut shell powder.

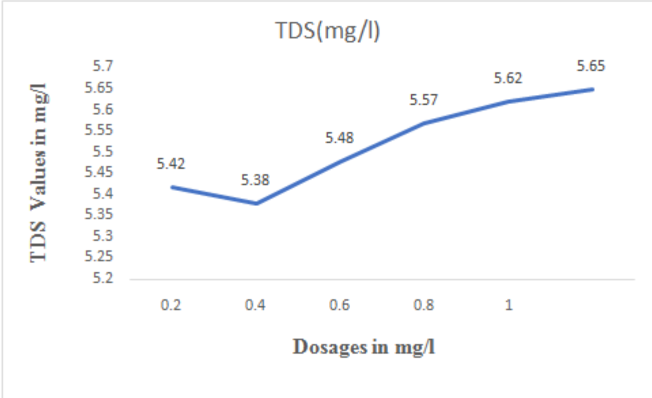

Fig- 4.5: Removal of TDS different dosage of Coconut shell powder.

Column Studies:

At 3 cm, 6 cm, and 9 cm, activated carbon-packed downflow fixed bed columns were used for column experiments. At the base of the column, glass wool was employed to stop activated carbon from leaching and blocking the drainage basin. In order to gently spread the solution onto the adsorbent surface and to maintain a constant flow, it was also positioned on top of the adsorbent bed. The initial cadmium solution concentrations were fixed. Sodium hydroxide (NaOH) and hydrochloric acid are used to adjust pH. In the column investigation, the ideal batch adsorption conditions were used. A peristaltic pump was used to pump the solution into the column in a downflow direction at a constant flow rate. For the first hour, effluents were collected every five minutes. Thereafter, they were collected every half-hour intervals until the exhaust point was reached in terms of the concentration of metal ions in the effluents. Utilising a spectrophotometer, residual concentrations were measured. All column experiments were carried out in triplicate throughout the room-temperature column investigation.

Fig- 4.6: Experimental Setup for Column study

Table: 4.2. Contact time in minutes Comparison of various parameters in different contact time

Parameter	3min	5min	6min
pH (%)	10.35	13.79	14.94
Turbidity (%)	26.42	30.56	33.16
TDS (%)	26.14	29.98	31.99

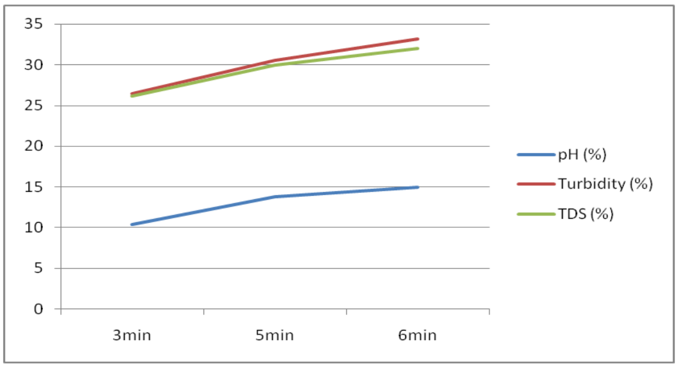

Fig- 4.7: Comparison of various parameters in1: 2 ratios in different contact time

Table: 4.3. Contact time in minutes Comparison of various parameters in different contact time Removal efficiency in 2:1 ratio

Parameter	3min	5min	6min
pH (%)	14.95	19.54	20.08
Turbidity (%)	38.34	46.11	52.33
TDS (%)	35.28	40.03	47.53

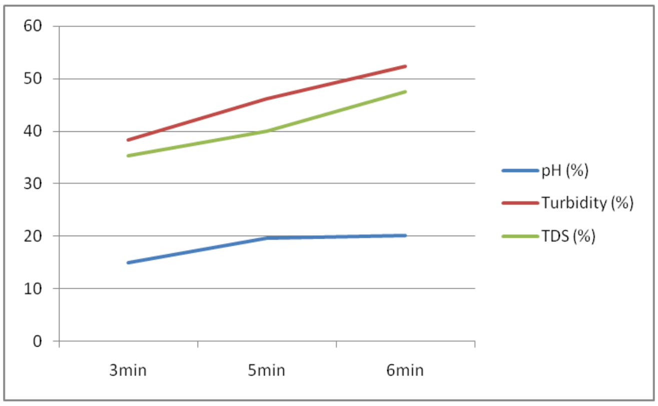

Fig- 4.8: Comparison of various parameters in 2:1 ratio in different contact time.

CONCLUSION

- The effluent must be properly treated since it poses risks to the environment and human health.
- Natural absorbents are very effective for reducing the physical chemical parameters of the wastewater, such as pH, turbidity, TDS, and others. Conventional methods for treating wastewater include trickling filters, the activated sludge process, aerated lagoons, and others. However, these methods are very expensive.
- They are low-cost due to the use of raw materials derived from renewable resources, safe, non-toxic, eco-friendly, and increase floc size.

For Orange peel powder

- In this study we can observe that pH was reduced maximum up to 6.3 by using Orange peel powder of dosage 1.0gm/l.
- The maximum turbidity removed by orange peel powder which is 131.2NTU for dosage of 0.4gm/l,
- The maximum reduction of TDS is 5.87 and 5.72 by using 0.6 gm/l and 0.8 gm/l dose of orange peel powder respectively.
- From the study we can conclude that Orange peel powder is more efficient absorbent for treating wastewater.

For Coconut shell powder

- In this investigation, we can see that utilising coconut shell powder at a dosage of 0.8 gm/l, pH was raised to a maximum of 6.45.
- At a dose of 0.4gm/l, coconut shell powder may eliminate up to 121.10NTU of turbidity.
- When coconut shell powder is used at doses of 0.6 gm/l and 0.8 gm/l, respectively, the maximum TDS decrease is 5.76 and 5.75.

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