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Application of Chemically Modified Neem Tree [Azadirachta indica] saw dust for industrial waste water treatment

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Abstract:

This research explores influence of Modified saw dust of neem tree [Azadirachta indica] on sugar industry waste water- With the motto waste to best. The application of bio-waste material – 5% H_2O_2 treated Neem saw dust with particle size 500 µm is moderately applicable for the removal of organic contamination from sugar industry waste water at room temperature. The physicochemical properties like pH, Hardness, alkalinity, chloride, COD and BOD are analyzed using standard methods of water and waste water analysis. This study explore the COD removal 36.85% and BOD removal 28.01% by 40gm/L of Modified Neem tree saw dust and then found exhaustion of saw dust for higher dosages. The application of bio waste material as an adsorbent for the removal of organic contamination like COD and BOD is moderately recommended as the data follow Freundlich and Langmuir adsorption isotherm.

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Key words: Modified neem tree saw dust, bio-adsorbent, COD, BOD, Hardness, Alkalinity, Chloride, Adsorption

Introduction:

Next to air, water is the most important natural resource necessary for the survival of human and animal life and also the environment of earth. Much of the water pollution is caused due to diversity in the composition of chemical reagents used in several chemical, pharmaceutical and food industries. These reagents range from inorganic compounds to polymers and organic products[1]. The pollution of air, water and land mainly occurs due to human activities like industrialization, mining, population growth, agricultural activities, burning of fossil fuels, etc[2, 3]. All these kind of pollution load can be removed from industrial waste water using different physico-chemical treatment methods like ion exchange, reverse osmosis, chemical precipitation, coagulaton, flocculation, electrodialysis, and adsorption etc[2,4]. Adsorption is an economic and eco-friendly of all these above treatment methods. Basically adsorption is a mass transfer operation, in which liquid or gas material deposits on the surface solid material[5]. The removal of metals or nonmetals and tiny particulates from a waste water solution by means of any biological component is known as biosorption [6]. In this regards the low cost bio-adsorbents obtained from agricultural and animal wastes are of major interest [7]. which incorporates Tea debris, babool bark, saw dust, Lemon leaf, Rice husk, Maize husk, Neem stem, Neem leaf, Groundnut shell powder, egg shell, plant leaves(neem, tamarind), coconut peel, banana peel, and cassava peel, Moringa Oleifera seed powder, Tamarind seed powder, and so many like vise easily accessible and more affordable plant materials have been utilized by researchers to accomplish adsorption phenomena [5, 8].

All these type of materials are just dumping in to environment, it causes damage to the surroundings. Biomass also can be used as adsorbent to separate heavy metals from aqueous solution. Azadirachta indica bark (neem bark) has maximum adsorption capacity towards iron metal ions. The bark has different functional groups at the surface of adsorption site which makes it an efficient adsorbent for iron. Maximum adsorption was seen within 30 minutes of contact time and later the reaction slowed down as it approached to steady state. When neem and babool tree barks were kept in solution containing many metal ions, 80–90% of chromium, cadmium, and manganese were adsorbed within a contact period of 10 minutes at pH 2 [9]. Yogita et al studied the use of neem bark powder as an adsorbent and concluded that this biowaste appears to be an efficient and cost effective for the removal of oil and grease, the highest removal found is 87.90 % for oil and grease at 2gm adsorbent dose [10]. Neem bark powder has shown high efficacy for the removal of metal ions from waste water [11, 12]. A long life span and being naturally abundant all over the world neem bark can be used reliable as biosorbents for oil removal from produced water [13].

Materials and Method:

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Sample Preparation:

Collection and characterization and then treatment with Neem [Azadirachta indica] saw dust of the combined wastewater samples is the heart of this study. The sampling is carried out from Sahakari Khand Udhyog Mandali Ltd, Bardoli (Gujarat). Samples were collected in sampling bottles and placed in icebox to preserve for analysis. The analyzed parameters were the pH, conductance, alkalinity, COD, BOD, hardness and chloride as per standard method [14]. The physicochemical treatments i.e adsorption with 5% H_2O_2 Modified neem [Azadirachta indica] is applied to combined wastewater in order to reduce COD and BOD. The combined waste water of sugar industry is treated with different doses (i.e.1 gm/L, 2 gm/L 5 gm/L, 10 gm/L, 20 gm/L, 30 gm/L, 40 gm/L, and 50 gm/L) of Modified neem [Azadirachta indica], stirred well and kept in contact for appropriate time duration (3 hours) at room temperature (26^0C), then filtered and then analyzed for the same characteristics.

Preparation Of Modified neem Saw Dust Powder:

Neem wood is collected from nearest sawmill shops from rural area. It is cleaned thoroughly with air using compressors and rinsed thoroughly with pure water to removal of dust particles.

Neem trunk contains three segments. First is outermost layer called bark and it is always present as top layer on wood which is normally dark brown or black colored. We use Bark for cut and grind in to fine particles. Bark first cut to small size pieces, then kept in hot air oven at more than 110°C for removal of moisture for 12 hours. Hammer mill is washed with water and cleaned properly and dried by hot air. The dried wood pieces are now sent to hammer mill to reduce the particle size. The product is then processed to mixer for further grinding. The final product is separated using Taylor sieve shaker by passing through the mesh to get particle size 500 µm. Then the nano particles are treated with 5% H_2O_2 keeping in contact for 24 hours, then wash with distilled water for several times to remove unreacted hydrogen peroxide. Oven dry at 110°C for removal of moisture for 12 hours. Store in air tight container.

Results and Discussion:

Table 1 represents the influence of dosages variation of Modified neem [Azadirachta indica] saw dust on various physico-chemical characteristics of combined waste water of Sugar Industry. The initial pH is 7.50 reduce to 7.28. Hardness decreases from 820 mg/L (initial) to 640 mg/L at 40 gm/L of Modified neem [Azadirachta indica] saw dust. Alkalinity decreases from 480 mg/L to 405 mg/L with 30 gm/L dosage and remain constant for all further dosages. The chloride content is slightly increases form 137.7 mg/L (initial) to 167.9mg/L. The COD content is found to be 1460 mg/L at initial stage and removed upto 922 mg/L at 40gm/L of Modified neem [Azadirachta indica] dose and no further removal is found up to 50 gm/L. The untreated sample has BOD value 1692 mg/L which removed upto to 1218 mg/L with 40gm/L of Modified neem [Azadirachta indica] and then remain unaffected for higher dose.

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Data of Table 1 can be explained as – The slight reduction in pH may be due to ionic salt present in Modified neem [Azadirachta indica] saw dust. This can be linked with removal of components contributing to acidic character of the waste water sample, similar conclusion can be drawn for increasing removal of alkalinity and hardness at higher dose of Modified neem saw dust. The chloride content increases slightly with increasing dose this may be due to the presence of some soluble salts having chloride in inside of Modified neem saw dust. The results for COD clearly establishes the removal of COD contributors can be explained on the basis of adsorption phenomenon and the extent can be co-related with increasing adsorption sites with increase in the dose, the similar adsorption phenomenon occurs for the removal of BOD causing contaminants. The data of table 2 and the linearity of plot of Freundlich and Langmuir adsorption isotherm indicate the monolayer coverage of adsorbate on the surface of biowaste molecules because modification can open up the site / surface of the agro waste material for more active surface for adsorption. chemical modification can reduce cellulose crystallinity as well as increase adsorbent porosity nature which gives hike to adsorption efficiency and capacity

Freundlich Isotherm:

$$\log x/m = \log K + 1/n \log C_{eq}$$

Linear plot of log C_{eq} Vs log x/m for Modified neem [Azadirachta indica] saw dust for both COD and BOD suggest the applicability of this isotherm and indicate a monolayer coverage of the adsorbate on the outer surface of the adsorbent. The steep slope indicates high adsorptive intensity at high equilibrium concentration that rapidly diminished at lower equilibrium concentration covered by the isotherm. As Freundlich equation indicates the adsorptive capacity x/m is a function of the equilibrium concentration of the solute. Therefore, higher capacity is obtained at higher equilibrium concentrations.

Langmuir isotherm:

The plot of $1/C_{eq} \times 10^3$ and $1/q_e \times 10^2$ is linear confirms applicability of Langmuir isotherm for COD and BOD. Langmuir isotherm is a plot of the amount of impurity adsorbed by Modified neem [Azadirachta indica] saw dust against the amount of impurity that remains in solution. It is a preliminary test to check the efficiency of particular material. Langmuir's model is a 'Ideal localized monolayer model' according to which:

- ✓ The molecules are adsorbed at definite sites on the surface of the adsorbent.
- ✓ Each site can accommodate only one molecule (monolayer).
- ✓ The area of each site is a fixed quantity determine solely by the geometry of the surface.
- ✓ The adsorption energy is the same at all the sites.
- ✓ Such behavior on the basis of kinetic consideration, presuming that the adsorbed molecules cannot migrate across the surface of the interact with another neighboring molecules can be mathematically expressed as under

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$$1/q_e = 1/\Theta_0 b \quad x \quad 1/C_{eq} + 1/\Theta_0$$

Conclusion:

- The final combined waste water of Sugar manufacturing unit is highly polluted having high COD and BOD.
- The maximum COD removal is found at 40 gm/L of Modified neem [Azadirachta indica] saw dust concentration i.e 36.85 %
- Modified neem [Azadirachta indica] saw dust removes BOD contributing components of the combined waste water of the sugar industry upto 28.01% with 40 gm/L of dose and then found exhaustion of saw dust for higher dosages.
- With increasing amount of Modified neem [Azadirachta indica] saw dust there found slight decrease in pH, and moderate decrease in alkalinity and hardness and slight increase in chloride content with increase in dose
- The linearity of plot and the data for its parameters clearly indicate that both this characteristic COD, BOD follow Freundlich and Langmuir adsorption isotherm. Hence At room temperature Modified neem [Azadirachta indica] saw dust works as an adsorbent. The adsorption capacity, intensity and efficiency is moderately increase due to chemical modification.
- The value of R^2 (correlation coefficient) compares Freundlich and Langmuir adsorption isotherm with each other , the higher value of R^2 confirims the applicability of isotherm.

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Table 1: Influence of dosage variation of Modified neem [Azadirachta indica] saw dust on various physic-chemical characteristics of Sugar industry waste water

Sr No	Dosage Modified neem saw dust (gm/l)	pH	Hardness (mg/L)	Alkalinity (mg/L)	Chloride (mg/L)	COD mg/L	BOD mg/L
1	0	7.50	820	480	137.7	1460	1692
2	1	7.50	820	480	140.2	1400	1610
3	2	7.53	795	475	145.9	1338	1530
4	5	7.49	760	460	149.2	1250	1466
5	10	7.44	730	440	154.2	1180	1405
6	20	7.38	690	420	160.7	1104	1350
7	30	7.31	660	405	167.9	1022	1298
8	40	7.28	640	405	167.9	922	1218
9	50	7.28	640	405	167.9	922	1218

Table 2 Freundlich and Langmuir Adsorption Isotherm parameters for COD & BOD Removal on Modified Neem Saw Dust

Freundlich Isotherm parameters for COD & BOD Removal on Modified Neem Saw Dust		
Freundlich Isotherm parameters		
Parameter	**COD Removal on Modified Neem Saw Dust**	**BOD Removal on Modified Neem Saw Dust**
Slope	4.1972	8.1923
Intercept	-11.412	-24.307
n (adsorption intensity)	0.2383	0.1221
k (adsorption capacity)	3.87258×10^{-12}	4.9317×10^{-25}
R^2 (correlation coefficient)	0.948	0.952
Langmuir Isotherm parameters		
Parameter	**COD Removal on Modified Neem Saw Dust**	**BOD Removal on Modified Neem Saw Dust**
Slope	19.711	46.499
Intercept	-12.841	-28.763
θ (adsorption capacity)	-0.0779	-0.0348
b (adsorption energy)	-1.5350	-1.6166
R^2 (correlation coefficient)	0.9502	0.9412

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Figure 1: Freundlich Adsorption isotherm for COD & BOD by Modified Neem Saw Dust

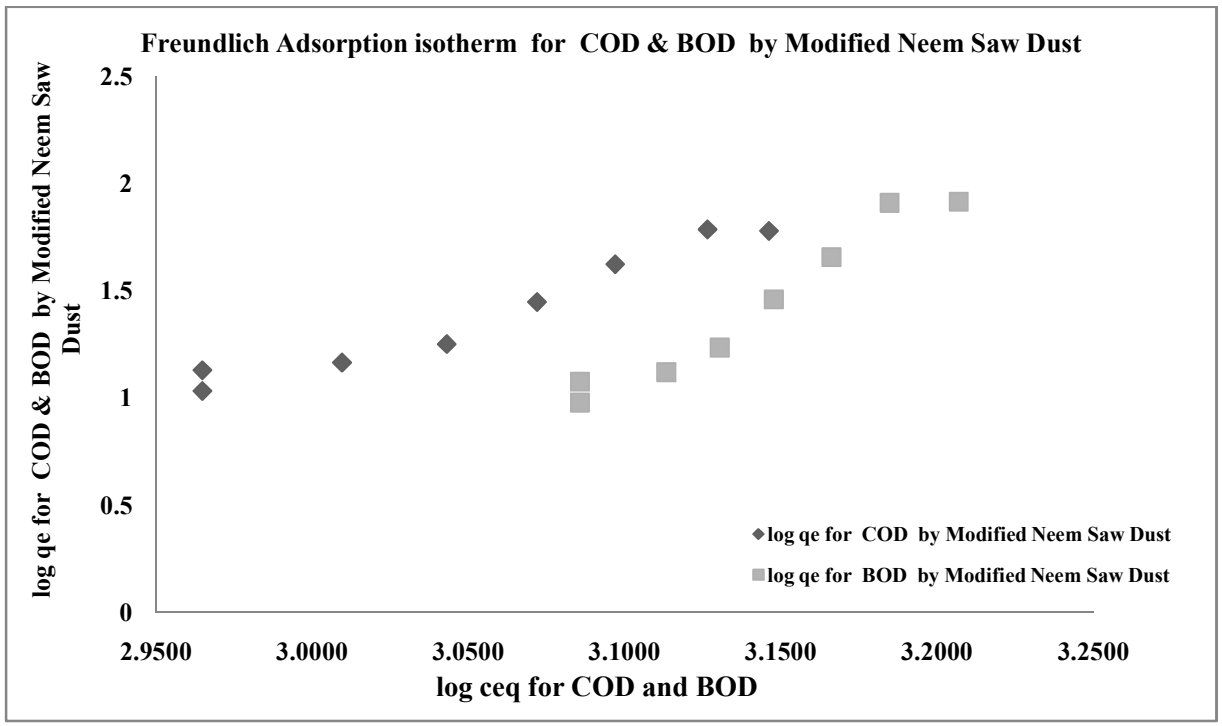

Figure 2 : Langmuir Adsorption isotherm for COD & BOD by Modified Neem Saw Dust

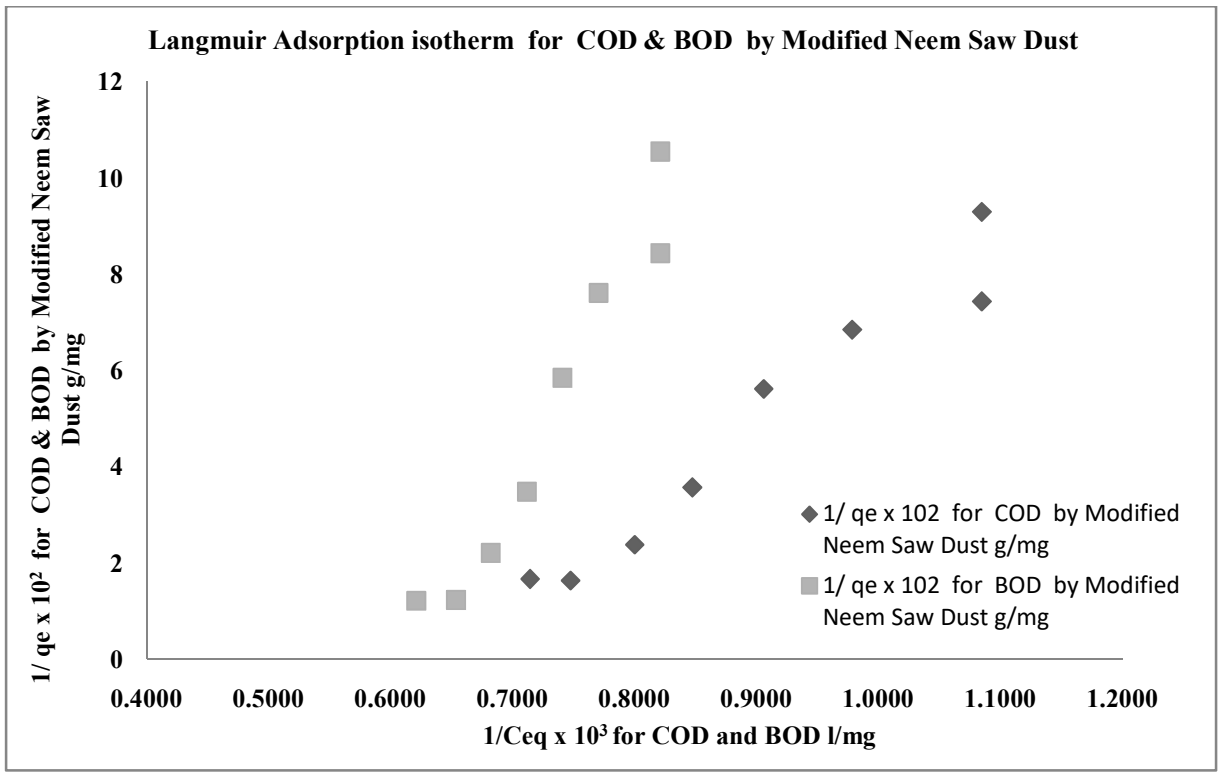

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Figure 3: % Removal of COD and BOD by Modified neem [Azadirachta indica] saw dust