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REMOVAL OF OIL AND GREASE FROM INDUSTRIAL WASTEWATER USING NEEM BARK AS AN ADSORBENT

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ABSTRACT:

There are several pollutants that can harm our environment. Oil and grease are one of the examples of a pollutant that can cause a severe environmental problem. The highest concentration of oil and grease inside the sewer system can cause the sewer to clog that can lead to overflow. It can affect not only to the environment but can also affecting our health. There are various methods of oil and grease removal that one of the examples is by using adsorption method. This method commonly uses activated carbon that is one of the effective adsorbents. Although effective, the cost for activated carbon is expensive thus a study was conducted by using agricultural residues as alternative adsorbents for oil and grease removal. In the present study, we used neem bark as an adsorbent for the removal of oil and grease from industrial wastewater. Optimization of adsorbent dose, optimization of pH, optimization of contact time and optimization of settling time are the parameter used for performance studies, to see the ability of adsorbents in removing oil and grease.

Key words: - *Adsorption, adsorbent, natural adsorbent, neem bark.*

INTRODUCTION:

There are number of pollutants that can harm the aquatic environment. Oil and grease (O&G) is one of pollutant responsible for water pollution. The major source of oil and grease in the water is crude oil spill. Oil and grease disturbs entire functioning of an aquatic ecosystem. Oil and grease is toxic to some organisms. The oil film also prevents oxygen transfer from the atmosphere and cause low dissolved oxygen level in the water (1). Millions of rupees spend every year on replacing oil and grease blocked pipes, repairing pump stations and cleaning illegal wastewater spills (2).

The conventional techniques to remove oil and grease are the use of skimming tanks and oil and grease traps in the waste water treatment plant. The main drawback of these methods is low efficiency of removal.

Oil and grease removal methods have been classified into several categories which are physical, mechanical, biological, photochemical, filtration, screening, coagulation and adsorption. Each treatment method has its own advantages and limitations. (3,4).

However, among the various existing technique used to remove oil and grease from waste water, adsorption process is the most popular, effective and economical technique (4,5).

The most important pollutants in the oil processing wastewater are conventional pollutants such as oil and grease, suspended solids, pH etc. and under non-conventional pollutants such as phenolic compounds, COD, sulphide and ammonia. Among these pollutants oil and grease is one of the most complicated pollutants to remove.

Among various available methods, adsorption appears to be promising technique and cost effective methods. Activated carbon is the most efficient adsorbent for the removal of oil and grease from wastewater but its high cost restricts the use of activated carbon. Therefore, there is an urgent need to search alternate economically viable adsorbent materials. Various studies have been carried out in search of suitable adsorbent (6,9).

Neem bark powder has shown high efficacy for the removal of metal ions from waste water (10,11). Thus, the studies on its adsorptive capacity make it acceptable to be used as biosorbent to decrease the traces of oil from produced water. Neem (Azadirachta Indica) tree can grow even in drastically unfavorable conditions which ensure its growth in almost every part of the world. Neem leaves generally used as antibacterial, antifungal, contraceptive, sedative and antiviral (12, 14). 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 (12).

In the present study, the neem bark powder has been used as an adsorbent for the removal of oil and grease from the industrial waste water.

MATERIAL AND METHODS:

Collection of water sample:

The waste water was collected from Vaidya V & I Infrastructure Pvt. Ltd located at Beltarodi, Nagpur (Maharashtra), India. The 2000 ml plastic bottles used for sampling were soaked with 10%HCl for 24 hours and thoroughly cleaned and also rinsed with distilled water. The collected water sample was brought in the laboratory for experimental studies**.**

Preparation of Neem bark powder: Neem bark was procured from the college premises and dried in sunlight for 4-5 days. The sun dried neem bark was cut into small pieces and then oven dried at 105^0C for 24 hours until constant weight is achieved. The oven dried bark were finely powdered using electric grinder and then sieved through IS sieved of 2.36mm size.

Characterization of wastewater: The wastewater was characterized by various parameters. In the present study the parameters tested were oil and grease concentration, pH and temperature.

Adsorption studies:

Different adsorption studies were carried out for the optimization of adsorbent dose, pH, contact time and settling time. All the adsorption process was performed at room temperature.

The experiment was carried in a 300 ml BOD bottles containing 200 ml water sample. The water sample containing oil and grease collected from Vaidya V&I infrastructure Pvt. Ltd. The oil and grease wastewater sample was treated with various adsorbent dose, pH, contact time and settling time. At the end of the treatment, the adsorbent was removed from the oil and grease water sample by passing through whatmann filter paper number 44. The concentration of oil and grease before and after treatment was calculated using gravimetric method. The control experiment was the flask without adsorbent.

Gravimetric based method:

The amount of oil and grease present in the water sample was determined by the partition gravimetric method. In this method 100 ml of wastewater sample was added in a clean separatory funnel. The acidity of the sample was adjusted at pH 2 or less by adding 5 ml sulphuric acid solution (6.0 N). It was then serially extracted three times with n-hexane in a separatory funnel.

After separating the solvent (now containing oil) from the water sample it was placed into round bottom flask which has been pre-weighted. It then underwent a distillation process to remove n-hexane. After that, the flask was placed in an oven for 12 hours at 106^0C to evaporator excess water. After the solvent was evaporated, the flask now is containing the residual oil and grease in dried and weighted. Knowing the weight of the empty flask, the amount of

residual oil and grease can be calculated (15).

$$\text{Oil and grease} = \frac{(A-B)\times 1{,}000 \times 1{,}000}{V}$$

Where, A=Final weight of round bottom flask (gm)
B=Initial weight of round bottom flask (gm)
V=Volume of sample taken (ml)

Experimental design and optimization using responses surface methodology:

Four different parameters namely adsorbent dosage (0.5 to 2.0 gm), pH (4 to 9), contact time (30 to 120 min.) and settling time (6 to 24 hrs.) were selected as the critical variables. The experiments were conducted and the measurement of percentage of oil and grease removal for each experiment were calculated using gravimetric-based method.

RESULT & DISCUSSION:

In the present study, neem bark powder is used as an adsorbent showing differential capacity of adsorption at different parameters in the industrial wastewater sample. Similarly, optimization of pH, adsorbent dose, contact time and settling time for the removal of oil and grease was considered. Data presented in the tabulation form and discussed in the light of available literature.

Optimization of adsorbent dose:

Maximum removal of oil and grease was 87.90% recorded with 2.0gm dose of adsorbent dose with waste water (Table No.1). However, it was observed that dose rate of adsorbent are directly proportional to the percent removal for oil and grease. (Figure No. 1).

In the present study, it was focused that the removal of oil and grease is dose dependent and show linear relationship. This might be due to the particle size and surface area of neem bark powder.

In the present investigation the percent removal of oil and grease from the effluent depends upon the surface area of adsorbent and electrostatic charges of the oil and grease.

Optimization of pH:

Adsorption efficiency was studied at various pH values ranging from 4 to 9. The optimization of pH for oil and grease removal was found to be 5. However, the lowest removal was to be at pH 9.(Shown in table no.2 and Figure No. 2).

Many investigations have shown that pH is the fundamental control variable for a large scale removal by different unconventional adsorbent (Pandey et.al. 1985; Gupta et.al. 1987; Khanna and Malhotra 1977). The removal of oil and grease from waste water by adsorption is highly dependent on the pH of the waste water which effect the surface charge of adsorbent and the degree of ionization and speciation of adsorbate (Weber 1972; Mall et.al. 1966, 2002).

However in the present study the different adsorption capacity of adsorbate at different pH which might activate the surface charge of adsorbent and ionization capacity of waste water in different manner.

Optimization of contact time:

Maximum removal of oil and grease was 85.31% recorded at120 minutes (2 hours) with optimum adsorbent dose i.e. 2gm as an adsorbent (Table No. 3). However it was observed that the increase in time as directly proportional to the percent removal (Shown in figure No. 3)

Optimization of settling time:

The settling time for percent removal of oil and grease were to be at 6 hrs, 12 hrs 18 hrs and 24 hrs. The maximum removal was reported at 12 hrs duration as a settling time. (Shown in table no. 4 and figure no. 4).

CONCLUSION

The neem bark has been used as an adsorbent by several workers. Recent investigations on the chemical modification of low-cost adsorbent have revealed the possibility of maximizing the adsorption for the removal of oil and grease.

The present study on the adsorption efficiency of commonly occurring oil and grease using non-conventional materials in their activated form have been

experimentally investigated using live wastewater from industries.

Neem bark powder used as an adsorbent in the present study. It is observed that highest removal of 87.90 % for oil and grease at 2gm adsorbent dose.

Maximum duration i.e., 12 hrs of settling time show maximum removal. However, in live wastewater from industry show good removal of oil and grease.

Experimental results of oil and grease adsorption were analysed for their fitness into Freundlich isotherm model. The present study of adsorption of oil and grease onto neem bark powder obey's Freundlich adsorption isotherm.

In the present experimental study, it is concluded that neem bark powder used as an adsorbent appears to be an efficient and cost effective for the removal of oil and grease. Further, it was suggested that neem bark adsorbent is a better substitute for the conventional adsorbent

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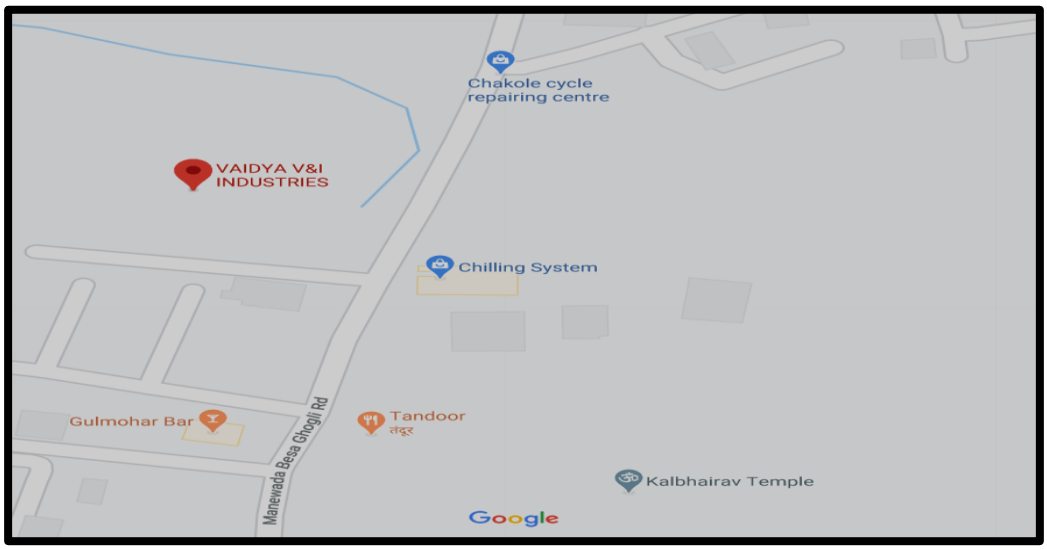

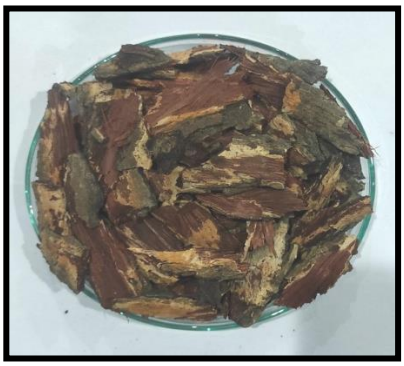

Figure.1 Neem bark

Figure.2 Neem bark powder

Table No. 1: Wastewater characteristics

Parameter	Value
Oil and grease	1770 mg/L
pH	6.58
Temperature	27.8^{0}C

Table No. 1 :-Optimization of Adsorbent Dose for the removal oil and grease

Sr. No.	Adsorbent Dose gm/100ml	Initial Concentration mg/lit	Remaining Concentration mg/lit	Amount Adsorbed mg/lit	Percent removal
1.	0.5	1770	894	876	49.49
2.	1.0	1770	684	1086	63.35
3.	1.5	1770	375	1395	78.81
4.	2.0	1770	214	1556	87.90

Table No. 2:- Optimization of pH for the removal oil and grease

Sr. No.	pH	Initial Concentration mg/lit	Remaining Concentration mg/lit	Amount Adsorbed mg/lit	Percent removal
1.	4	1770	362	1408	79.54
2.	5	1770	272	1498	84.63
3.	6	1770	418	1352	76.38
4.	7	1770	555	1215	68.64
5.	8	1770	685	1085	61.29
6.	9	1770	875	873	49.32

Table No. 3 :-Optimization of contact time for the removal oil and grease

Sr. No.	Contact Time (Minutes)	Initial Concentration mg/lit	Remaining Concentration mg/lit	Amount Adsorbed mg/lit	Percent removal
1.	30	1770	587	1183	66.83
2.	60	1770	518	1252	70.73
3.	90	1770	297	1473	83.22
4.	120	1770	260	1510	85.31

Table No. 4:- Optimization settling time for the removal oil and grease

Sr. No.	Settling time (hours)	Initial Concentration mg/lit	Remaining Concentration mg/lit	Amount Adsorbed mg/lit	Percent removal
1.	6	1770	272	1498	84.63
2.	12	1770	235	1535	86.72
3.	18	1770	403	1367	77.23
4.	24	1770	507	1263	71.35

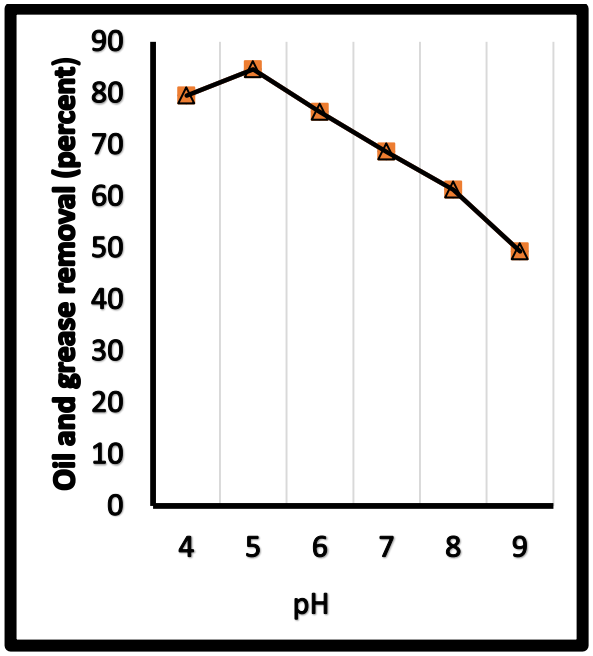

Fig. 1 Effect of Adsorbent dose on removal of oil and grease

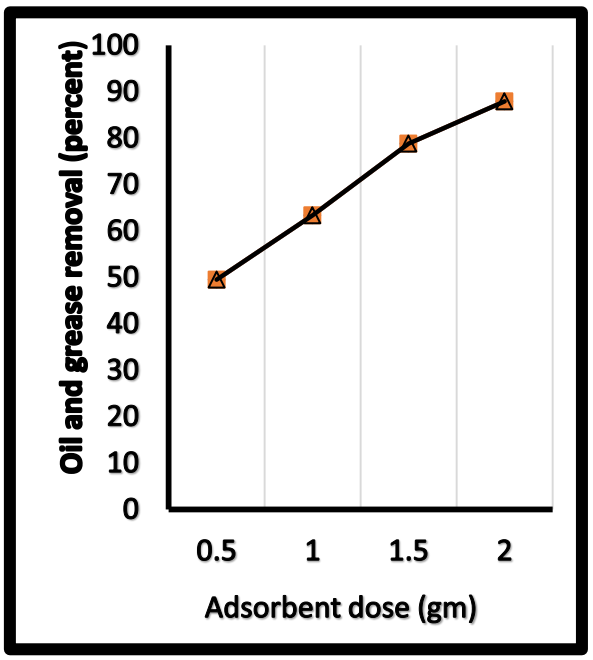

Fig. 2 Effect of pH on removal of oil and grease

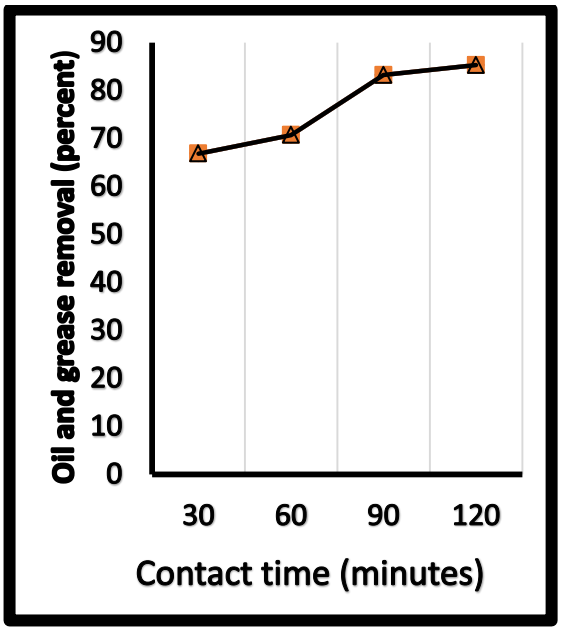

Fig. 3 Effect of contact time (min.) grease

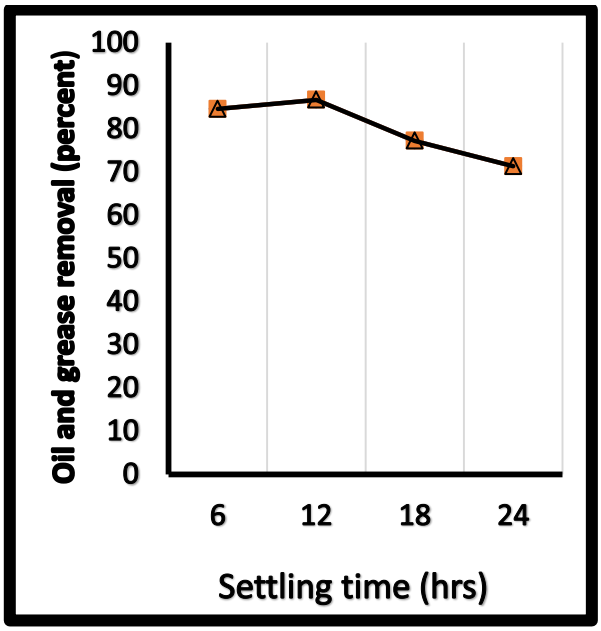

Fig. 4 Effect of settling time (hrs) on removal of oil and removal of oil and grease