**EFFECTS OF NATURAL COAGULANT IN THE TREATMENT OF PHARMACEUTICAL WASTEWATER**

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**ABSTRACT**

The objective of this work is to treat pharmaceutical wastewater by using inexpensive, environmentally benign ingredients as Natural coagulants. In this study, inexpensive coagulants, namely the powdered Neem leaves are used to treat the pharmaceutical wastewater. The leaves were harvested, sun-dried, and ground until they were the size of 300 and 150 micron sieve particles. Untreated Pharmaceutical wastewater was collected from industry. The chosen natural coagulant (namely Neem leaf powder), are individually added in different concentration of 1ml, 2ml, 3ml, 4ml, 5ml and 6ml in a 1000 ml wastewater taken in a beaker to find the optimum dosage using Jar test apparatus. The tests are carried out from the optimum dosage in different hydraulic retention time (2, 4, 6, 8hrs) by using natural coagulants. Conclusions are drawn based on the Chemical Oxygen Demand for the comparatives study of raw pharmaceutical wastewater by using natural coagulant in different sieve sizes for a COD Concentration. The maximum percentage of COD reduction was 85.90% at COD concentration with 150 µ under 8hrs HRT.

***Keywords:*** Natural coagulants, low cost, pharmaceutical effluents, wastewater treatment.

Chemical Oxygen Demand, Hydraulic Retention Time.

**INTRODUCTION**

In India, the disposal of pharmaceutical wastewater poses a significant environmental challenge due to its complex composition and potential adverse effects on ecosystems and human health [1]. Traditional methods of wastewater treatment often on chemical additives, which can introduce additional pollutants and high operational costs. In recent years, there has been growing interest in exploring sustainable and eco-friendly alternatives for wastewater treatment[2].Natural coagulants derived from plant sources, such as Neem leaves (Azadirachta indica) and moringa leaves (Moringa oleifera) [3], have emerged as promising coagulants for pharmaceutical wastewater treatment. These natural substances contain bioactive compounds that exhibit coagulation and flocculation properties, allowing them to effectively remove suspended solids, organic contaminants, and even certain pathogens from wastewater.[4] The efficacy of Neem leaves as natural coagulants has been demonstrated in various studies, showcasing their ability to reduce turbidity, chemical oxygen demand (COD), and other pollutants in pharmaceutical wastewater. Furthermore, the use aligns with the principle of green chemistry, promoting sustainability and environmental stewardship in wastewater management practices [5].As there is a need to identify the particle size and HRT for the maximum COD reduction, an attempt with different sieve size and HRT is worked out in this study.

**MATERIALS**

**Pharmaceutical wastewater**

The pharmaceutical wastewater is collected from a pharmaceutical company located in Kurumbapet, Puducherry. The pharmaceutical wastewater is collected in 10 litres plastic can. The samples were collected and its characteristics listed in Table 1.

Description: A beaker with a liquid in it

Description automatically generated**Fig 1 Untreated Pharmaceutical Wastewater**

**Neem Leaves**

Neem leaves are collected from a number of tall Neem trees and were allowed to dry at room temperature in a shade for a long time till the leaves becomes crispy as shown in Fig 2 and 3 that could be crushed into a fine powder in a mechanical grinder [6]. The Neem Leaf Powder (NLP) was sieved through 300 and 150 microns and retained in pan as shown in Fig 3. The NLP was preserved in glass bottles for future use as a coagulant.

A bowl of leaves on a white surface

Description automatically generated

**Fig 2 Dried Neem Leaf Fig 3 Neem Leaf powder**

**METHODOLOGY**

The Neem Leaf Powder used with different sieve sizes of 300 and 150 µ. The reduction in percentage of COD is measured to understand the efficiency of Natural Coagulants used. The best dosage of Natural Coagulant for the chosen COD concentration by Jar test apparatus was found to be 3ml [7].The same dosage is applied in different HRT’s to understand the Maximum COD reduction.

**Characteristics of Pharmaceutical Wastewater**

**Table 1 Initial Characteristics of Pharmaceutical Wastewater**

|  |  |  |
| --- | --- | --- |
| **Sl.No** | **Parameters** | **Initial Reading in mg/l** |
|  | **pH** | 5.96 |
|  | **Turbidity** | 817 NTU |
|  | **Total solids** | 2178 |
|  | **Suspended solids** | 366 |
|  | **Total Dissolved Solids** | 1012 |
|  | **Volatile suspended solids** | 260 |
|  | **Conductivity** | 1641 |
|  | **Total alkalinity** | 440 |
|  | **Chlorides** | 280 |
|  | **COD** | 6416 |
|  | **BOD** | 1100 |
|  | **Phenolic compound (C6H5OH)** | BLQ(LOQ:0.002) |
|  | **Phosphate** | 27 |

**RESULT AND DISCUSSION**

When the Neem leaf powdered of size 300µ is subjected to different HRT’s the pharmaceutical wastewater undergoes treatment and as shown as Table 2.

**Table 2 shows Variation of parameters of different HRT in 300 µ sieve size at concentration of COD 6000 mg\L in Pharmaceutical wastewater using Neem leaf.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **SL No** | **Parameters** | **Initial Reading in mg/l** | **2HRT in mg/l** | **4HRT in mg/l** | **6HRT in mg/l** | **8HRT in mg/l** |
| 1 | pH | 5.96 | 6.82 | 6.70 | 6.67 | 6.58 |
| 2 | Turbidity | 817 NTU | 320 NTU | 261 NTU | 127 NTU | 92 NTU |
| 3 | Total solids | 2178 | 1170 | 1171 | 1134 | 1114 |
| 4 | Suspended solids | 366 | 187 | 179 | 172 | 166 |
| 5 | Total Dissolved Solids | 1812 | 983 | 992 | 962 | 948 |
| 6 | Volatile suspended solids | 260 | 130 | 120 | 107 | 101 |
| 7 | Conductivity | 1641 | 1503 | 1583 | 1489 | 1377 |
| 8 | Total alkalinity | 440 | 398 | 371 | 364 | 354 |
| 9 | Chlorides | 280 | 221 | 183 | 178 | 154 |
| 10 | COD | 6416 | 4528 | 3426 | 1786 | 1286 |
| 11 | BOD | 1100 | 920 | 870 | 620 | 510 |
| 12 | Phenolic compound (C6H5OH) | BLQ(LOQ:0.002) | BLQ(LOQ:  0.001) | BLQ(LOQ:  0.001) | BLQ(LOQ:  0.002) | BLQ(LOQ:  0.002) |
| 13 | Phosphate | 27 | 14 | 13 | 13 | 13 |

The pH remains in the range of 6.58 to 6.82 under different HRT which is an amenable situation for the biological degradation of wastewater. The Total Dissolved Solids reduction was maximum 52% at 8 HRT and with Minimum percentage reduction at 2HRT. The COD value reduced to 1286mg/l from 6416 mg/l for 8 Hrs HRT, which shows that an increased in HRT leads to maximum reduction of COD.

**Table 3 .Variation of parameters of different HRT in 150 µ sieve size at concentration of COD**

**6000 mg\L in Pharmaceutical wastewater using Neem leaf.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **SL No** | **Parameters** | **Initial Reading in mg/l** | **2HRT in mg/l** | **4HRT in mg/l** | **6HRT in mg/l** | **8HRT in mg/l** |
| 1 | pH | 5.96 | 6.65 | 6.66 | 6.54 | 6.55 |
| 2 | Turbidity | 817 NTU | 210 NTU | 181 NTU | 105 NTU | 78 NTU |
| 3 | Total solids | 2178 | 1110 | 990 | 972 | 960 |
| 4 | Suspended solids | 366 | 174 | 154 | 144 | 134 |
| 5 | Total Dissolved Solids | 1812 | 936 | 836 | 828 | 818 |
| 6 | Volatile suspended solids | 260 | 110 | 105 | 103 | 97 |
| 7 | Conductivity | 1641 | 1491 | 1472 | 1432 | 1348 |
| 8 | Total alkalinity | 440 | 354 | 342 | 286 | 254 |
| 9 | Chlorides | 280 | 178 | 154 | 151 | 134 |
| 10 | COD | 6416 | 2132 | 1862 | 1546 | 1106 |
| 11 | BOD | 1100 | 770 | 680 | 540 | 420 |
| 12 | Phenolic compound (C6H5OH) | BLQ(LOQ:0.002) | BLQ(LOQ:  0.002) | BLQ(LOQ:  0.002) | BLQ(LOQ:  0.002) | BLQ(LOQ:  0.002) |
| 13 | Phosphate | 27 | 14 | 13 | 13 | 13 |

When the Neem leaf powdered was added to pharmaceutical wastewater with 150 micron sieve the changes in the characteristic are shown in pH, TDS and COD are mentioned in Table 3 and fig 4. The pH remains in the range of 6.65 to 6.55 under different HRT which is an amenable situation for the biological degradation of wastewater. The Total Dissolved Solids reduction was maximum 54.85 % at 8 HRT and with Minimum percentage reduction at 2HRT. The COD value reduced to 1106mg/l from 6416 mg/l for 8 Hrs HRT, which shows that an increased in HRT leads to maximum reduction of COD by using the natural coagulant at a sieve size of 150 micron.

**Fig 4 Variation of COD for different sieve size at different HRT in COD concentration of 6000 mg\L in pharmaceutical wastewater**

**CONCLUSIONS**

* The optimum dosage for COD concentration 6000 mg/l was 3 ml/L and when subjected to different HRT of 8 Hrs it shows a maximum reduction of COD for 150µ.
* The Maximum COD reduction in Neem Leaf Powder (NLP) at COD concentration of 6000 mg/l was 1106mg/l.
* The rate of reduction of COD level is 82.76% while utilizing Neem leaf powder as a Natural Coagulant with 150µ sieve size at 8hrs HRT.
* Therefore, maximum COD level is reduced in Neem leaf powder at the 8hrs HRT in 150µ sieve at the COD Concentration of 6000 mg/l have best efficiency of Natural Coagulant. Hence the Sludge obtained from the process is also used as a Fertilizer.

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