# A TREAMENT OF DOMESTIC SEWAGE AND GENERATION OF BIO SLUDGE USING NATURAL COAGULANTS

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## Abstract

*The waste generated from various human activities promotes an environmental degradation. Sewage a waste produced through human is a source of water pollution. An improper handling of sewage and waste generated from societies pollutes fresh water bodies. In Indian conditions, conventional treatments like Activated Sludge Process, Oxidation Ponds, Aerated lagoons, and Trickling filters are the most suitable treatment process to treat sewage generated in urban areas. While the land required to setting conventional treatment plant along with energy and time required is more which increases overall cost of the treatment process. To upgrade conventional treatment process and reduce cost of treatment, uses of natural coagulants are best alternative. The study is carried out to check efficiency of combinations of natural coagulants in different preparations, to treat sewage. Natural coagulants extracted from seeds of Acacia Nilotica [Babul] and Mangifera Indica [Mango] are used with different combinations to treat sewage. After laboratory analysis of treated water through primary treatment process shows around 45% and 56 % of BOD and TSS removal respectively which is more than primary settling tank of conventional treatment process. Which will increases efficiency of primary treatment and reduces organic loading over secondary treatment. Due this the size of secondary unit can be reduced so area of land required to set plant can also be reduced. Use of natural coagulants will minimize time and energy required for aeration. Also sludge generated through primary treatment process will effectively used as soil stabilizer after proper composting. This study aims to reduce overall cost of sewage treatment along with recovery of plant nutrients as compost.*

***Keywords:*** *Sewage, Combination of natural Coagulants, Sludge etc…*

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## 1. INTRODUCTION

The waste generated from various human activities promotes environmental degradation. Improper handling of sewage and waste generated through societies pollutes fresh water bodies. In Indian conditions, conventional treatments like Activated Sludge Process is the most suitable treatment process to treat sewage generated. While the land required to setting conventional treatment plant along with energy and time is more which increases overall cost of treatment process. In waste water treatment chemical coagulation and flocculation treatment processes are used to overcome these problems. The chemical method has limited success in waste water treatment because of its lack of consistency in meeting discharge requirements, high costs for chemicals, handling and disposal of great volumes of sludge resulting from addition of chemicals, and numerous operating problems [11].

Coagulant extract from naturally available material like seeds of plant may be a good alternative to chemical coagulants. A natural coagulant will improve the quality of treated sewage and also recover plant nutrients in the form of sludge. Natural coagulants may be support to secondary treatment based on microbial activities, which has been badly affected by chemical coagulation.

Chun-Yang Yin [2] reviewed that plant based coagulants are cost effective as compare with chemical coagulants in water as well as waste water treatment. Hitendra Bhuptawat, et. al. [6] investigated efficiency of Moringa oleifera individually and in combination with alum for different proportions to treat waste water. Mishra M. Agarwal, et. al.[13], investigated Plantago Psyllium mucilage a low cost flocculating material able to remove suspended solids from sewage and tannery waste. The agro based materials like Moringa Oleifera (Surjana seeds); Nirmali seed (Strychnos potatorum) and Maize (Zeemays) are evaluated as natural coagulant aid with alum by Pramod Kumar Raghuwanshi, et.al. [17]. Dange P S, Lad R K [3,4] studied Mangifera Indica and Acacia Nilotica separately to see individual base impact as Natural coagulant to treat sewage. All these studies shows natural coagulants used individually or in combine with alum, In this study natural coagulants are used in combination with different proportions.

In this study, the attempt has been made that quality of treated sewage, sludge generated through primary treatment can be improved by natural coagulation and cost of overall treatment of sewage can be reduced in terms of less land required to set treatment plant, construction cost and reduction in energy and time required to treat sewage.

## 2. Materials and MethodOLOGY

### 2.1 Materials

Acacia Nilotica [Babul] fruits were collected from village Chikhali, Tal. & Dist. Osmanabad and Mangifera Indica [Alphonoso Mango] fruits are purchased from local market and seeds of mango used for this study.

### 2.2 Methodology

The procedural method to be followed in order to ultimately find out the optimum dose of the coagulant used, to remove the turbidity of raw water is shown in the following flow diagram.

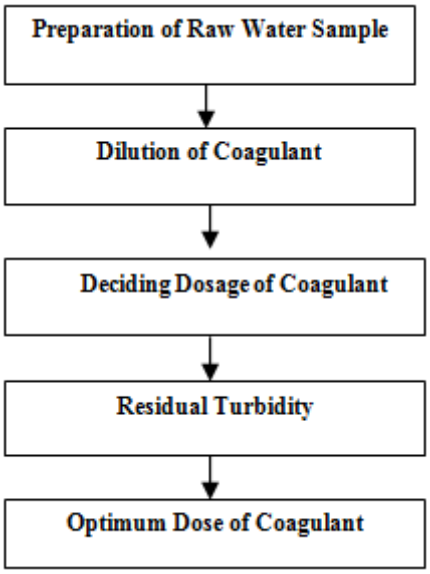


**Fig - 1:** A Flow Diagram of Research Approach

For the pilot plant study, first sewage treatment units were designed for sewage discharge of 1 Mld and then units were fabricated with scale of 25.

Table 1 shows sizes of designed and pilot plant model units.

**Table -1:** Sizes of Designed and Pilot Plant Model Units

| Name of Unit | Sizes of Designed Units For 1 Mld discharge (mm) | | Sizes of Units Reduced with Scale of 25 for pilot plant model (mm) | |
|---|---|---|---|---|
| | Depth | Diameter | Depth | Diameter |
| Flash Mixer | 1500 | 1800 | 60 | 80 |
| Clari-flocculator | 3000 | 6000 | 120 | 240 |

The coagulating constituents were extracted from natural materials as Dried Mangifera Indica seeds were broken to separate out hard upper cover. Mangifera Indica seeds soft inner portion and Acacia nilotica seeds were grinded to a fine powder and stored in air tight container separately. 10 grams of powdered materials were mixed in distilled water using magnetic stirrer with a speed of 100 rpm for 15 minutes to prepare 1000 ml of solution. The solution was allowed to settle suspended solids. Then supernatant pass through Whatman filter paper no 40 and the filtered liquid collected as extracted natural coagulant, which has been used for further study work.

1. The samples were collected twice in a week from sewage treatment plant located in Pimpri- Chichwad Municipal Corporation Area and studied through pilot plant model.
2. Optimum dosages for natural coagulants in combination with different proportions are determined by Jar test for different turbidity range.

Table 2 shows different turbidity range with dosage of natural coagulants.

**Table 2:** Dosage of Natural Coagulants for Different Turbidity

| Sr. No. | Type of Turbidity | Range of Turbidity, NTU | Dosage in ml/lit | | | |
|---|---|---|---|---|---|---|
| 1 | Low Turbidity | 50 – 100 | 4 | 8 | 12 | 16 |
| 2 | Medium Turbidity | 100 – 150 | 8 | 12 | 16 | 20 |
| 3 | High Turbidity | More than 150 NTU | 12 | 16 | 20 | 24 |

The natural coagulant, Acacia Nilotica [AN] and Mangifera Indica [MI] were used in combinations with different proportions (Refer Table 3).

**Table - 3**: Proportions of Coagulants

| Particulars | Proportion |
|---|---|
| [MI : AN] | 80 : 20 % |
| [MI : AN] | 60 : 40 % |
| [MI : AN] | 50 : 50 % |
| [MI : AN] | 40 : 60 % |
| [MI : AN] | 20 : 80 % |

The Jar test for finding optimum dosage was carried out with rapid mixing about 100 rpm for 1 minute and slow mixing about 30 rpm for 30 minutes. Residual turbidity for different combinations of coagulant dosages was measured in the interval of 120 and 720 minutes. A Graph used to determine optimum dosage shows relation between residual turbidity and optimum dosage for different turbidity range

Figure 2 shows for combination of MI and AN in proportion of [80 : 20] as natural coagulant for low turbidity, similarly other graphs were prepared for the determination of optimum dosages.

The optimum dosage for natural coagulants, alum and their combinations with different turbidity are shown in Table 4.

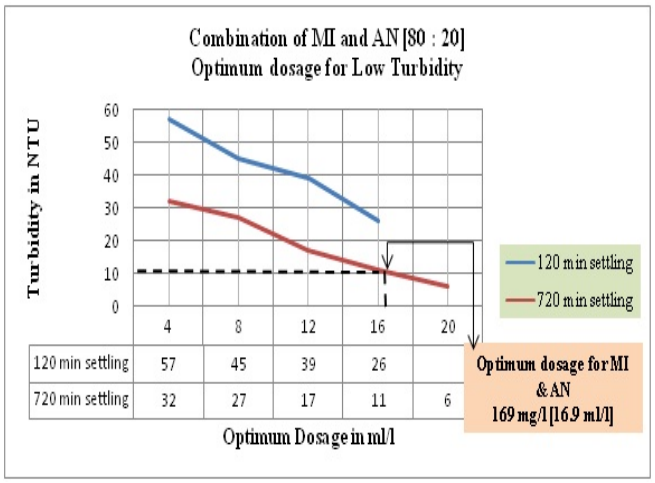


**Fig -2**: Optimum dosage for MI and AN combination in proportion of [80: 20] %

**Table - 4**: Optimum dosages for Acacia Nilotica [AN] and Combination of AN and Alum [A]

| Coagulant particulars | Proportion % | Optimum Dosage mg / l (for turbidity range) | | |
|---|---|---|---|---|
| | | Low | Med. | High |
| [MI : AN] | [80:20] | 169 | 191 | 198 |
| [MI : AN] | [60:40] | 171 | 194 | 200 |
| [MI : AN] | [50:50] | 172 | 196 | 203 |
| [MI : AN] | [40:60] | 175 | 198 | 205 |
| [MI : AN] | [20:80] | 178 | 201 | 209 |

**From Table 4 it is observed that:**

1. For the combinations of natural Coagulants as [80:20, 60:40 and 50:50] % sample residual turbidity is in the range of 10 NTU after 720 minutes settling.
2. The sewage samples were collected from Sewage Treatment Plants located in the vicinity of Pimpri Chinchwad Municipal Corporation. Laboratory study model is consists of only Flash mixer and Clariflocculator; so sewage samples are collected from inlet of PST [Primary Sedimentation Tank] after screening and grit removal through Screen and Grit Chamber.
3. The collected sewage was treated through pilot scale model using natural coagulants. Sewage samples are treated through laboratory study model; In flash mixer sample with optimum dose determined earlier as per turbidity range mixed rapidly at the rate of 100 rpm for 1 minute so that mix the coagulant throughout the sample.

From flash mixer sewage water sample passed in Clariflocculator where sample is stirring at a speed of 10 rpm and continue mixing for 30 mins. This slower mixing speed helps to promote for floc formation by enhancing particle collisions, and formed floc settle at bottom of tank. The supernatant is collected and used for further laboratory analysis

The laboratory analysis of treated sewage was carried out for the determination of concentration of parameters like pH, DO, TSS, BOD and COD.

Also, the laboratory analysis of sludge was carried out for the determination of concentration of parameters like Conductivity, N,P, K, pH, etc.

## 3. MODEL APPLICATIONS, RESULTS AND DISCUSSIONS

Treated sewage through clariflocculator was analyzed in laboratory to check quality in terms of parameters like TSS, BOD and COD and the results of the same are shown in Table 5.

**Table – 5:** Summary of the quality of sewage after clari-flocculator using AN and different percentage of AN & Alum

| Coagulant particulars & their Proportion | Value | % Removal | | |
|---|---|---|---|---|
| | | TSS | BOD | COD |
| [AN : MI] [80:20] | Range | 49.61 to 58.50 | 41.20 to 49.80 | 49.50 to 62.60 |
| | Average | 54.55 | 45.80 | 56.85 |
| [AN : MI] [60:40] | Range | 48.90 to 56..35 | 40.70 to 49.00 | 48.65 to 59.15 |
| | Average | 53.05 | 44.65 | 52.75 |
| [AN : MI] [50:50] | Range | 48.25 to 55.30 | 39.27 to 47.50 | 47.50 to 56.09 |
| | Average | 52.60 | 43.60 | 52.85 |
| [AN : MI] [40:60] | Range | 46.98 to 53.90 | 38.14 to 45.72 | 47.00 to 53.89 |
| | Average | 50.50 | 42.85 | 52.60 |
| [AN : MI] [20:80] | Range | 46.65 to 52.80 | 37.86 to 43.90 | 45.67 to 51.39 |
| | Average | 51.80 | 42.90 | 49.25 |

**From Table 5 it is observed that:**

- By using AN with MI [80:20] % as Coagulant, average TSS, BOD and COD removal efficiency is 54.55, 45.80 and 56.85 % respectively from sewage.
- By using AN with MI [60:40] % as Coagulant, average TSS, BOD and COD removal efficiency is 53.05, 44.65 and 52.75 % respectively from sewage.
- By using AN with MI [50:50] % as Coagulant, average TSS, BOD and COD removal efficiency is 52.60, 43.60 and 52.85 % respectively from sewage.
- By using AN with MI [40:60] % as Coagulant, average TSS, BOD and COD removal efficiency is 50.50, 42.85 and 52.60 % respectively from sewage.
- By using AN with MI [20:80] % as Coagulant, average TSS, BOD and COD removal efficiency is 51.80, 42.90 and 49.25 % respectively from sewage.

For combination of MI and AN in proportion [50 : 50] %, the sludge from clariflocculator was collected for the determination of concentration of parameters N, P, K, and pH and the results of the same are shown in Table No. 7.

**Table - 7:** Summary of the quality of Sludge after clari-flocculator using AN: MI [50 : 50] as Natural coagulant

| Sr. No. | Particular | Concentration |
|---|---|---|
| 1 | Total nitrogen [N] | 0.30 to 0.49 % |
| 2 | Phosphates [$P_2O_5$] | 0.20 to 0.45 % |
| 3 | Potash [$K_2O$] | 2.66 to 3.04 % |
| 4 | pH | 6.20 to 7.28 |

**From Table 7 it is observed that:**

- By using AN with MI [50:50] % as Coagulant, sludge generated through clarifloculator contains concentration of Total nitrogen [N] around 0.30 to 0.49 %.
- By using AN with MI [50:50] % as Coagulant, sludge generated through clarifloculator contains concentration of Phosphates [$P_2O_5$] around 0.20 to 0.45%.
- By using AN with MI [50:50] %bvas Coagulant, sludge generated through clarifloculator contains concentration of Potash [$K_2O$] around 2.66 to 3.04%.
- By using AN with MI [50:50] % as Coagulant, pH of sludge generated through clarifloculator is in the range of 6.20 to 7.28.

## 4. CONCLUSION

From the study it is concluded that

- TSS and BOD removal efficiency is increased due to combined effect of natural coagulants.
- As quality of effluent from primary process is improved by natural coagulation than conventional treatment process, TSS and BOD loadings over secondary units are reduced. So the sizes of units, time of treatment and energy required to aeration reduced.
- By using Acasia Nilotica and Mangifera indica [80:20] shows higher removal of TSS, and BOD which is around 54.55% & 45.80% respectively and removal of TSS and BOD which is less around 51.80% & 42.99% respectively by using Acasia Nilotica and Mangifera indica [20:80]. Both cases show better results than conventional treatment process.
- The constituents found in sludge are Total nitrogen [N] from 0.30 to 0.49 %, Phosphates [$P_2O_5$] from 0.20 to 0.45% & Potash [$K_2O$] from 2.66 to 3.04%. Sludge generated after clariflocculator by using AN with MI [50:50] % as a natural coagulant will be a good manure after composting.
- The use of AN and MI in combination is best option to treat sewage.
- The rural economy will improve as coagulants are based on plants.

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