Upgrading Conventional Sewage Treatment Process by using Mangifera Indica

Mr Purushottam S. Dange1 Dr. Ravindra K Lad2
1Research Scholar 2Professor
1,2Department of Civil Engineering
1,2Padmasree Dr. D. Y. Patil Institute of Engineering and Technology, Pimpri, Pune-18,
1,2Savitribai Phule Pune University, Pune

Abstract— Unbalanced industrial development and concentration of population in urban areas creates severe problems related to water. Sewage produced from the human activity contributes in water pollution. Conventional methods are much better to treat waste water as compare with Coagulation and flocculation which are physical-chemical methods. Chemicals used to treat waste water by clarifloculation generate sludge which is one sort of pollutant. For upgrading conventional methods to treat waste water, there is a need to think sustainable way to minimize waste by using naturally available materials. The seeds of less water required plants of rural area could be a best option for this. It is a low cost material and also will have income for rural people. A lot of work has been carried out on Water Treatment by natural Coagulation with natural coagulants; now there is need to concentrate on recycling of water in less developed communities to ensure their basic needs of water from domestic waste water treatment. This study consecrates over use of natural coagulant for sewage treatment and also quality and uses of sludge generated by using natural coagulants during treatment of sewage. An attempt has been made to use of seeds of Mango [Mangifera indica], as a natural coagulant for the treatment of sewage to minimize the cost of treatment and to achieve good quality of sludge and treated wastewater. A pilot plant study with laboratory analysis shows that Mango [Mangifera indica] seeds, as natural coagulant remove around 32% BOD and 30% TSS in primary treatment. Sludge generated through treatment of sewage may be used as manure after composting. Natural coagulation for treating sewage is a best way to reduce the organic loading over aeration tank of activated sludge process. This will reduce cost of waste water treatment by sustainable way.

Key words: Sewage, Natural Coagulant, Mangifera Indica and Sludge

I. INTRODUCTION

Unbalanced industrial development and concentration of population in urban areas creates severe problems related to water. Sewage produced from the human activity contributes in water pollution. Conventional methods are much better to treat waste water as compare with Coagulation and flocculation which are physical-chemical methods. To overcome waste hazards and to restrict the resulted effects on the environment, investigators are studying the possibility of using new methods and materials to treat wastewater.

Coagulation and flocculation processes are physical-chemical methods that widely used in the treatment of wastewater. This method of treatment has met with 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 [10].

For upgrading conventional methods to treat waste water, there is a need to think sustainable way to minimize waste by using naturally available materials. The seeds of less water required plants of rural area could be a best option for this. It is a low cost material and also will have income for rural people. Chun Yang Yin [3] studied about plant based coagulant sources, processes, effectiveness and relevant coagulating mechanisms for treatment of waste water. Monika Agarwal, Rajani Srinivasan, Anuradha Mishra [13] investigated the flocculation efficiency of okra gum for treatment of sewage waste water. Hitendra Bhuptawat, G.K. Folkard and Sanjeev Chaudhari [5] Extracted Moringa Oleifera (Surjana seeds ) by water and used to treat waste water. Mishra M. Agarwal, M. Bajpai, S. Rajani and R. P. Mishra [12], investigated Plantago Psyllium mucilage a low cost flocculating material able to remove suspended solids from sewage and tannery waste. Pramod Kumar Raghuvanshi, Monika Mandloi, Arvind J. Sharma [16] investigated the agro based materials like Moringa Oleifera (Surjana seeds); Nirmali seed (Strychnos potatorum) and Maize (Zea mays) are evaluated as natural coagulant aid with alum. Beltrun-heredia, J. Sanchez-Martin, M Barraddo Moreno [1] observed Moringa Oleifera seed extract was feasible coagulant in removing surfactants such long chain detergents from aqueous effluents. Nuruddin A Oladoja, Yekini D Aliu [15], the settling characteristics of the sludge obtained from the use of Snail Shell alone and in combination with alum was studied by measuring the sludge volume index over time. Syafalni, Han Khim Lim, Norli Ismail, Ismail Abustan [16],

Some investigators discussed natural way to extract coagulant through natural materials.Dry Moringa oleifera seeds were grounded to fine powder of approximate size 600 µm and mixed with tap water in proportion of 2 g M. oleifera powder in 100 ml water. Mixer was vigorously shaken for 30 minutes and this was then passed from filter paper (Whatman No. 1) [5]. The okra gum was obtained by aqueous extraction of the seedpods of okra plant followed by precipitation with alcohol [13]. The natural material plan tago psyllium mucilage was purified by precipitation from aqueous solution with alcohol and finally washed with acetone and dried [16]. Others use chemical extraction for improving extracted coagulant quality. But as going for a sustainable way, in this study, coagulation extracted by natural process.

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II. MATERIALS AND METHODS

The Study consist experimental work over collected sewage samples by Pilot plant for treating collected sewage samples by natural coagulation and laboratory analysis to check quality of treated water as well sewage.

A. Experimental Work:

In first stage of experimental work the sewage samples were collected from Sewage Treatment Plants of PCMC area. A Table I shows details of Sewage Treatment Plants.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of STP</th>
<th>Capacity In Mld</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>STP 1</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>STP 2</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>STP 3</td>
<td>16</td>
</tr>
</tbody>
</table>

Table 1: Details of Sewage Treatment Plant

The samples were collected twice in a week from each plant and studied through pilot plant model.

1) Pilot plant study was carried out as follows:

- Coagulant Extraction
  Mangifera Indica [Alphonso Mangos] fruits purchased from local market. Seeds of mango fruits removed and kept open to atmosphere about 24 hours for drying. After drying, Seeds of Mangifera Indica , further kept in hot air oven for 24 hours at 1050C temperature to moisture removal if any . Dried Mangifera Indica seeds were broken to separate out hard upper cover. Mangifera Indica seeds soft inner portion, were grinded to a fine powder and stored in air tight container. 10 grams of powdered materials were mixed in distilled water using magnetic stirrer with a speed of 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 60, 120 and 720 mins. A Figure I shows graph for Mangifera Indica as natural coagulant for low turbidity, similarly other graphs are prepared for the determination of optimum dosages.

- Coagulant Dosages
  The optimum doses were calculated for natural coagulant and natural coagulant in combination with Alum. The following dosages of Mangifera Indica extract as Natural coagulant were decided for low, medium and high turbidity sewage sample. Table III shows dosage of natural coagulants for different turbidity.

<table>
<thead>
<tr>
<th>Turbidity</th>
<th>Range of Turbidity, NTU</th>
<th>Dosage in ml/lit.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>50 – 100</td>
<td>4 8 12 16</td>
</tr>
<tr>
<td>Medium</td>
<td>100 – 150</td>
<td>8 12 16 20</td>
</tr>
<tr>
<td>High</td>
<td>More than 150 NTU</td>
<td>12 16 20 24</td>
</tr>
</tbody>
</table>

Table 2: Sizes of Designed and Pilot Plant Model

3) For treating sewage water through pilot plant, dosage was determined based on turbidity removal efficiency of extracted coagulating material.

Fig. 1: Optimum Dosage of Mangifera Indica for Low Turbidity

Based on the relation between residual turbidity and optimum dosage, graphs are prepared for separate coagulants and different combinations for the determination of optimum dosages.
The optimum dosage for natural coagulants, alum and their combinations with different turbidity are shown in Table V.

<table>
<thead>
<tr>
<th>Coagulant particulars</th>
<th>Proportion %</th>
<th>Optimum Dosage mg / l (for turbidity range)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Med.</td>
</tr>
<tr>
<td>[MI]</td>
<td>100</td>
<td>168</td>
</tr>
<tr>
<td>[MI : A]</td>
<td>[80:20]</td>
<td>148</td>
</tr>
<tr>
<td>[MI : A]</td>
<td>[60:40]</td>
<td>136</td>
</tr>
<tr>
<td>[MI : A]</td>
<td>[50:50]</td>
<td>132</td>
</tr>
<tr>
<td>[MI : A]</td>
<td>[40:60]</td>
<td>140*</td>
</tr>
<tr>
<td>[MI : A]</td>
<td>[20:80]</td>
<td>112**</td>
</tr>
<tr>
<td>[A]</td>
<td>100</td>
<td>78**</td>
</tr>
</tbody>
</table>

Table 5: Optimum Dosages For Acacia Nilotica [An] And Combination of An And Alum [A]

2) From Table V It Is Observed That:

1) For natural Coagulants [100 %] and natural coagulants with alum [80:20, 60:40 and 50:50] % sample residual turbidity is in the range of 10 NTU after 720 minutes settling.

2) For combination of [Natural coagulants: Alum] in proportion of [40:60] % sample residual turbidity is in range of 10 NTU after 120 minutes settling.

3) For combination of [Natural coagulants: Alum] in proportion of [20:80] % as well Alum [100%], sample residual turbidity is in the range of 10 NTU after 60 minutes settling.

The sewage was collected from different Sewage Treatment Plants which are located in the vicinity of Pimpri Chinchwad Municipal Corporation. Laboratory study model 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.

4) The collected sewage was treated through pilot scale model using natural coagulants. Sewage samples are treated through laboratory study model; in flash mixer, the sample was mixed rapidly at the rate of 100 rpm for 1 minute with optimum dose determined earlier as per turbidity range. 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 floe formation by enhancing particle collisions, and formed floc which leads to settled suspended impurities at bottom of the 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.

III. MODEL APPLICATIONS, RESULTS AND DISCUSSIONS

The sludge was collected from bottom hopper of clariflocculator for the determination of concentration of parameters N, P, K and pH and the results of the same are shown in Table VI.

Table 6: The Quality of Sludge after Clariflocculator Using Mi as Natural Coagulant

1) From Table VI It Is Observed That:

- By using MI [100%] as Coagulant, sludge generated through clariflocculator contains concentration of Total nitrogen [N] around 0.15 to 0.21 %.
- By using MI [100%] as Coagulant, sludge generated through clariflocculator contains concentration of Phosphates [P_2O_5] around 0.35 to 0.65 %.
- By using MI [100%] as Coagulant, sludge generated through clariflocculator contains concentration of Potash [K_2O] around 2.90 to 4.23 %.
- By using MI [100%] as Coagulant, pH of sludge generated through clariflocculator is in the range of 5.2 to 5.78.

The sewage after clariflocculator was collected for the determination of concentration of parameters TSS, BOD and COD and the results of the same are shown in Table VII.

Table 7: Summary of the Quality of Sewage after Clariflocculator Using Mi and Different Percentage of Mi & Alum
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2) From Table VII It is Observed That:
- By using MI [100%] as Coagulant, average TSS, BOD and COD removal efficiency is 31.62, 32.42 and 33.43 % respectively from sewage.
- By using MI with A [80:20] % as Coagulant, average TSS, BOD and COD removal efficiency is 36.75, 35.54 and 40.68 % respectively from sewage.
- By using MI with A [60:40] % as Coagulant, average TSS, BOD and COD removal efficiency is 42.91, 41.88 and 46.06 % respectively from sewage.
- By using MI with A [50:50] % as Coagulant, average TSS, BOD and COD removal efficiency is 46.84, 45.80 and 51.07 % respectively from sewage.
- By using MI with A [40:60] % as Coagulant, average TSS, BOD and COD removal efficiency is 53.89, 52.62 and 61.10 % respectively from sewage.
- By using MI with A [20:80] % as Coagulant, average TSS, BOD and COD removal efficiency is 66.86, 65.62 and 69.20 % respectively from sewage.
- By using A [100%] as Coagulant, average TSS, BOD and COD removal efficiency is 75.26, 75.72 and 75.75 % respectively from sewage.

IV. CONCLUSIONS

By using Mangifera Indica as a natural coagulant to treat sewage, the average TSS, BOD and COD of sewage is reduced 31.62, 32.42 and 33.43 % respectively. It is also observed that the TSS, BOD and COD removal efficiency increased by using combination of MI and alum.

Sludge generated after clariflocculator by using MI will be good manure after composting. The constituents found in sludge are Total nitrogen [N] from 0.15 to 0.21 %, Phosphates [P2O5] from 0.35 to 0.65 % & Potash [K2O] from 2.90 to 4.23 %.

Thus, it is concluded that Natural coagulation for treating sewage is a best way to reduce the organic loading over aeration tank of activated sludge process. Thus the sizes of secondary treatment units like aeration tank and secondary sedimentation tank can be reduced. Also the cost of energy which required for aerator in aeration tank will be minimized.

The use of MI as natural coagulant reduces the construction cost, energy and also recovers nutrients in terms of sludge. This leads to improve rural economy.

REFERENCES
