Appropriate Technology for Industrial Wastewater Treatment of Paint Industry

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Abstract: The objective of this study is to introduce a complete wastewater treatment process suitable for treatment of highly polluted industrial wastewater of paint industry. This objective was achieved through an experimental program using prototype model for continuous operation. The proposed treatment process includes physical/chemical treatment followed by filtration process through palm hems as filtration media with possible aeration for 1 hr and Dissolved Air Floatation (DAF) unit when needed. Aeration process for 1 hr was only used when the raw wastewater showed toxicity. The chemical agents used were NaOH, Alum, Fe Sal. and polymer. The concerned measured parameters for raw and treated water were COD, TSS and BOD. The average percentages of removals for COD, TSS and BOD after applying the proposed treatment process were 85%, 91% and 90%, respectively which are considered accepted as secondary treated effluent when compared with traditional treatment processes.

Key words: Paint wastewater · Physical/chemical treatment · Palm hems

INTRODUCTION

Paint is generally considered as a mixture of pigment, binder, solvent and additives. Paint classification can be made on many different bases; one convenient method is to classify paints based on their primary solvent for waste reproduction and disposal. Using this approach, paints can be classified as water based, organic solvent based or powder (dry) and without solvent [1]. The major waste that paint industry must manage is dominantly equipment cleaning wastes, which makes up 80% of the waste generated in paint manufacture [2].

Latex paint generally consist of organic and inorganic pigments and dyestuffs, extenders, cellulose and non cellulose thickeners, latexes, emulsifying agents, anti foaming agents, preservatives, solvents and coalescing agents. The treatment of latex paint wastewater for reuse thus requires effective treatment for the removal of suspended solids, metal ions and microorganisms. Wastewater is generated primarily due to cleaning operations of mixers, reactors, blenders, packing machines and floors [3].

In general, paint effluents are alkaline and have high BOD, COD, heavy metals, suspended solids and colored materials [4]. Palm hemp has the following advantage in industrial sector; a) Hemp requires less moisture to grow, b) Hemp’s fiber bundles are stronger and tougher, c) Hemp is generally pest resistant, drought resistant and light frost resistant. With proper leaf removal, hemp has low net nutrient requirements and requires minimal cultivation [5].

In recent years, electrochemical oxidation is becoming an alternative for wastewater treatment and starting to replace traditional processes, because many industrial processes produce toxic wastewaters, which are not easily biodegradable and requiring costly physical or physic-chemical pretreatments.

Many researchers had investigated the electrochemical oxidation of various types of wastewater containing, olive oil [6], human wastes [7] and tannery wastewater [8].

However, there is a lack of researches dealing with electrochemical treatment of paint wastes in literature; present publications are only related to conventional treatment methods. A recent study by Kutluay et al. [9] investigated the chemical treatability of water-based industry wastewater via adsorption and the authors concluded that highest COD removal efficiency was achieved with sodium bentonite. Another study by Dovletoglu et al. [10] dealt with coagulation-flocculation of paint industry wastewater using ferrous and aluminum sulphate and polyaluminum chloride. Aboulhassan et al. [11] studied the improvement of paint effluent coagulant using natural and synthetic coagulant agents. Who concluded from his study that Fe Sal is efficient at pH range 8-9 and optimal dose of 650 mg/L to remove 82%
of chemical oxygen demand and 94% of color. Electrochemical treatment of industrial paint wastewater with response surface methodology was studied by Bahadir et al. [12]. This study introduces untraditional physical chemical treatment process to be recommended for treatment of highly polluted industrial wastewater of paint industries.

MATERIALS AND METHODS

The suggested treatment process consists of chemical/physical treatment followed by aeration process for short period of time and finally filtration process through an agro fiber filter media of palm hemps. Eleven raw wastewater samples were taken from different paint factories in six October industrial zone. The parameters of COD, TSS and BOD in addition to pH were measured at different treatment stages to be compared with the raw industrial wastewater using standard methods [13].

Two prototype models were designed and manufactured. The first one was for palm hamps filter while the second one for continuous operation of the whole suggested process of treatment. The prototype model includes chemical mixing compartment, flocculation zone, lamella clarification zone, Dissolved Air Floatation (DAF) with all necessary pump, air compressor, skimmer, etc... followed by palm hemp filter model. It was possible by using the above prototype model connected to the filter media model to run continuous flow operations and optimize the test results for different parameters. In order to define the characteristics of the raw wastewater of paint industry, five raw wastewater samples were taken from paint factory at different times and complete analysis was performed. In order to optimize the different parameters to recommend the proposed treatment processes, six raw wastewater samples were collected from several paint factories in six of October industrial city at different times.

The sample analysis of the other six samples showed high toxicity in most of the raw waste water. The experimental programme was performed by using a well designed prototype model which allowed changing the sequence of different proposed treatment processes and measuring different parameters. The prototype model includes chemicals mixing zone, flocculation zone, lamella clarification zone, D.A.F compartment and palm hems filtration stage (Fig. 1).

RESULTS AND DISCUSSION

The summary of some selected test results were showed in (Tables 1-3), while (Table 4) showed the optimum treatment process. The obtained results showed that, the best sequence of treatment processes for waste

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Table 1: Chemical/physical treatment with DAF for sample No.2.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Raw W.W</th>
<th>After NaOH</th>
<th>After Alum</th>
<th>After DAF</th>
</tr>
</thead>
<tbody>
<tr>
<td>COD</td>
<td>mg/L</td>
<td>36850</td>
<td>10250 72%</td>
<td>10200 --</td>
<td>5200 49%</td>
</tr>
<tr>
<td>TSS</td>
<td>mg/L</td>
<td>1780</td>
<td>605 66%</td>
<td>175 71%</td>
<td>79 55%</td>
</tr>
<tr>
<td>BOD</td>
<td>mg/L</td>
<td>8000</td>
<td>1400 82.5%</td>
<td>1350 3.6%</td>
<td>1400 --</td>
</tr>
</tbody>
</table>


Table 2: Chemical/physical treatment with filter for sample No.3.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Raw W.W</th>
<th>After Alum</th>
<th>After Alum + Filter</th>
<th>After Filter + Alum</th>
</tr>
</thead>
<tbody>
<tr>
<td>COD</td>
<td>mg/L</td>
<td>28750</td>
<td>3463 88%</td>
<td>2225 36%</td>
<td>3219 89%</td>
</tr>
<tr>
<td>TSS</td>
<td>mg/L</td>
<td>1670</td>
<td>150 91%</td>
<td>70 53%</td>
<td>110 93%</td>
</tr>
</tbody>
</table>

Table 3: Chemical/physical treatment with filter for sample No.4.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Raw W.W</th>
<th>After (NaOH+Fe Sal)</th>
<th>After (NaOH+Fe Sal) + Filter</th>
<th>Raw W.W + Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>COD</td>
<td>mg/L</td>
<td>15220</td>
<td>9340 38.6%</td>
<td>5650 39.5%</td>
<td>18200 -19.6%</td>
</tr>
<tr>
<td>TSS</td>
<td>mg/L</td>
<td>3700</td>
<td>1200 67.6%</td>
<td>850 29%</td>
<td>1700 54%</td>
</tr>
<tr>
<td>BOD</td>
<td>mg/L</td>
<td>Toxic</td>
<td>Toxic</td>
<td>Toxic</td>
<td>Toxic</td>
</tr>
</tbody>
</table>
Fig. 1: Sections in prototype model
Table 4: Effect of Chemical/physical treatment with aeration and filtration on treatment processes for sample No.6.

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Raw W.W value (PH)</th>
<th>Value (R %)</th>
<th>Raw W.W + (NaOH + Alum) value (COD mg/L)</th>
<th>Value (R %)</th>
<th>Raw W.W ++ value (TSS mg/L)</th>
<th>Value (R %)</th>
<th>Raw W.W ++ 2hrs. Aeration value (BOD mg/L)</th>
<th>Value (R %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH</td>
<td>--</td>
<td>6.63</td>
<td>8.7</td>
<td>7.23</td>
<td>6.71</td>
<td>6.83</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COD</td>
<td>mg/L</td>
<td>9575</td>
<td>747</td>
<td>607</td>
<td>7050</td>
<td>4775</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSS</td>
<td>mg/L</td>
<td>6006</td>
<td>220</td>
<td>185</td>
<td>1594</td>
<td>1293</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOD</td>
<td>mg/L</td>
<td>Toxic</td>
<td>Toxic</td>
<td>Toxic</td>
<td>Toxic</td>
<td>1950</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 2: Effect of different treatment processes on COD removal (sample no.6).

Fig. 3: Effect of different treatment processes on TSS removal (sample no.6).
water of paint industry consists of chemical/physical treatment using sodium hydroxide and alum as coagulant agents followed by lamella clarification process, aeration process for 1 to 2 hrs and finally palm hemps filtration process. However, Fig. 2 shows that the percentage of COD removal after Chemical/Physical treatment was 92% while COD percentage of removal due to aeration for one hour after chemical physical treatment was 20% while the percentage of COD removal due to palm hemps filtration was 11%. In addition, Fig. 3 shows that the percentage of TSS removal after Chemical/Physical treatment was 96% while TSS percentage of removal due to aeration for one hour and filtration through palm hemps filter were 16% and 12%, respectively.

Table 4 shows that the percentage of BOD removal due to palm hemps filtration was 32.7%. The total COD, TSS and BOD5 percentages of removals after applying the above proposed treatment process is 94.9%, 96.5% and 85% as shown in (Table 4) of sample no 6. Moreover, the effect of toxic compounds could be cancelled by applying (1 to 2 hrs) aeration prior to filtrations process

**CONCLUSION**

From the obtained results it is recommend that, the treatment process for industrial wastewater of paint industry is to apply chemical / physical treatment process using lamella clarification followed by aeration process for 1 to 2 hrs and finally to apply palm hemps filtration process to obtain final treated effluent.

**REFERENCES**

2. The Massachusetts Toxics Use Reduction Institute, 1993. Substitution case study: alternatives to solvent-based paints, technical report no. 4, University of Massachusetts, Lowell,
5. Said, A.H., 1998. Effect of coagulant and polymer doses direct filtration. AWWA.,