STUDY ON DISPOSAL OF EFFLUENT TREATMENT PLANT SLUDGE OF TIRUPPUR TEXTILE PROCESSING INDUSTRIES

K. Ravichandran
Research Scholar, Department of Civil Engineering, Karpagam Academy of Higher Education, Coimbatore, Tamilnadu, India

Dr. R. Sundararajan
Ph.D Supervisor, Department of Civil Engineering, KAHE, Coimbatore, Tamilnadu, India

ABSTRACT

Textile processing industries generate large quantity of effluent from the bleaching, dyeing and in printing process. The dyeing units in Tiruppur have implemented ZLDS either individually or collectively (IETPs/CETPs) and the system is in operation for the past ten years. The sludge generated from the ZLDs of textile processing industries are classified as Hazardous waste as per Hazardous Wastes (M&TBM) Rules. The approved Methods of disposal of solid sludge are incineration & secured landfill (SLF). As incineration and establishing SLF is being costly, there was stagnation in disposal of ZLDs sludge. Recently, the CPCB issued guidelines for using hazardous waste in cement Kiln Power Steel Industry by Co-processing technology. Co-processing is the use of waste as a source of energy, to replace natural mineral resources and fossil fuels such as coal, petroleum and gas in industrial processes. On the basis of the Guidelines, a trial was carried out by M/s. Ultratech Cement Limited, Reddipalayam, Ariyalur, Tamilnadu for check the feasibility of using the said sludge in cement industries for co-processing. Thus, this study reveals the feasibility of using sludge generated from Textile industries in Tiruppur by co-processing technology in cement industry. This study also reveals the advantage of Co-processing of sludge in cement industry over incineration and SLF.

Keywords: Textile Industry; ZLDs Sludge; Incineration; SLF; Co-Processing.

1. INTRODUCTION

Tiruppur is a major knitwear centre in India with more than 9000 small scale Garment units supported with 700 Textile and bleaching units and 250 printing units. The dyeing units generate huge volume of effluent from the process and the units have provided zero liquid discharge plants (ZLDS) for the treatment of wastewater and the treated wastewater after membrane technology treatment is reused.

Currently, 18 common effluent treatment plants (CETPs) and more than 50 individual effluent treatment plants (IETPs) are in operation in Tiruppur. About one crore litres of effluent is treated and recycled in these plants. The treatment system comprises of physio chemical treatment system followed by Reverse Osmosis Filtration System and Multiple Effect Evaporation system. The physio chemical treatment system removes the colour and other organic loading and it comprises of equalisation, coagulation, settling and aeration system. The physio chemical treatment system makes the effluent fit for the subsequent filtration process. The process of coagulation and settling in the said process removes the colour and it generates large volume of sludge and the sludge is dewatered and dried either in sludge drying beds or in Mechanical Filter press. In Tiruppur, about 100 Tonnes of Hazardous ETP sludge is generated daily. The sludge generated from the ETP is considered as Hazardous waste as per the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 under the category 35.3 (Chemical sludge from waste water treatment).

Secured Land Fill (SLF) and Incineration are the general approved methods for the disposal of the dyeing effluent ETP sludge. In secured land fill, the sludge is dumped in pits lined with double layer Geo membrane system with provision for collection and treatment of leachate from the system. After filling with Hazardous sludge scientific closure of the pits are carried out. Incineration is a waste treatment process that involves the combustion of organic substances contained in waste materials. Incineration of waste materials converts the waste into ash, flue gas and heat. The ash is mostly formed by the inorganic constituents of the waste, and may take the form of solid lumps or particulates carried by the flue gas. The flue gases must be cleaned of gaseous and particulate pollutants before they are dispersed into the atmosphere. In some cases, the heat generated by incineration can be used to generate electric power.

As incineration and establishment of SLF is being costly, there was stagnation in disposal of ZLDs sludge. This leads to the search of alternate technology of disposal of hazardous waste in a better way. In February 2010 CPCB has issued guidelines for co processing of Hazardous waste in Cement Kiln-Power-Steel Industry. Co-processing is the use of waste as a source of energy, to replace natural mineral resources and fossil fuels such as coal, petroleum and gas in industrial processes.

The production of cement in India is about 200 Million tonnes per annum, for which estimated coal and lime stone requirement are 40 Million Tons per annum and 320 Million Tons per annum, respectively. The study was carried out by CPCB in order to check the potential utilization of entire hazardous waste generation for co-processing. Apart from Cement Industry, Thermal Power Plant, Iron and Steel Industry are other potential candidates for co-processing for disposal of Hazardous waste.

Thus, this study reveals the feasibility of using said sludge generated from Textile industries in Tiruppur by co-processing technology in cement industry. This study also reveals the advantage of co-processing of sludge in cement industry over incineration and SLF.
2. MATERIALS AND METHODOLOGY

2.1. Materials
The ETP sludge was collected from CETPs and IETPs of dyeing units in Tiruppur. The compositions of effluent from Tiruppur Industries were obtained from Tamilnadu pollution Control board (TNPCB), Tamilnadu. The trail experiments were conducted by Ultra tech Cement Ltd, Reddipalayam, Ariyalur was given permission by Tamilnadu Pollution Control Board to conduct trial study by using the dyeing ETP sludge in their Kiln. The unit has engaged with M/s Vimta labs, Hyderabad to monitor the various air quality parameters and to make analysis of raw materials, product analysis and various process parameters and the entire study was made under the supervision of TNPCB.

2.2. Methodology
1. This study was conducted for five day.
   - **Pre-trial** Day-1- Normal fuel and normal Raw material (to assess baseline emission value)
   - **Trial period** Day-2,3,4- Normal fuel and Raw material mixed with CETP/IETP waste.
   - **Post-trial** Day-5-Normal fuel and normal Raw material.
2. The CETP sludge was mixed with raw material to a percentage of 6.5% i.e at a feeding rate of 14.5 TPD
3. The emission of various pollutants such as SO2, Nox, HCl, HF, Hydrocarbons, CO, TOC,PAH, Dioxin and furan etc were monitored during co processing of hazardous waste, pre and post trial of co processing.

3. RESULTS AND DISCUSSION

3.1. Results
The ETP sludge was collected form CETPs and IETPs of dyeing units in Tiruppur. The chemical composition of the ETP sludge was analysed and given in the Table 1. From Table 1, it was observed that the sludge is Hazardous in nature and should properly collected, stored, treated and disposed as per the provisions of Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016.

### Table 1 Chemical Characteristics of Dyeing Effluent Treatment Plant sludge

<table>
<thead>
<tr>
<th>S.No</th>
<th>Industry Name</th>
<th>SiO₂ (%</th>
<th>Al₂O₃ (%)</th>
<th>Fe₂O₃ (%)</th>
<th>CaO (%)</th>
<th>MgO (%)</th>
<th>K₂O (%)</th>
<th>Na₂O (%)</th>
<th>SO₃ (%)</th>
<th>Chlorides (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S.S.M.Fine Yarns</td>
<td>2.12</td>
<td>32.20</td>
<td>0.16</td>
<td>1.33</td>
<td>0.01</td>
<td>0.10</td>
<td>0.73</td>
<td>6.91</td>
<td>0.24</td>
</tr>
<tr>
<td>2</td>
<td>Jasmine Towels Pvt.Ltd.,</td>
<td>10.2</td>
<td>2.25</td>
<td>2.22</td>
<td>33.90</td>
<td>6.84</td>
<td>0.16</td>
<td>0.16</td>
<td>0.62</td>
<td>0.19</td>
</tr>
<tr>
<td>3</td>
<td>Jay Jay Mills (I) Pvt.Ltd.,</td>
<td>2.41</td>
<td>0.45</td>
<td>28.90</td>
<td>1.61</td>
<td>2.01</td>
<td>0.58</td>
<td>1.47</td>
<td>2.73</td>
<td>2.02</td>
</tr>
<tr>
<td>4</td>
<td>United Bleachers (P) Ltd.,</td>
<td>6.02</td>
<td>26.30</td>
<td>16.10</td>
<td>7.32</td>
<td>0.37</td>
<td>0.14</td>
<td>1.41</td>
<td>13.75</td>
<td>2.19</td>
</tr>
<tr>
<td>5</td>
<td>Victus Dyeing</td>
<td>1.72</td>
<td>0.34</td>
<td>17.53</td>
<td>28.72</td>
<td>0.96</td>
<td>0.19</td>
<td>1.67</td>
<td>1.47</td>
<td>2.14</td>
</tr>
<tr>
<td>6</td>
<td>Design Process</td>
<td>1.71</td>
<td>0.30</td>
<td>12.10</td>
<td>41.18</td>
<td>1.49</td>
<td>0.01</td>
<td>0.21</td>
<td>0.92</td>
<td>0.07</td>
</tr>
<tr>
<td>7</td>
<td>Rajalakshmi Textile Processors Pvt Ltd</td>
<td>24.92</td>
<td>3.78</td>
<td>16.77</td>
<td>18.3</td>
<td>3.78</td>
<td>1.53</td>
<td>1.14</td>
<td>0.86</td>
<td>0.75</td>
</tr>
<tr>
<td>8</td>
<td>R.K.EXPORTS (Karur) PVT LTD</td>
<td>17</td>
<td>9.92</td>
<td>0.72</td>
<td>3.66</td>
<td>0.44</td>
<td>0.54</td>
<td>1.00</td>
<td>4.81</td>
<td>0.54</td>
</tr>
</tbody>
</table>
3.1. Current practice for disposal of ETP Sludge

Secured land fill (SLF) and Incineration are the general approved methods for the disposal of the dyeing effluent ETP sludge in Tiruppur.

3.1.1. Secured Land Fill

For disposing the Hazardous sludge generated from CETPs and IETPs of dyeing units in Tiruppur were directed to provide SLF individually or advised to send the waste to the common TSDF established at Gummidipoondi. Establishing SLF individually requires vast land area and involves high capital cost. In Tamilnadu only one common SLF at Gummidipoondi is in function and Transportation of the sludge from dyeing units to the common SLF at Gummidipoondi from Tiruppur involves huge transportation cost and there was stagnation in disposal of ETP sludge from Tiruppur dyeing units.

Common TSDF at Gummidipoondi

![Figure 1 Haz sludge Filling in SLF](image1)

![Figure 2 SLF after closure with Green Cover](image2)

In the year 2011, it was estimated about one lakh fifty thousand tonnes of ETP sludge was accumulated and stored in Tiruppur. Improper storage and disposal of ETP sludge generated from the dyeing units lead to generation of leachate and again it contaminated the surface and the ground water. The accumulated quantity of ETP sludge stored in IETPs and CETPs is given in Table-2

Table 2 Quantity of sludge accumulated in Tiruppur IETPS/CETPS in 2011

<table>
<thead>
<tr>
<th>SL.No</th>
<th>Name of the plant</th>
<th>Quantity in Tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M/s Veerapandy CETP</td>
<td>28500 Tonnes</td>
</tr>
<tr>
<td>2</td>
<td>M/s Kunnagalpalayam CETP</td>
<td>11000 tonnes</td>
</tr>
<tr>
<td>3</td>
<td>M/s Chinnakarai CETP</td>
<td>13500 Tonnes</td>
</tr>
<tr>
<td>4</td>
<td>M/s Andipalaym CETP</td>
<td>14500 Tonnes</td>
</tr>
<tr>
<td>5</td>
<td>M/s Angerpalaym CETP</td>
<td>23000 tonnes</td>
</tr>
<tr>
<td>6</td>
<td>M/s Mannaрай CETP</td>
<td>18000 Tonnes</td>
</tr>
<tr>
<td>7</td>
<td>M/s Kasipalaym CETP</td>
<td>7800 Tonnes</td>
</tr>
<tr>
<td>8</td>
<td>Individual IETPs</td>
<td>35000 Tonnes</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>151300 Tonnes</td>
</tr>
</tbody>
</table>

Source: TNPCB
3.1.1.2. Incineration

Incineration is also one of the approved methods of disposal of ETP sludge generated from dyeing industry in Tiruppur. But the cost of providing incinerator would depend on its capacity ranging from Rs 10 crores to 30 crores. Incineration cost of Incinerable hazardous waste is about Rs. 16,000/- per MT and incinerator if not operated optimally may contribute to emissions including toxic Dioxins and Furans. Further the incineration ash is also to be disposed in secured landfill. This method also requires huge energy, skilled personnel, and continuous maintenance.

3.1.2. Co Processing of ETP sludge in Cements Industry

Mixing ETP sludge with cement raw material(co processing) destroy the hazardous waste at a higher temperature of around 1400°C at longer residence time in the kiln and its inorganic content of the sludge gets fixed with the cement clinker apart from using the energy content of the wastes. Apart from this, no residues are left, which in case of incineration still requires being land filled as incinerator ash. Further the acidic gases, if any generated during co-processing gets neutralized, since the raw material is alkaline in nature. Such phenomenon also reduces resource requirement such as coal and lime stone. Thus utilization of Hazardous wastes for co-processing will be an environmentally safe procedure for destruction of hazardous wastes. Further alternate raw mix also offers conservation of traditional raw materials.

3.1.2.1. A Case Study: Co-processing of Sludge in Cement Industry

Central Pollution Control Board(CPCB), in February 2010 has published “Guidelines on co processing of hazardous waste in cement industry”. As per the guidelines the cement plant has to ensure that they meet the particulate matter emission standards during co-processing as prescribed under consent order issued to the unit. For other pollutants such as CO, TOC, NOx, HCL, SO2, HF, Total Dioxins and Furans, Cd + TI + their compounds, Hg and its compounds, Sb + As + Pb + Co + Cr + Cu + Mn + Ni + V + their compounds, emission values during co-processing shall not exceed the baseline emission. Baseline emission is nothing but the emission range observed before trial.

As per the permission, M/s Ultratech cement Ltd has conducted trial run with ETP sludge and the emission parameters are presented in Table 3.

Table 3 Summary of average values of emissions during trial run with CETP sludge in cement kiln

<table>
<thead>
<tr>
<th>SL.No</th>
<th>Parameters</th>
<th>Unit</th>
<th>Pre-trial</th>
<th>Trial with CETP sludge</th>
<th>Post-trial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Average</td>
<td>Range</td>
<td>Average</td>
</tr>
<tr>
<td>1</td>
<td>Particulate matter</td>
<td>mg/Nm³</td>
<td>22.3</td>
<td>17.3-25.9</td>
<td>22.1</td>
</tr>
<tr>
<td>2</td>
<td>Sulphur dioxide</td>
<td>mg/Nm³</td>
<td>&lt;3-2</td>
<td>&lt;3-2</td>
<td>&lt;3-2</td>
</tr>
<tr>
<td>3</td>
<td>Oxides of Nitrogen(NOx)</td>
<td>mg/Nm³</td>
<td>1448</td>
<td>1382-1585</td>
<td>1392</td>
</tr>
<tr>
<td>4</td>
<td>Hydro carbons</td>
<td>mg/Nm³</td>
<td>189.2</td>
<td>134.4-244.0</td>
<td>172.9</td>
</tr>
<tr>
<td>5</td>
<td>Carbon Monoxide</td>
<td>mg/Nm³</td>
<td>118.2</td>
<td>93.1-128.6</td>
<td>101.6</td>
</tr>
<tr>
<td>6</td>
<td>Hydrogen Chloride(HCL)</td>
<td>mg/Nm³</td>
<td>18.5</td>
<td>16.9-20.4</td>
<td>18.3</td>
</tr>
</tbody>
</table>
Fig 1 to 3 represents the emission trend during the co processing, pre trial and post trial.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Unit</th>
<th>Pre trial</th>
<th>Trial with waste</th>
<th>Post trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Hydrogen Fluoride (HF)</td>
<td>mg/Nm³</td>
<td>2.5</td>
<td>2.0-3.2</td>
<td>2.0</td>
</tr>
<tr>
<td>8</td>
<td>Total Organic Carbon</td>
<td>mg/Nm³</td>
<td>4.5</td>
<td>4.5</td>
<td>4.3</td>
</tr>
<tr>
<td>9</td>
<td>Poly Aromatic Hydrocarbons</td>
<td>µg/Nm³</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>10</td>
<td>Volatile organic compounds</td>
<td>µg/Nm³</td>
<td>4.9</td>
<td>4.7-5.1</td>
<td>4.5</td>
</tr>
<tr>
<td>11</td>
<td>Cyanide</td>
<td>mg/Nm³</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>12</td>
<td>Mercury</td>
<td>mg/Nm³</td>
<td>0.003</td>
<td>0.003</td>
<td>0.002</td>
</tr>
<tr>
<td>13</td>
<td>Cadmium + Thallium (Cd + TI)</td>
<td>mg/Nm³</td>
<td>0.005</td>
<td>0.005</td>
<td>0.003</td>
</tr>
<tr>
<td>14</td>
<td>Total Metal</td>
<td>mg/Nm³</td>
<td>0.329</td>
<td>0.329</td>
<td>0.312</td>
</tr>
<tr>
<td>15</td>
<td>Total dioxins and Furans</td>
<td>ng/Nm³</td>
<td>0.0049</td>
<td>0.0049</td>
<td>0.0047</td>
</tr>
</tbody>
</table>

**Figure 1** Emission Trend (Particulate matter, HCL, HF, SO₂)

**Figure 2** Emission Trend (Hydro Carbon and Carbon Monoxide)
From the table 3 and fig 1 to 3, the following were observed

1. The particulate matter emissions during the said three phases were always less than the permitted value of 50 mg/Nm$^3$ and maximum observed was 25.9 mg/Nm$^3$.

2. Sulphur di oxide emission during entire trial co-processing period with CETP sludge was observed to be less than 3.2 mg/Nm$^3$.

3. Oxides of nitrogen emissions, which were much dependent on the temperature, were ranging between 1317 to 1567 mg/Nm$^3$ during trial co-processing with hazardous waste. HCL and HF emissions values were found to be 17.5 to 19.2 mg/Nm$^3$ and 1.8 to 2.2 mg/Nm$^3$ respectively during trial co-processing with hazardous waste.

4. Volatile organic compounds were found to be 4.2 to 4.8 μg/Nm$^3$ during trial co-processing with hazardous waste. Poly aromatic hydrocarbon emissions were observed to be less than < 0.01 μg/Nm$^3$ during entire trial co-processing with hazardous waste.

5. Dioxins and Furans were found to be 0.0049 ng/Nm$^3$ during pre trial period, 0.0047 to 0.0048 ng/Nm$^3$ during co processing with waste and 0.0048 ng/Nm$^3$ during post trial period.

6. The total heavy metals and mercury emission values are 0.309 to 0.315 mg/Nm$^3$ and 0.001 to 0.002 mg/Nm$^3$ during trial co-processing with hazardous waste.

7. Total organic carbon was 4.1 to 4.6 mg/Nm$^3$ during trial co-processing with hazardous waste. Ambient air quality was found to be normal representing the industrial waste.

8. No significant chemical composition variation and physical properties variation was found in clinker produced with raw material mixed with CETP sludge of 6.5 %

9. As the results of the study were found encouraging Central Pollution Control Board has given permission using ETP sludge in cement kiln.

3.2. DISCUSSION

1. Disposal of ETP sludge in secured land fill requires vast land area and it involves high capital and transportation cost. In case of common facility and if the transportation cost is cheaper than the SLF disposal option can be considered.
2. As per CPCB guidelines for co processing of ETP sludge in cement Kiln trial study for fixing the ratio of mix to be studied. Further the unit has to ensure the particulate emission from the kiln should not exceed the permitted concentration of consent order issued to the unit. Regarding the emission of other pollutants it should not exceed the baseline concentration. The trial conducted at M/s Ultratech cements Ltd with 6.5 % mix of sludge with raw material complied with the said directions of CPCB in terms of emission level.

3. As on date more than 90% of the accumulated quantity of sludge stored in Tiruppur is already disposed by Coprocessing in the following Cement plants.
   b. M/s Chettinad Cement Industries, Puliur, Karur.
   c. M/s India Cements Ltd, Sankari,
   d. M/s ACC Ltd, Madhukarai, Coimbatore

4. CONCLUSION
Co processing of ETP sludge along with the cement raw material has negligible impact on Clinker composition and the overall impact of the Hazardous waste co processing is beneficial to environment in terms of disposal, air impacts and conservation of raw material.

Hence Co-processing is an Eco Friendly Technology for disposing the hazardous Waste Technology.

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