CHAPTER 3

STUDY OF EXISTING COMMON BIO-MEDICAL WASTE TREATMENT FACILITY (CBMWTF)

3.1 GENERAL

CBMWTF was established at Chettipalayam which is reasonably far away from the residential and sensitive area, nearly 20kms from the city in 2001. In order to provide all the requisite systems, CBMWTF has a built up area of around 3000 sq.ft with a land area of 1 acre. The initial cost of construction was around 2 lakhs. CBMWTF charges Rs.2.50/bed/day to hospitals. The unit started operation in 2007 even though it was established in 2001. Majority of IBMW generators are yet to get enrolled in IMA, Coimbatore to utilize this off-site treatment facility.

Segregation is the key to success for any waste management scheme. It has to be conducted at the point of generation, to keep non-infectious waste from becoming infectious. Segregation of waste before disposal, except for syringes and needles was not practiced by majority of hospitals. Only in few hospitals, wastes were segregated in a proper manner as per the BMW rules. From the samples received at the facility, it is observed that the wastes are not collected separately in coloured containers/ bags as prescribed. It is observed, that all the segregated wastes are put into a single container that had no label or symbol on it.
To improve the working conditions of the employees and creating awareness among Administrators, doctors, nurses and health care workers, training must be given adequately so that they understand the risks involved proper management of wastes and the consequences of poor practices. They must be made aware of the possibilities and importance of waste segregation of injections and hazardous waste from the general waste at source. A thorough programme of training for those responsible for waste handling in health care establishments, and for municipal workers collecting waste from health care establishments, to ensure that they adopt professional attitudes to waste management and apply approved practices. Their training must include the use of protective clothing and specialist equipment to allow them to carry out their responsibilities in a manner which ensures their own safety as well as that of the public. It is essential that low-grade workers understand that their future depends on them providing a high level of service. The sanitation staffs are also well trained and do their job hygienically. Some instruction of waste pickers and recyclers of health care wastes on the risks involved and the precautions which could be taken would also be advisable. Better health care provision for waste pickers and recyclers is urgently needed. The protective gears are also worn and systematic care is taken to avoid manual contact with the hazardous waste. All the medical professionals must be made aware of Bio-medical waste (Management and Handling) Rules 1998.

3.2 COLLECTION AND TRANSPORTATION

CBMWTF collects 3.2 to 3.5 tonnes of Biomedical Waste (BMW) per day from the 295 hospitals from Coimbatore, Tirupur, Erode, and Sathyamangalam using five trucks as shown in Figure 3.1. It starts to collect the wastes around 6.00 am and returns around 5.00 pm daily. Separate cabins are provided for the driver and the bio-medical waste containers. The base of
the waste cabin is leak proof to avoid pilferage of liquid during transportation and it is designed to facilitate easy wash. The waste cabins have provisions for sufficient openings so that waste containers can be easily loaded and unloaded. No untreated biomedical waste is stored beyond a period of 48 h as per Bio-medical waste (Management and Handling) Rules 1998.

![Figure 3.1 Collection of Biomedical waste](image)

3.3 UNIT OPERATIONS OF CBMWTF

3.3.1 Autoclave

The primary purpose of autoclave is to sterilize/ disinfect the wastes. Microorganism, which contribute to infection do not survive beyond 80°C. However, Ministry of Forest and Environment (MoEF) has stipulated a temperature of 135°C and 35 psi pressure. To ensure disinfection, 30-35 minutes sterilization time is required. CBMWTF has an autoclave of 250 kg/cycle capacity exists in the CBMWTF as shown in Figure 3.2(a) and 3.2(b) and it is operated at the working temperature of 125°C and the pressure of about 35 psi with the retention time of 30 minutes. At this temperature and pressure, microorganisms are completely destroyed and thus render the wastes infection free. It has a temperature probe locator in exit drain to ensure accurate temperature reading. The arrangement of unique condenser removes
excess moisture for less weight at the time of disposal. The autoclaving system is operated and maintained as per MoEF. An autoclave label is used as an indicator for the completion of autoclaving.

![Autoclave exists in CBMWTF](image)

**Figure 3.2 Autoclave exists in CBMWTF**

### 3.3.2 Segregation of Waste

In CBMWTF all the disinfected waste from the autoclave is led for the segregation of rubber, glass, plastics and metals as shown in Figure 3.3. About 8 labourers are involved in the segregation and they are working 6 hours a day. As per regulation, T.T injection is given and medical check up conducted every month by the agency. The sharps are segregated by the magnetic hub separator and the segregated sharps are dumped in the dumping pit. The segregated plastics are sent to the shredder.

![Segregation of Autoclaved Waste](image)

**Figure 3.3 Segregation of Autoclaved Waste**
3.3.3 Shredder

The segregated plastics like syringes are shredded by means of the shredder as shown in Figure 3.4. Shredded wastes are stored in bags. A section outside the built up area is meant for storage of these shredded wastes waiting for the transportation to the recycling plants. Development of non-PVC plastics as a substitute for plastics which is used in the manufacture of disposable items can reduce the quantity of plastic wastes to the environment. Figure 3.5 shows the flow diagram for autoclaving, segregation and shredding.

![Figure 3.4 Shredder](image)

**Figure 3.5 Flow diagrams for autoclaving, segregation and shredding**

3.3.4 Incineration

Figure 3.6 shows the unit operations of the incinerator existing in CBMWTF.
The CBMWTF has the incinerator of capacity 2000kg as shown in Figure 3.7. It has two chambers, one is the primary chamber (3.17m x 1.22m x 1.9m) with the working temperature of 850°C and another is the secondary chamber (3.17m x 1.14m x 1.9m) with the working temperature of 1050°C. Chambers are insulated and lined with high temperature refractory. Wastes are burnt partly by electric burners and partly by addition of diesel with 90% combustion efficiency. Electric burners are used for heating up the chambers. Every day it consumes 50-80 litres of diesel and whenever power shutdown exists, it consumes 150 litres of diesel.
The arrangements of programmable digital temperature controls and chart recorder are available in the CBMWTF. The Table 3.1 shows the operating and emission details of the incinerator.

### Table 3.1 Operating and emission details of Incinerator

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Existing in CBMWTF</th>
<th>Permissible limits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incineration standards</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combustion efficiency</td>
<td>90%</td>
<td>99.0%</td>
</tr>
<tr>
<td><strong>Temperature of the primary chamber</strong></td>
<td>850°C</td>
<td>800 ± 50°C</td>
</tr>
<tr>
<td><strong>Temperature of the secondary chamber</strong></td>
<td>1050°C</td>
<td>1050 ± 50°C</td>
</tr>
<tr>
<td><strong>Emission standards</strong></td>
<td></td>
<td>Concentration mg/Nm³ @ (12% CO₂ correction)</td>
</tr>
<tr>
<td>1. Particulate matter</td>
<td>-</td>
<td>150</td>
</tr>
<tr>
<td>2. Nitrogen Oxides</td>
<td>-</td>
<td>450</td>
</tr>
<tr>
<td>3. HCL</td>
<td>-</td>
<td>50</td>
</tr>
<tr>
<td><strong>Minimum stack height</strong></td>
<td>30m</td>
<td>30m above ground</td>
</tr>
</tbody>
</table>

#### 3.3.5 Quench Column

The smoke from the incinerator is allowed to enter into the quench column as shown in Figure 3.8 where the water is sprayed from the top so that the temperature gets reduced and the particulates from the smoke settles down. The size of the quench column is 4m height and 80 cm diameter.

*Figure 3.8 Quench column*
3.3.6 Wet Scrubber

The resultant smoke from the quench column is allowed to enter into the wet scrubber (shown in Figure 3.9) for further reduction of temperature. The size of the wet scrubber is about 4m height and 80 cm diameter. The temperature is reduced up to the range of 35°C – 55°C. The wash water and slurry formed is treated separately.

![Figure 3.9 Wet Scrubber](image)

3.3.7 Droplet Separator

The mixed form of water, ash and smoke are led into the droplet separator (Figure 3.10(a)) which has four inclined racks. The mixture from the scrubber is poured up with pressure will hit the racks. As a result, the ash gets filtered out by the racks, the water left out is sent for the treatment. And the smoke remaining is let into the atmosphere by means of a stack (Figure 3.10(b)). The facility has an Effluent treatment Plant (ETP) with the inclusion of an equalization tank (Figure 3.10(c)) of size 4m x 2m, a filter bed (Figure 3.10(d)) and a sludge drying bed. The effluent from the scrubber and the droplet separator is sent to the equalization tank where the water is neutralized by adding lime. The water is then sent into the filter bed from where the effluent is recirculated into the scrubber after cleaning their particulates. The filter bed consists of sand filter and activated carbon filter.
The ash from the incinerator is disposed by means of secured landfill as shown in Figure 3.11. The size of the landfill is 4.5m x 9m and the depth of about 3.6m. The landfill is filled up with the alternate layers of blue metal and gravel. Each layer is covered with clay sheets and finally the whole layer is covered with the sand layer. In CBMWTF, one landfill has been completed and the new one is in progress. In between the sand layer and the metal layer, leachate pipes are fixed which is led into the settling tank where the sediment gets separated and the water is recycled to the quench column.
3.4 ANALYSIS DETAILS OF EFFLUENT

Table 3.2 shows the analysis details of the effluent from the CBMWTF with the permissible values.

Table 3.2 Analysis details of Effluent from the CBMWTF

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Untreated effluent</th>
<th>Treated effluent</th>
<th>Permissible limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6-12</td>
<td>6-8</td>
<td>6.5-9.0</td>
</tr>
<tr>
<td>Total suspended solids (mg l⁻¹)</td>
<td>45-550</td>
<td>20-350</td>
<td>100</td>
</tr>
<tr>
<td>Total dissolved solids (mg l⁻¹)</td>
<td>1900-10300</td>
<td>1500-5500</td>
<td>500</td>
</tr>
<tr>
<td>Chlorides (mg l⁻¹)</td>
<td>750-3500</td>
<td>700-1700</td>
<td>250</td>
</tr>
<tr>
<td>Sulphates (mg l⁻¹)</td>
<td>200-600</td>
<td>150-300</td>
<td>250</td>
</tr>
<tr>
<td>BOD (mg l⁻¹)</td>
<td>25-75</td>
<td>15-35</td>
<td>30</td>
</tr>
<tr>
<td>COD (mg l⁻¹)</td>
<td>200-500</td>
<td>120-300</td>
<td>250</td>
</tr>
<tr>
<td>Oil and grease</td>
<td>&lt;1-4</td>
<td>&lt;1-2</td>
<td>10</td>
</tr>
</tbody>
</table>

3.5 ADVANTAGES

The study presents the status of the existing CBMWTF at Chettipalayam, Coimbatore. An appropriate strategy for safe management of BMW has been taken up integrating technical, financial, institutional, managerial, social and environmental issues. The technology used in CBMWTF is a combination of Autoclave for disinfection, Incineration and
Secured landfill. CBMWTF handles BMW, treats them and safely disposes in a secured land fill. The performance of CBMWTF can be enhanced with co-operative efforts of BMW generators. This can be possible if a healthy coordination exists between CBMWTF and BMW generators.

The procedure is cost effective due to the following reasons,

- Only one or two incinerators, autoclave units are needed for a district instead of one for each hospital.
- The supervision is better in central system, which maintains the safe disposal of biomedical wastes.
- Proper supervision, operation and care reduces the maintenance cost and increases the life of equipments.

3.6 COMPLEXITY

All the BMW generators are yet to get enrolled to utilize this off-site facility. Many BMW generators do not adhere to the rules of segregation into the container bags at the point of generation and are not labeled according to schedule III of BMW (Management and Handling) rules, 1998. Improper segregation of biomedical wastes poses a huge risk towards the workers in CBMWTF. Such an improper segregation practices increase the amount of infectious waste and the cost of their disposal. The collecting bags which are thin and low resistance to tears enabled the stagnation of liquids on the floor and the creation of infection.

The combustor operates at low temperatures, at which pollutants produced from materials such as plastics and cytotoxic drugs are difficult to destroy. According to Greek Joint Ministerial Decision, most cytotoxic drugs require temperatures above 1000°C and some requiring more than 1200°C
(Pruss et al 1999). But CBMWTF Incinerator’s first chamber operates at 850°C and second chamber at 1050°C. Wet bio-medical wastes consume more fuel in Incineration process and the treatment is risky for chlorinated plastics. During incineration and post combustion cooling, waste components dissociate and recombine, forming hundreds and thousands of new molecules, which are referred to as products of incomplete combustion (PIC). Metals are not destroyed, but are dispersed into the environment. “The complete combustion of all hydrocarbons to produce only water and carbon-dioxide is theoretical and could occur only under ideal condition. But in real-world, combustion systems always produce PICs. If the waste is not properly segregated and PVC material is allowed to enter the waste stream, it will lead to incomplete combustion. The air emissions from the incinerator are likely to contain toxic compounds – polychlorinated dibenzo-p-dioxins (referred to as dioxins) and polychlorinated dibenzo furans (referred to as furans), which are much more detrimental than the starting material. In view of the fuel costs, plant personnel will be tempted to charge the incinerator even before the required temperatures are attained. This will also lead to incomplete combustion and associated air pollution. Stack gas emissions may contain potential toxic pollutants such as HCl, cadmium, mercury and lead. The capital cost of the incineration set-up increases due to addition of air pollution control equipment. It is mandatory to install suitable control equipment to meet the regulations. Incinerator consumes a lot of fuel and hence their operational cost is high. The presence of glass in the waste stream could also cause problems (such as slagging) when the waste is incinerated. Efficiency depends on process optimization; hence it requires skilled operators. Air pollution control equipments lead to liquid waste, which may require certain treatment prior to discharge.

Fly ash from the incinerators have high concentrations of dangerous toxins such as dioxins. (Alvim Ferraz et al., 2000; Walker and Cooper, 1992;
Glasser et al., 1991; Lee et al., 1991; Powell, 1987; Fritsky et al., 2001; Yuhas et al., 1994). Ashes (Fly and bottom ash) from the incinerators are categorized as hazardous wastes and it was not adequately treated. After cooling down the combustor, the ash was collected in bags or cardboard boxes and requires disposal in a secured landfill. Loading of the Incinerator with large amounts of fluids and large bulky moist objects that burn slowly & produce relatively low temperatures and also loading of Incinerator with materials that could cause operational problems to the combustion unit (Tsakona et al 2007) (e.g. flammable materials) or produce toxic pollutants (e.g. batteries) should be avoided. A proper operational procedure and emergency planning is required to avoid occupational hazards and potential fire accidents.