Bio-medical liquid waste

Concerns and management

An expansion in the number of health facilities across the country and the burgeoning problem of un-treated biomedical waste had led to the passing of the Biomedical Waste (Management and Handling) rules 1998, but almost eight years down the line, much more needs to be done on the ground.

Handling of bio-medical waste is proving to be an overwhelming challenge for the government and the health sector. However, within the broader theme of bio-medical waste, liquid bio-medical waste is emerging as particularly difficult to handle. Liquid biomedical waste is far more mobile and moves to a wider area after entering the subsurface water bodies or underground aquifers.

Challenge of liquid bio-medical waste

Most existing systems and technologies being used in handling liquid bio-medical waste are failing to address this problem. For instance, the routine exercise of pouring biomedical liquid waste is being questioned for posing higher infection threat to medical staff due to its susceptibility to spilling, splashing and aerosolising. Liquid biomedical waste, if untreated, contains a wide variety of material that poses health hazards.

Liquid bio-medical waste standards

According to the Biomedical Waste (Management and Handling) Rules 1998, liquid pathological and chemical waste should be appropriately treated before discharge into the sewer. Pathological waste must be treated with chemical disinfectants, neutralised and then flushed into the sewage system. Chemical waste should first be neutralised with appropriate reagents and then flushed into the sewer system.

The treated effluent should conform to the limits shown in Table 1 on the next page.

These limits are applicable to hospitals that are either connected with sewers without terminal sewage treatment plant or not connected to public sewers for discharge into public sewers with terminal facilities, the general standards as notified under the Environment (Protection) Act, 1986 should be applicable.

Section (3) of the Act states: “For the purpose of protecting and improving the quality of the environment and preventing and abating the environmental pollution, the standards for emission or discharge of environmental pollutants from the industries, operations or processes shall be specified in schedule I or IV.”

The schedule contains general standards for discharge of effluents. Thirty-five parameters are specified for those to be discharged into municipal sewage.

Minimal safety requirements

Where medical establishments cannot afford treatment of biomedical liquid waste, following measures should be undertaken to reduce risks:

- Patients with enteric diseases should be isolated to wards where their excreta can be collected in buckets for chemical disinfection. This is of utmost importance in cases of cholera outbreaks.
- No chemicals or pharmaceuticals should be discharged into the sewer.
- Sludges from hospital cesspools should be dehydrated on natural drying beds and disinfected chemically (for example, with sodium hypochlorite, chlorine gas, or preferably chlorine dioxide).
- Sewage from these establishments should never be used for agricultural, aqua-cultural, drinking water, or recreational purposes.

AT A GLANCE

- Most existing technologies and practices are failing to deal with the problem of liquid bio-medical waste.
- The Environment Protection Act lists 35 parameters for the discharge of effluents into municipal sewage.
- Many hospitals, in particular those that are not connected to any municipal treatment plant, have their own Sewage Treatment Plants (STPs) or Effluent Treatment Plants (ETPs).
- There is no doubt that liquid medical waste management is a major problem for healthcare facilities and their employees. However, technology and treatment solutions are available.
Treatment of liquid bio-medical waste

On-site treatment or pre-treatment of wastewater

Many hospitals, in particular those that are not connected to any municipal treatment plant, have their own Sewage Treatment Plants (STPs) or Effluent Treatment Plants (ETPs). These plants carry out primary, secondary and tertiary treatment of liquid bio-medical waste followed by sludge treatment.

Hospitals with Effluent Treatment Plants

Himalayan Institute of Hospital Trust

This is a 750-bed hospital near Dehradun and caters to the healthcare needs of 700 villages.

The ETP here was set up on January 2004 at a cost of Rs 2,00,000, with treatment capacity of 100 m3 / day. It is based on aerobic activated sludge process and controls the BOD, COD, pH and total suspended solid. It was set up with the aim of preventing groundwater pollution, energy conservation, meeting water needs and maintaining the ground water table. Some of the treated effluent is recycled as fertilizer for gardens on the hospital premises spread over 300 acres. Some of this is also sold for use in the fields nearby.

The savings in costs and also in the ground water has encouraged the institute to get another STP constructed, which will recycle 2,00,000 litre of water per day. This water will be supplied to the campus and hostels.

Choithram Hospital and Research Centre

Choithram Hospital and Research Centre is a 350-bed tertiary care center in Indore, with a daily OPD attendance of 475 patients. The total water requirement of the hospital is 5,00,000 litres. The ETP plant here was set in November 2001.

The analysis of the hospital effluent before and after treatment is shown in Table 2 all the physico-chemical parameters are within the specified limits. The chlorination results in complete inactivation of the Multiple Drug Resistant bacteria and thus makes the effluent water safe.

The daily input of effluent is approximately 3,39,000 litres and approximately 3,00,000 litres of treated water is recovered. The treated effluent water is used for irrigation and sanitary cleaning. The hospital does not face water shortage any longer. Moreover, more than 5,000 kg. of dried sludge is available every month as manure for its gardens.
Alternative use for biotechnology products

Yashraj Biotechnology Limited is a Mumbai-based company manufacturing diagnostic antigens from native source. It specialises in the field of isolation and purification of native antigenic proteins from biological fluids. Ward fluids in disease state (like ascites/pleural fluids, cerebrospinal fluid), normal state (like post delivery residual blood in cord), urine and donated or rejected blood are collected by the company for isolation of human proteins and native biological markers that are used in manufacture of In Vitro Diagnostics as calibrators and controls.

The collection of these fluids is done in leak proof plastic bottles (duly labeled with biohazard symbol and the company’s address) containing preservatives (anti-microbial and protein stabilisers). Once collected the bottles are transported to their manufacturing facility in Mumbai under four layer safety packaging on lines of WHO and US Federal laws. This packaging offers safety at four levels beginning with non-leaking unbreakable bottles, followed by individual secondary self-sealing bag, jumbo bags, hard plastic container secured an sealed with strips.

Any leftovers are chemically disinfected using one percent hypochlorite solution and disposed in CETP lines, as per guidelines in Biomedical Waste (Management & Handling) Rules, 1998. They are authorised by MPCB for these activities under contract with Mumbai Biomedical Waste Management Co. Records are maintained for such activities. The company does not offer any monetary benefit to the hospital and participation is completely voluntary.

Best management practices for liquid bio-medical waste management

- Medical establishments in remote locations should provide for minimal treatment of wastewater through affordable means (for example, use of lagoons to achieve an acceptable level of purification, followed by infiltration of final effluent to the land).  
- Sewage containing such waste should never be used for agricultural or aquaculture purposes.  
- Sewage should not be discharged into or near water bodies that are used for drinking water.  
- A mercury spill kit should be at hand and staff should be trained to recover the spill using correct techniques.  
- A properly sized grease interceptor should be installed and maintained to reduce the discharge of oil and grease from kitchen and food preparation areas to the sanitary sewer system.

Where feasible, solvents should be recovered for reuse.  
There is no doubt that liquid biomedical waste management is a major problem for healthcare facilities. However, technology and treatment solutions do exist. These solutions, combined with proper training in handling of waste will enable healthcare organisations to diffuse this critical problem while safely, and cost effectively, managing their liquid biomedical waste.

Table 2: Physico-chemical and bacteriological analysis of effluent water

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value before ETP</th>
<th>Value after ETP</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total viable bacterial count</td>
<td>9 X 104</td>
<td>Nil</td>
<td>-</td>
</tr>
<tr>
<td>MDR Coliform [%]</td>
<td>1.5</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>Chem. Oxygen Demand [mg/liter]</td>
<td>280</td>
<td>22.56</td>
<td>&lt;250</td>
</tr>
<tr>
<td>Biological oxygen demand</td>
<td>45</td>
<td>3.6</td>
<td>&lt;30</td>
</tr>
<tr>
<td>Total Solids</td>
<td>1066</td>
<td>630</td>
<td>&lt;2200</td>
</tr>
<tr>
<td>Total dissolved solids &gt;mg/ltr.</td>
<td>942</td>
<td>630</td>
<td>&lt;2100</td>
</tr>
<tr>
<td>Total suspended solids mg/ltr.</td>
<td>124</td>
<td>&lt;2</td>
<td>&lt;100</td>
</tr>
<tr>
<td>pH</td>
<td>7</td>
<td>8.8</td>
<td>6.5-9</td>
</tr>
</tbody>
</table>

Table 3: Physico-chemical and bacteriological analysis of effluent water

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Domestic</th>
<th>Laundry</th>
<th>Kitchen</th>
<th>Boiler</th>
<th>Entire Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak flow Kl/day</td>
<td>385</td>
<td>75</td>
<td>30</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Oil &amp; Grease mg/L</td>
<td>10-20</td>
<td>50-75</td>
<td>150-175</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Suspended solids mg/L</td>
<td>100-150</td>
<td>150-200</td>
<td>300-400</td>
<td>200-250</td>
<td></td>
</tr>
<tr>
<td>B.O.D. mg/L</td>
<td>200-250</td>
<td>100-150</td>
<td>500-600</td>
<td>20-30</td>
<td>6</td>
</tr>
<tr>
<td>C.O.D. mg/L</td>
<td>400-600</td>
<td>600-800</td>
<td>1000-1100</td>
<td>40-50</td>
<td>29</td>
</tr>
<tr>
<td>pH</td>
<td>---</td>
<td>7.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Type of biological fluids collected for various antigens/proteins

<table>
<thead>
<tr>
<th>Source Material</th>
<th>Antigen/Protein Extracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Ascitic/Pleural Fluid</td>
<td>C Reactive Protein (CRP)</td>
</tr>
<tr>
<td>Human Cancer Ascitic/Pleural Fluid</td>
<td>Cancer Protein 15-3, 19-9, 125, 72-4</td>
</tr>
<tr>
<td>Human Urine</td>
<td>Beta 2 Microglobulin (B2M)</td>
</tr>
<tr>
<td>Human Meconium</td>
<td>Carcino Embryonic Antigen (CEA)</td>
</tr>
<tr>
<td>Human Cord Blood</td>
<td>Alpha Feto Protein (AFP)</td>
</tr>
<tr>
<td>Human Blood</td>
<td>Hepatitis B surface antigen ad and ay</td>
</tr>
<tr>
<td>Human Seminal Fluid</td>
<td>Prostate Specific Antigen (PSA)</td>
</tr>
<tr>
<td>Human Leukocytes</td>
<td>Myeloperoxidase (MPO), Proteinase 3 (PR-3)</td>
</tr>
</tbody>
</table>
**Figure 1: Schematic flow sheet of Effluent Treatment Plant**

- Raw effluent from laundry, canteen, etc.
- All other effluent streams from the premises

1. **Bar Screen**
2. **Oil and Grease trap**
3. **Effluent Collection Tank**
4. **Aeration Tank**
5. **Clarifier**
6. **Sludge Drying Beds**
7. **Biosludge**
8. **Filter Feed Tank**
9. **Pressure Sand Filter**
10. **Chlorine Contact Tank**
11. **Treated Water Tank**
12. **Filtrate**
13. **Sludge**

**References and suggested reading**

5. Email and telephonic conversation with S.K. Gupta, Manager-Quality Assurance & Regulatory Affairs, Yashraj Biotechnology Limited, Mumbai
7. Personal interview with Dr Sudhakar Vira, medical superintendent, Sir Ganga Ram Hospital.

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