Environment Conservation Journal 12(1&2) 87-93, 2011
(ISSN 0972-3099) Abstracted and Indexed

Liquid bio-medical waste management strategy

Parag Dalal

Received: 05.12.2010 **Revised: 15.01.2011** **Accepted: 25.03.2011**

Abstract

Bio-medical waste has become a major concern in the world over as it poses serious environmental hazard. The collection and disposal of bio-hazardous liquid can pose a significant risk and occupational challenge to hospital staff as microbial content in this waste may contain significant pathogens. Occupational risks associated with working in Health Care Establishments (HCE's), need to take proper precautions in handling any material from these centers.The scope of this study is limited to bio-medical liquid waste management as per Bio-medical waste (Management & Handling) Rules, 1998 prescribed by CPCB. The objective of this study was to assess the waste handling and treatment system of hospital biomedical liquid waste & its mandatory compliance with Regulatory Notification of Bio-medical waste (Management & Handling) Rules, 1998, under Environmental Protection Act-1986, Ministry of Environment and Forestry, Government of India. In accordance with rules, every hospital generating liquid BMW needs to set up requisite treatment facilities of BMW in site. Here we have carried out detailed field study for liquid bio-medical waste in selected HCE's for quantification and characterization of liquid medical waste streams from the different facilities *i.e.* operation theatre laboratories *etc*. Also study the existing wastewater management system of these selected HCE's. To assess the feasibility of discharging the liquid bio-medical waste into sewer, with or without treatment and if treatment is required then use the techno-viable treatment schemes for HCE's.

Keywords: *Biomedical waste, Health care establishment, Effluent treatent plant*

Introduction

Bio-medical waste has become a major concern world over as it poses serious environmental hazards. The collection and disposal of bio hazardous liquid can pose a significant risk and occupational challenge to hospital staff as microbial content in this waste may contain significant pathogens. Occupational risks associated with working in Health Care Establishments (HCE's), need to take proper precautions in handling any material from these centers. In India, very little has been done in the area of BMW management so far Notification (1998). Regulations for management of BMW are different all over the world but the risk of exposure is almost same for health care workers. The comprehensive interim policy has been developed to provide standards and guidelines for collection, storage, handling, treatment and disposal of BMW along with safety and precautionary measures for all HCE's in western countries.

Author's Address

School of Studies in Environment Management
Vikram University, Ujjain, M.P. (India)
E-mail: parag.ujn@gmail.com, paragdalal@rediffmail.com

However in Indian legislative framework there is no comprehensive guideline for occupation health and safety aspect.The scope of study is limited to Bio-medical liquid waste management as per Biomedical Waste (Management and Handling) Rules, 1998 prescribed by CPCB. The present study was undertaken with following objectives:-

To identify common type of HCE's existing and clubs them into broad categories.

To carry out detailed field study for liquid bio-medical waste in selected HCE's for quantification and characterization of liquid medical waste streams from the different facilities *i.e.* operation theatre, laboratories *etc*.

To study the existing wastewater management system of selected HCE's and also to analyze the efficacy of the ETP's, if existing.

To assess the feasibility of discharging the liquid bio-medical waste into sewer, with or without treatment.

To come out with the techno-viable treatment schemes for HCE's, if the treatment is required.

To recommend comprehensive wastewater management system for HCE's.

Quantification and Characterization of Liquid bio-medical waste-detailed field study.

The detailed field studies of selected HCE's were conducted to generate base line data on water use pattern, wastewater generation and characterization of wastewater streams from different streams/sections of the establishment and the existing liquid BMW management system.

Quantity of wastewater generated was assessed by interacting with concerned medical staff and on site assessment by knowing actual washing duration and pattern. An assessment was made regarding the feasibility of discharging of liquid waste to the sewer with or without treatment so that it meets the prescribed discharge standards.

Materials and Method

Main Sources of Liquid Bio-Medical Waste

It is the waste which is generated from the different sources from the HCE's as given in Table 1

Table-1: Sources of Bio-Medical Liquid Waste Generation

S.No.	Section	Source
1.	Microbiology lab	Spent savalon solution used for soaking vials Wastewater during vials washing Wastewater during bottle washing Wastewater during dish washing
2.	Operation theatre	Wastewater during scrubbing and instrument washing Body fluids generated during operations Wastewater from bleach wash of clothes used in operation theatre
3.	Bio-chemistry lab	Wastewater generated during the testing Wastewater generated during instrument washing
4.	Blood bank	Hypo solution used in disinfecting of used syringes
5.	Histo-pathology lab	Spent formaldehyde solution Spent alcohol solution Spent acetone solution Spent xylene solution Spent dye solution

Hazards from Liquid Waste

Contaminated liquid is produced by wards treating patients with enteric diseases and is a particular problem during outbreak of diarrhoea disease. Radioactive isotopes from oncology department could cause risk to human health, ehen found its way to sewer etc, but can be minimized by suitable measures. The toxic effect of any chemical pollutant in liquid waste can cause retardation of the active bacteria in sewage purification process which may give rise to additional hazards.

Legislative Framework for Liquid BMW

As per the BMW Rules, 1998 and amendment there of all liquid medical waste must be disinfected by chemical treatment using at least 1% hypo-chlorite solution or any other equivalent chemical reagent before discharge in to drains, CPCB (2000). The liquid chemical waste should be neutralized before discharged into drains. According to schedule-III of above rules, standards for effluent generated from hospital are as below:-

Table-2: Standards for effluent generated from hospital

Parameters	Permissible Limit
pH	6.5-9.0
Suspended solid	< 100 mg/l
Oil & grease	< 10 mg/l
BOD	< 30 mg/l
COD	< 250 mg/l
Bioassay test	90% survival of fish after 96 hrs

These limits are applicable to those hospitals, which are either connected to sewers without terminal sewage treatment plant or not connected to public sewers U.S. Environment protection agency (1986).

Treatment of Wastewater

In modern society proper management of wastewater is a necessity, not an option. Wastewaters are usually classified as industrial wastewater or municipal wastewater. Many industrial wastewaters require pre-treatment to remove non-compatible substances prior to discharge into the municipal system. Characteristics of industrial wastewater vary greatly from industry to industry and consequently, treatment processes for industrial wastewater also vary. A wastewater treatment system is composed of combination of unit operations and unit processes designed to reduce certain constituents of wastewater to an acceptable limit. The treatment systems are often divided into primary, secondary and tertiary systems.

Pre-Treatment of Wastewater

This stage is the key to the whole management process, because at this stage wastes are segregated into infectious and non-infectious, thus minimizing the risks to staff and public as well as resources used for the treatment purpose. Segregation of waste allows special attention to be given to the relatively small quantities of wastes.

Segregation starts mainly with doctors and nurses, and therefore they should be made aware of the important responsibilities that lies upon them.

The containers for storing segregated waste should be clearly identifiable. The best system is to use colored plastic bags/containers. The color coding and types of containers shall be followed as per the schedule II of Bio-medical Waste (Management & Handling) Rules, 1998, MoEF, (1998).Sharps need special attention while segregating and storing because needles can act as reservoirs of pathogens in which the pathogens may survive for a long time because of the presence of blood, and also that the sharps can provide a direct route into the bloodstream by puncturing the skin. Syringe and needles should be damaged before putting into the containers, so that rag pickers cannot collect them for the purpose of resale, which may get recycled at some later stage. Sharps must always be kept in puncture-proof containers to avoid injuries and infection to those handling them.Plastic bags for storing the waste may be suspended inside a frame or be placed inside a study container. A lid should be provided to cover the opening of the bag at the top. Every room such as ward, laboratory, operation theatre, etc. should have containers/bags for the types of wastes that are generated in that room. In all rooms except isolation wards there should be a container for general waste. All wastes from isolation wards should be regarded as infectious waste. Each container may be clearly labeled to show the ward or room where it is kept. The reason for this labeling is that it may be necessary to be able to trace the waste back to its source. For example, if a porter is injured by a syringe or blade that has been put into a bag rather than into the correct sharps container, it is possible to determine the origin of that waste and identify the member of staff who was responsible for that ward. It may also help in knowing the type of infection that may have been transmitted.

Primary Treatment of Wastewater

The purpose of primary treatment is to remove solid materials from the incoming wastewater. Large debris may be removed by screen or may be reduced in size by grinding devices. A typical primary system should remove approximately one-half of the suspended solids in the incoming wastewater. Wastewater contains a wide variety of solids of various shapes, sizes and densities. Effective removal of these solids may require a combination of unit operations such as screening, grinding and settling.

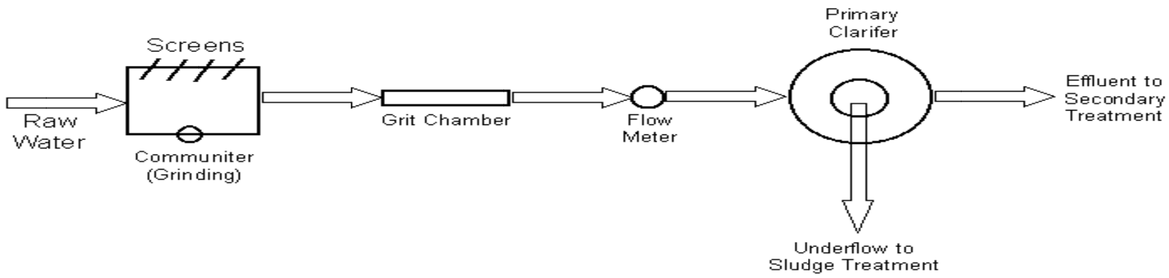


Fig. 1: Primary Treatment of Waste Water

A) Screening Screening devices are used to remove coarse solids from wastewater. A coarse solid consists of sticks, rags, boards and other large objects. Wastewater screens are classified as fine or coarse, depending on their construction. Coarse screens usually consists of vertical bars spaced 1 or more cm apart and inclined away from the incoming flow. Fine screens usually consist of woven-wire cloth or perforated plates mounted on a rotating disc or drum partially submerged in the flow, or on a traveling belt. Screening devices are contained in rectangular channels that receive the flow from the collection system. Proper ventilation must be provided to prevent accumulation of explosive gases. Hydraulically, flow velocity should not exceed 1m/s (3.3ft/s) in the channel. Clean bars and screens result in a head loss of less than 0.1m. The quantity of solids removed by screening depends primarily on screen opening size. Screened solids are coated with organic material of a very objectionable nature and should be promptly disposed of to prevent a health hazard Gayatri *et al.* (2004).

B) Grit Removal Wastewater consists a wide assortment of inorganic solids such as pebbles, sand, silt, eggshells, glass and metal fragments. Most of the substances in grit are abrasive in nature and will cause accelerated wear on pumps and sludge-handling equipment with which it comes in contact. Grit deposits in areas of low hydraulic shear in pipes, sumps and clarifiers may absorb grease and solidify. Grit removal facilities basically consist of an enlarged channel area where reduced flow velocities allow grit to settle out. The deposited grit is removed by mechanical scrapers. Hydraulically, grit chambers are designed to remove, by type-1 settling, discrete particles with diameters of 0.2 mm and specific gravity of 2.65. Since a wide variation in flow rates may be encountered, the horizontal velocity must be artificially controlled. In larger treatment plants, the trend is toward aerated grit chambers. Turbulence created by the injection of compressed air keeps lighter organic material in suspension while the heavier grit falls to the bottom. Adjustment of air quantities provides settling control. If the sewage is anaerobic when it arrives at the plant, aeration serves to strip noxious gases from the liquid and to restore it immediately to an aerobic condition, which allows for better treatment. Grit, particularly from channel-type grit chambers, may contain a sizeable fraction of biodegradable organics that must be removed by washing.

Secondary Treatment of Wastewater

The effluent from primary treatment still contains 40 to 50% of the original suspended solids and virtually all the original dissolved organics and inorganic. To meet the minimum EPA standards for discharge, the organic fraction, suspended and dissolved, must be significantly reduced. This organic removal, referred to as secondary treatment, may consist of chemical-physical processes or biological processes. Combinations of chemical-physical operations such as coagulation, micro screening, filtration, chemical oxidation, carbon adsorption, and other processes can be used to remove the solids and reduce the BOD to acceptable limits.

In biological treatment, microorganisms use the organics in the wastewater as a food supply and convert into biological cells, or biomass. Because wastewater contains a wide variety of organics, a wide variety of organisms, or a mixed culture, is required for complete treatment. Most mixed cultures also contain grazers, or organisms that prey on their species. The microorganisms involved in wastewater treatment are essentially the same as those that degrade organic material in natural freshwater systems Singh and Sharma (1996).

Activated Sludge Process – The process derives its name from the fact that setteled containing living or active, microorganisms is returned to the reactor to increase the available biomass and speed up the reactions. The process is aerobic, with oxygen being supplied by dissolution from entrained air.
The rate at which oxygen is consumed by the microorganism in the biological reactor is called the oxygen utilization rate. For the activated sludge process, the oxygen utilization rate will always exceed rate of natural replenishment, thus some artificial means of adding oxygen must be used. With the exception of the pure oxygen system, oxygen is supplied by aerating the mixed liquor in the biological reactor. Aeration techniques consist of using air diffusers to inject compressed air into the biological reactor and/or using mechanical mixers to stir the contents violently enough to entrain and distribute air through the liquid.

Tertiary Treatment of Wastewater

The secondary effluent will probably contain at least 20mg/l suspended organic matter, which is to high for efficient disinfection. It should therefore be subjected to tertiary treatment, such as lagooning, if no space is available for creating a lagoon, rapid sand filtration may be substituted to produce a tertiary effluent with a much reduced content of suspended organic matter (< 10 mg/l).

A) Disinfection The disinfection of wastewater is usually required where portions of the effluent may come in contact with humans. Chemical oxidants are generally considered the most effective disinfectants, with required dosages being much higher than those used for cleaner water. Chlorine is the most common disinfectant in use.

B) Chlorine Disinfection To achieve pathogen concentration comparable to those found in natural waters, the tertiary effluents would be subjected to the breakpoint. This may be done with chlorine dioxide, sodium hypochlorite or chlorine gas. Another option is UV light disinfection.

C) Lagooning In a region or a regular health care establishment that cannot afford sewage treatment plants, a lagooning system is the minimal requirement for treatment of wastewater. The system should comprise two successive lagoons to achieve an acceptable level of purification of bio-medical sewage. Lagooning may be followed by infiltration of the effluent into the land, benefiting from the filtering capacity of the soil.

General Preservation Schemes

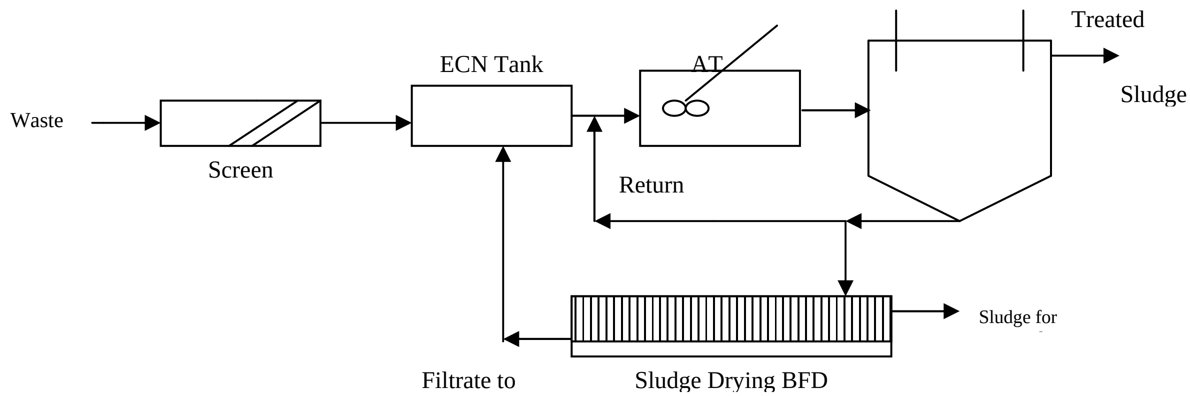
To minimize the potential for volatilization or biodegradation between sampling and analysis, keep samples as cool as possible without freezing. Avoid using dry ice because it will freeze samples and may cause glass containers to break. Keep composite samples cool with ice or a refrigeration system set at 4˚C during composting. Analyze samples as quickly as possible on arrival at the laboratory. Use chemical preservations only when they are shown not to interfere with the analysis being made. When they are used, add them to the sample bottle initially so that all sample portions are preserved as soon as collected. Because a preservation method for one determination may interfere with another one, samples for multiple determinations may need to be split and preserved separately.
Methods of preservation are relatively limited and are intended generally to retard biological action, retard hydrolysis of chemical compounds and complexes and reduced volatility of constituents Acharya and Singh (2000). Preservation methods are limited to pH control, chemical addition, and the use of amber and opaque bottles, refrigeration, filtration and freezing.

Activity Description

The study was undertaken with the objective to quantify and characterize liquid medical wastewater from different facilities so as to assess the wastewater treatment requirement.

Results and Discussion

The body suction fluid should be disinfected before being discharged to the drain.



It is recommended to put more bleach during the bleach wash of clothes in operation theatre. It will not only reduce the MPN, COD and BOD values of the wastewater but also improve the bleaching of the clothes.The wastewater from the bio-chemistry lab should be disinfected before being discharged to the drain.

It is recommended to avoid the discharge of spent formaldehyde, alcohol, acetone, xylene and dye solutions to the drain as these solutions will render very high COD and BOD values to the wastewater. Since the quality of solution is very less, these solutions may be incinerated at scientifically designed incinerator Baveja *et al*. (2000).

Effort may be made to reduce the quality of wastewater generation in the laundry section. From the table given above, it can be seen that the final outlet wastewater is already complying with the applicable sewer discharge standards having terminal ETP, thus the wastewater can be discharged to municipal sewers without any further treatment. However, since the MPN value for the wastewater is quite high it is recommended to have an arrangement for disinfecting the wastewater before being finally discharged into sewer.

However, in case the sewer is not connected with the terminal ETP, the wastewater doesn't comply with the standard. Therefore the total wastewater from the entire hospital, including general wastewater (kitchen, toilets etc), is required to be treated to meet surface water discharge standards. The proposed treatment scheme for the total wastewater is as given below.

A) Screening – Wastewater should be passed through screens from different sources to remove particles larger than the screen size. The coarse screen should be placed nearer to the source of generation and the fine screen should be placed in the combined drain of all sources.

B) Equalization Tank – The wastewater from different sources should be passed into an equalization tank to homogenize the waster characteristics. Residence time of one day needs to be provided for homogenizing characteristics of the wastewater.

C) Activated Sludge Process (extended aeration system) Aeration tank – The wastewater from equalization tank has to be pumped into an aeration tank.

The wastewater needs to be aerated using surface/diffused aerators to supply oxygen for the respiration and growth of bacteria. The aeration should ensure dissolved oxygen content between 1-2mg/l to enable growth of bacteria and help flocculate and settlement of sludge. Residence time of 4hrs should be provided for the wastewater. MLSS in the range of 3500 mg/l has to be maintained in the tank.

Settling tank/clari-flocculator – The biodegraded wastewater from aeration tank has to be passed into a settling tank or clari-floccculator. The supernatant from settling tank will overflow as treated wastewater. The bottom sludge will be pumped out. Part of the sludge pumped will be recycled for maintaining MLSS in aeration tank. When the MLSS exceeds the design limit the excess sludge should be disposed of into sludge drying bed.

Sludge drying bed – The excess sludge should be disposed into a sludge drying bed for solar drying. Once the sludge is dried it has to be removed and the bed prepared for disposing another batch of sludge. Typical drying times for sludge may vary between 4-7 days at accordingly number of beds should be provided.

Conclusion

At present in most HCE's the wastewater generated from different sources is directly (after disinfections) discharged into municipal sewer without segregation at source.Waste water characteristics shows two broad trends:

High volume and low concentration

Low volume and high concentration

The glassware and other sample testing apparatus are disinfected with hypo cleaned with (germicide) washed with soap solution before being reused.

This washing activity leads to generation of high amount of wastewater.

The wastewater from X-rays ultrasound laboratories arises from developed and fixer spent solution .The fixer spent solution is sold out for extraction of silver but the developer spent solution is discharged in drain, which is low in volume and high in strength.

In OPD the wastewater arise from needles; gloves washing etc. in tap water and some components are dipped in 1% hypochlorite solution for 3-4 hrs before washing in tap water.

The wastewater from the laboratories of manufacturing drugs, vaccines etc have high pollution load.

There is lack of awareness regarding proper waste management among health care professional.

References

Acharya, D.B. and Singh, Meeta, 2000. The book of Hospital Management. Minerva Press, New Delhi 15,47.

Baveja, G, Muralidhar, S. and Aggrawal, P., 2000. Hospital Waste Management – an overview Hospital ***Today*** 5 (9), 485-486.

CPCB, 2000. "Guidelines on Boi-Medical Waste Management" Central Pollution Control Board,New Delhi.

Gyaathri, V. Patil and Kamala, Pokhrel, 2004. "Boimedical Solid Waste managrment in an Indian hospital a case study". Jr of Waste Management XXX-XXX, A Belgaum, http://www.indnav.com, download on 05-04-2004.

MoEF, 1998. "Bio-Medical Waste (Management Handling) Rules, 1998" Ministry of Enviroment & Forest, New Delhi.

Notification : Bio-medical Waste (Management and Handling) Rules, 1998. *Ministry of Enviroment and Forests*, GOI (E), part 3(ii), New Delhi, 27-07-1998.

Singh, I.B. and Sharma, R.K., 1996 ."Hospital Waste Disposal System and Technology" *Jr. of Academy of Hospital Administration,* July: 8(2)44-8.

U.S. Enviromental Protection Agency, 1986. *EPA Guide for Infectious Waste management Office of Solid Waste and Emergency Response*, Washington, D.C. EPA 530-SW-86-014.