Assessment of Biomedical Waste Generation, Treatment and Disposal Technology in Jabalpur City

Ankit Koshta[1], Dr. Shailza Verma[2], M K Koshta[3]

1 Research Scholar, Department of Civil Engineering, JEC Jabalpur

2 Assistant Professor, Department of Civil Engineering, JEC Jabalpur

3 Associate Professor, Department of Civil Engineering, JEC Jabalpur

Abstract: **The biomedical waste increases day by day due to increase in population results in increased number and sizes of hospitals and pathology labs as well as increased use of disposable medical products etc. The hospital wastes are infectious wastes which if not properly treated and disposed of pose a great health risk. Besides it may lead to environmental pollution and resulting the scarcity of natural resources. Across India, more than 4.2 lack kg of biomedical waste is generated everyday but only 2.4 lack kg of this waste is scientifically treated. India has 84,809 hospitals and other healthcare facilities but only 48, 183 use either common biomedical waste treatment facilities or engage private agencies to treat their waste. Jabalpur city has been selected as a Smart City in the list of 98 Smart Cities. According to the purpose of the Smart Cities mission is to drive economical growth and improve the quality of life of people by enabling local area development and harnessing technology, especially technology that leads to smart outcomes. In present Jabalpur more than 250 small and medium size healthcares established but only 146 health care centers are disposed their waste to (CBMWTF) which is covered 198 healthcare waste from Jabalpur and Katni city. This paper makes an attempt by giving idea about biomedical waste generation in Jabalpur and technology used for their treatment and identifying lacking of present technology and the alternate technology option for common bio medical waste treatment plant.**

Keywords: **Biomedical Waste Management; Generation; Treatment and disposal Technology.**

I - INTRODUCTION

Biomedical waste is any matter (solid, fluid or liquid) including container and any intermediate product, which is generated throughout diagnosis, treatment or vaccination of person or animals or in research activities or in the production or testing thereof. Biomedical waste is infectious, hazardous waste due to potentially high risk to human health and environment. Sometime this waste is disposed with municipal solid waste. The biomedical waste increases day by day due to increased number and sizes of hospitals and pathology labs as well as increased use of disposable medical products.

Amar dhere et.al. 2011 reported a survey across India more than 4.2 lack kg of biomedical waste is generated every day but only 2.4 lack kg (57.14%) of this waste is scientifically treated and remaining waste are mixed with municipal waste. India has 84,809 hospitals and healthcares facilities but only 48,183 use either common biomedical waste treatment facilities or engage private agencies to treat their waste.

Hassan et. Al.2008 reported a survey on Bangladesh HCE generate a total of 5,562 kg/day of wastes, of which about 77.4 per cent are non-hazardous and about 22.6 per cent are hazardous. The average waste generation rate for the surveyed HCE is 1.9 kg/bed/day or 0.5 kg/patient/day. The study reveals that there is no proper, systematic management of medical waste except in a few private HCE that segregate their infectious wastes. Some cleaners were found to salvage used sharps, saline bags, blood bags and test tubes for resale or reuse.

Bio-medical waste management law-

According to Ministry of Environment and Forest, Environmental Protection act 1986, Biomedical Waste Management Guidelines were introduced. The silent features of these guidelines are as follows:-

- These rules apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle bio medical waste in any form.
- Bio-medical waste means any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production or testing of biological.
- It shall be the duty of every occupier of an institution generating biomedical waste which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank by whatever name called to take all steps to ensure that such waste is handled without any adverse effect to human health and the environment.
- Biomedical waste shall be segregated into containers/bags at the point of generation in colour

coding container prior to storage, transportation, treatment and disposal. The containers shall be labeled as non-washable and prominently Biohazard waste visible mark.

- No untreated biomedical waste shall be kept stored beyond a period of 48 hours.
- Bio-medical waste shall be treated and disposed according to nature of waste as schedule I , which gives standards for different technologies for their treatment.

Central Pollution Control Board brought out technical guidelines manuals for hospital waste management in 2000, and revised in 28th march 2016, it gives guidance for bio-medical waste segregation, storage, transport and treatment. The CPCB manual gave special emphasis to incineration, covering incinerator emissions, maintenance requirement, and operation problem & solution and pollution control system.

Central Pollution Control Board also gave guidelines for Common Bio-medical waste treatment facilities sets out requirement for location, land requirement, coverage area, treatment equipments, infrastructure setup, record keeping, Collection and Transportation of Bio-medical Waste, Disposal of Solid Waste, Cost to be Charged by the CBWTF Operator from the HealthCare Units and other operation issues.

II - CLASSIFICATIONS OF BIO-MEDICAL WASTE

According to nature the biomedical wastes is classified in two categories. These are non-hazardous and others are hazardous in nature. It is required to treat and dispose according to their nature. The disposal of waste would be easier when it is segregated according to their categories. It has been mentioned under the Bio-Medical Waste Rules (1998). When the wastes are classified and segregated for treatment and disposal it would be necessary and helpful to place it in particular type of container for disposal. About 75-90 percent of the bio medical waste is non-hazardous and harmless as any other municipal waste. The remaining 10-25 percent differs waste can be injurious to health and harmful to the environment. If both wastes are mixed together then the entire lot becomes harmful.

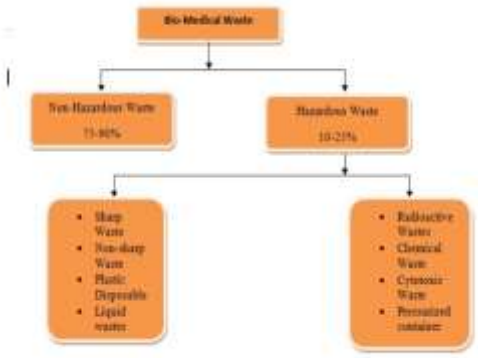

Fig 1 Classification of Bio Medical Waste

MATERIALS AND METHODS

The information and data on waste generation, disposal, and storage, transportation, and treatment facilities, and the problems faced by the waste management staffs in the hospitals was collected from the hospital records and during field visits in CBMWTF centre in Jabalpur city. The general information about the some randomly selected hospitals was also taken. The biomedical waste generated has been calculated with the obtained data. Data entry and analysis was done in Microsoft Excel 2010.

Quantity of Bio Medical Waste Generation-

The quantity of waste generated in a hospital depends on the national income and the type of facility provided by concerned. In a high earnings nation state a University Hospital can produce up to 4-9 kg of waste/bed/day and at General and District hospital it ranges from 1-4kg of waste/bed/day. (Ahmed et all 2014)

In the Madhya Pradesh total more than 2845 health care facilities are established and they are average generated waste is 7136 kg/day (CPCB, 2014) Figure 2(a) and 2 (b) presents the quantity of waste generated in Madhya Pradesh from the year of 2011 to 2014. It can be seen that total waste generated has been increased from 5645 Kg/day to 8355 kg/day whereas presents the quantity of waste generated per bed has been reduced from 175.36 gm per day to 135.07 gm per day.

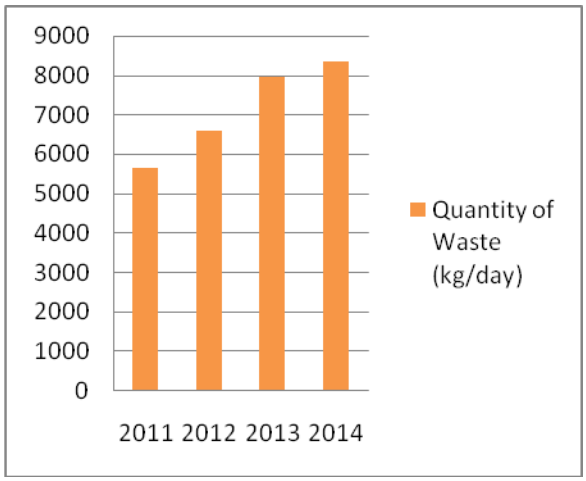

Fig 2(a) Quantity of BMW generated in MP

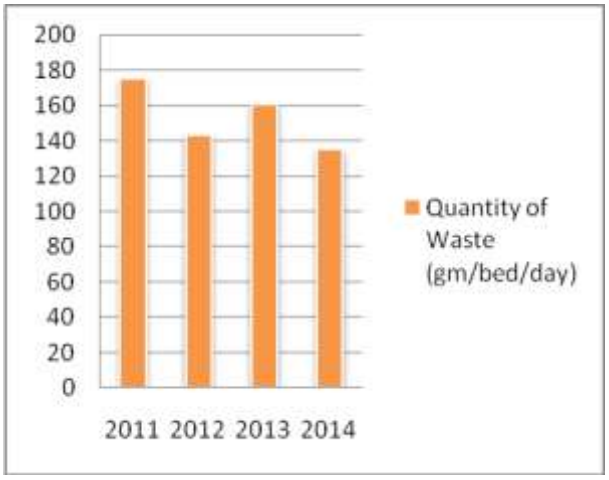

Fig 2(b) Quantity of BMW generated in MP

Case Study

Jabalpur is a district of Madhya Pradesh state. It comprises of 1 hospital of more than 500 beds, 2 hospital of bed strength between (200-500) beds, 14 hospitals of bed strength (50-199), 67 hospitals of (0-49) beds and other 75 healthcares institution generated waste like blood bank, pathology, nursing home, dispensary. The objectives of the present study included probing quantity of waste generated. Table 1shows the classes of healthcares according to bed strength.

Category of healthcare	No of Beds	No of health cares
Class-A	> 500	1
Class-B	200-500	2
Class-C	50-200	14
Class-D	0-50	56
Class-E	Other	73
Total		146

Fig 3(a) show the quantity of waste generated in 2015 by Class-A, Class-B, Class-C, Class-D and Class-E types healthcares in which Class-A generated 145.44 kg/day waste, Class-B generated 109kg/day, Class-C generated 285 kg/day, Class-D generated 201 kg/day and Class-E generated 75kg/day. It is observed that in Class-C type healthcares waste generation rate is higher than other classes in Jabalpur.

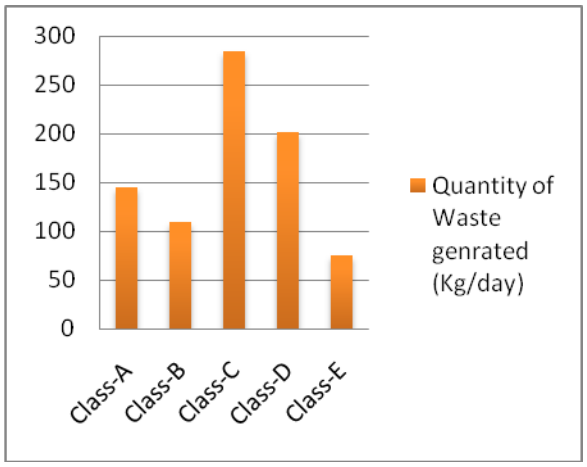

Fig 3(a) Quantity of BMW generated by different classes of healthcares in 2015

Fig 3(b) show the quantity of waste generated in 2016 by Class-A, Class-B, Class-C, Class-D and Class-E types healthcares in which Class-A generated 159.99 kg/day waste, Class-B generated 110kg/day, Class-C generated 282 kg/day, Class-D generated 203.4 kg/day and Class-E generated 74kg/day. It is observed that in Class-C type healthcares waste generation rate is higher than other classes in Jabalpur.

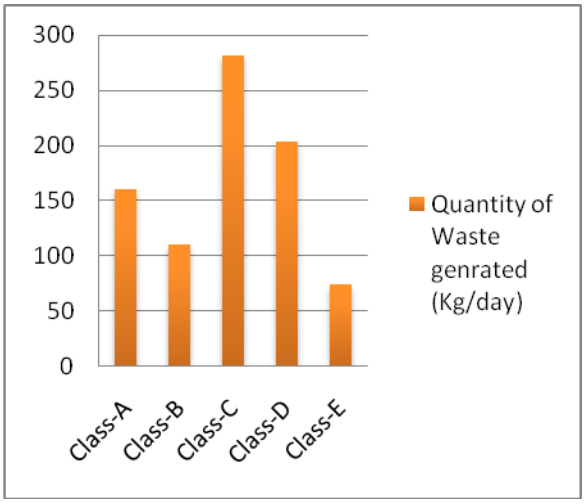

Fig 3(b) Quantity of BMW generated by different classes of healthcares in 2016

Present scenario of BMW Treatment and Disposal

At Jabalpur city a CBMWTF was established which is 1 km near from the residential and sensitive area. In order to provide all the requisite systems, CBMWTF has a built up area of around 3200 sq. ft. with a land area of 1 acre. The initial cost of construction was around 3 lacks. CBMWTF charges Rs.95/bed/month to hospitals. There are some techniques are presently followed by CBMWTF at Jabalpur are:

1. *Waste Collection and Transportation*

At present Jabalpur Elite Engineers (CBMWTF) covered 159 health care facilities from Jabalpur and Katni which collected treated and disposed 862 kg waste per day of Biomedical Waste (BMW) using three mini trucks. It starts to collect the wastes around 6.00 am and returns around 5.00 pm daily. Truck having separate cabins is 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 hrs as per Bio-medical waste (Management and Handling) Rules 1998. But some time due to holidays waste is collected after 48 hrs.

2. *Segregation of Waste*

The waste received from HCF are not properly segregated so CBMWTF disinfect the waste in the autoclave and then led for the segregation of rubber, glass, plastics and metals in buckets as shown in Figure 4 About 6 laborers are involved in the segregation and they are working 6 hours a day. As per regulation, T.T injection is given and medical checkup 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.

Fig 4 Bins for segregated Waste

3. *Disinfection by Autoclave*

An autoclave is a pressure chamber to thermally disinfection and sterilization of reusable medical wastes. It is design for treatment by steam into direct contact with waste, in a control manner and for sufficient duration to disinfect the waste. The microorganism culture which does not survive beyond 80°C. However, Ministry of Forest and Environment (MoEF) has stipulated a temperature of 135° C and 31 psi pressure for a vacuum autoclave. To ensure disinfection, 30-35 minutes sterilization time is required. CBMWTF has pre vacuum type autoclave of 250 kg/cycle capacity. 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.

4. *Shredder*

The segregated plastics like syringes are shredded by means of the Shredder. 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. Figure 3 shows the flow diagram for autoclaving, segregation and shredding.

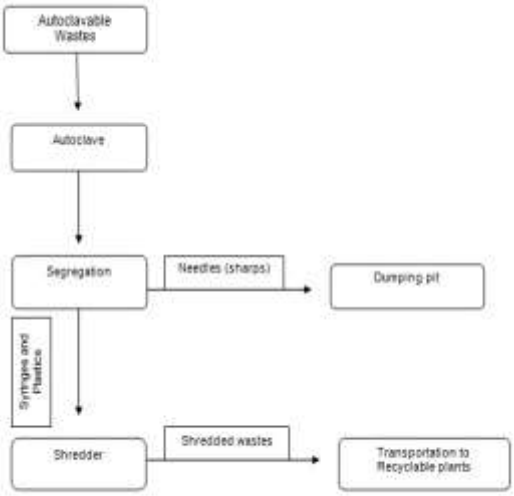

Figure 5 Flow diagrams for autoclaving, segregation and shredding

5. Incineration

Incineration is a high temperature dry oxidation process that reduces organic and combustible waste to inorganic, incombustible matter and results in a very significant reduction of waste volume and weight. The CBMWTF has the incinerator of capacity 100kg/hr. It has a double chamber direct flame with the working temperature of 850°C and 1050°C. The waste loading is manually done in the plant. 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 liters of diesel and whenever power shutdown exists, it consumes 150 liters of diesel. Figure 4 shows the unit operations of the incinerator existing in CBMWTF. The incineration should follow the guidelines of air emission standards and should be measured and monitored frequently.

.

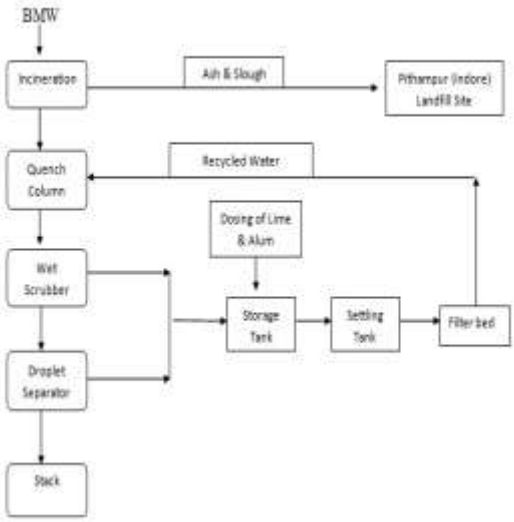

Figure 6 Unit operations of the incinerator existing in CBMWTF

5. Equalization tank

The facility has an Effluent treatment Plant (ETP) with the inclusion of an equalization tank 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 re circulated into the scrubber after cleaning their particulates.

Problems in present BMW Management System

As per the guidelines the waste should be segregated and collected in different dustbins at the source itself according to the given colour coding. During the field visits it was found that waste are not segregated and collected in many hospitals. If we mix the hazardous and non-hazardous waste, the 100% waste becomes hazardous. Further it may affect the health of the workers segregating it at CBMWTF. 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.

The incinerator is used to burn the waste, but it may have significant air emission control problems, There is a possibility of the survival of pathogens if the incineration is incomplete or done at low temperature. According to a study by Nema and Ganeshprasad (2002) Airflow that is in excess of the stoichiometric requirement for combustion is essential for the incinerator to enhance the combustion process. The demand for excess airflow limits the temperature that is achievable. Due to

insufficient temperature generated in the process chamber, incinerators produce extremely toxic products like furanes and dioxins. This can cause air pollution or the toxic pollutants can remain in the bottom ash, eventually finding their way into landfills. Therefore there is a need of an environment friendly technology which changes organic waste into commercially useful product.

A number of technologies have been compared and presented in **Table 2.** There are various alternative technologies for the treatment and disposal of biomedical waste useful for hospitals and health care settings. However, they are costly but cost effective if continuously process with high productivity. In the present study a plasma pyrolysis technology is suggested for safe disposal of medical waste. It is an environmental friendly technology, which change organic waste into commercially useful product.

Plasma Pyrolysis – It is a technology for safe disposal of medical waste, it is an smoke free environmental friendly technology, which change organic waste into commercially useful product. The illustrate heat generated by plasma enables it to dispose all type of waste including municipal waste, bio medical waste in a safe manner. Medical waste is pyrolysed in to CO, H_2, and hydrocarbons when it comes in contact with plasma arc and these gases burned and produce high temperature. The heat produced is used as an additional heat source in this process. It is a high-heat thermal process operates at temperature ranging from 540° C to 8300° C or high temperature. This temperature changes physical and chemical destruction of waste and reduce mass and volume also. Also due to compact size it can be used in small premises.

Result and Conclusion

The present work shows that the biomedical waste treatment and disposal are done by CBWTF at Jabalpur. As per the data of CBWTF, the waste treated and disposed are 817 kg/day from the 146 healthcares of Jabalpur city in the year of 2016. The healthcares of the city generate 0.2 kg/bed/day. It may be noted that there are so many hospitals not sending the BMW waste to the CBMWTF and throw it in the open area, which is very infectious and dangerous o the public health and animals also. It is found that all the waste management activities like collection, segregation, transportation; treatment and disposal need to be done as per the guidelines.

In the present technology some improvements are needed such as segregation should be done the source of generation, containers of recommended colours with proper labelling and marking of infectious waste should be used for different types of wastes. Proper measuring and monitoring of waste should be done at source itself. Presently incineration is used by the CBMWTF at Jabalpur city which may have some problem of air pollution and pathogens. In the present study an environmental friendly plasma pyrolysis technology is suggested for safe disposal of medical waste. More research will be needed to improve the policy of waste management practices and its quality control system.

Table 2 comparisons various alternative technologies for the treatment and disposal of biomedical waste

Treatment Systems	Autoclaves	Incineration	Chemical	Plasma
Description	Steam Sterelization (direct handling)	High temperature waste incineration	Mixing preground waste with chemicals, such as chlorine	Electronic plasma mass exchange
Sterilization Efficacy	Mediaum	High	Depend on Chemical strenght and dispersement through the waste	High
Capital cost	Low	High	Moderate	High
Operating Cost	Low	High	Low	High
Operator maintenance skills	Low Skill level required	High level operator and maintanace skill required	high level required for chemeical control and grinder	Low level operator and high skill
Enviromentally	Odorous but non toxis gases	Can be highly toxic	some chlorine emission	No odorous and no toxic
Waste suitability	All waste except body-part organs, drugs, incuneration ash	All waste except body-part organs, drugs, incuneration ash	All waste except body-part organs, incuneration ash	All waste except body-part organs, drugs, incuneration ash
Treated waste characteristics	Wet waste, all material recognizable	Mostly ash, may contain toxic substances	shredded wet waste, containing chemicals used as disinfectants	Wet waste, all material recognizable
Ecologically	Re useableWaste	Infection waste, non reuseble	Infection waste	All waste
Water Requirment	No	Yes	Yes	No
Volume Reduction	NO	80% of volume	No	80% of volume

References

1. Government of India, Ministry of Environment and Forests " Bio-Medical Waste (Management and Handling) Rules Gazette of India. 1998 (27 Jul)". Available from:http://envfor.nic.in/legis/hsm/biomed.html
2. B. Ramesh Babu(2008) "Management of Biomedical Waste in India and Other Countries: A

Review" J. Int. Environmental Application & Science, Vol. 4 (1): 65-78 (2009)

3. Amar Dhereb (2011) " Biomedical waste management : A Case Study of Y.C.M. hospital, Pimpri-Chinchhwad, Pune" 2nd National Confrence on urban, Industrial & Hospital(2011)
4. Zarook M. Shareefdeen " Medical Waste Management and Control" Journal of Environmental Protection, 2012
5. WHO, (The World Health Organization), "Waste Man-agement at Medical Centers," 2010. http://www.who.or.id/eng/contents/aceh/wsh/books/es/ES08CD.pdf
6. Madhya Pradesh Pollution Control Board, "Handling of Bio-Medical Waste," 2010. http://www.mppcb.nic.in/Bio_Categories.htm
7. Patil G.V., and Pokhrel K., (2004) "Biomedical solid waste management in an Indian hospital: a case study. *Waste management* 2(5),592-599.
8. M. M. Hassan, S. A. Ahmed, K. A. Rahman and T. K. Biswas, "Pattern of Medical Waste Management-Existing Scenario in Dhaka City, Bangladesh," *BMC Public Health*, Vol. 8, 2008, p. 36
9. Himabindu P. A et all (2015) "A Critical Review on Biomedical Waste and Effect of Mismanagement" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 IJERTV4IS030179 www.ijert.org Vol. 4 Issue 03, March-2015
10. Ahmed N. O., Gasmelseed G. A., and Musa A. E. (2014) Assessment of Medical Solid Waste Management in Khartoum State Hospitals, Journal of Applied and Industrial Sciences, 2 (4), pp 201-205
11. S. K. Nema* and K. S. Ganeshprasad "Plasma pyrolysis of medical waste'

