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Biomedical Waste Management- Current Practices and Future Prospective in Urban Area

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ABSTRACT: Inadequate Bio-Medical waste management so can cause environmental pollution, unpleasant smell, growth and multiplication of vectors like insects, rodents and worms and will cause the transmission of diseases like infectious disease, cholera, infectious disease and AIDS through injuries from syringes and needles contaminated with human. Effective BMW management (BMWM) is obligatory for healthy humans and cleaner setting. this text reviews concerning varied Bio- medical waste generated in ward No181 & ward No 182 of Bruhath Bengaluru Mahanagara Palike (BBMP) and adopting correct technical possibility to treat Bio-medical waste at supply to boost the segregation, transportation, and disposal ways, to decrease environmental pollution thus on modification the dynamic of BMW disposal and treatment.

The study was underneath taken in hospitals falling underneath metropolis town limits throughout the amount of March 2021 to Gregorian calendar month 2021. The study was a region of assessing overall system for waste management in hospitals and in varied clinics in metropolis town. The study space covers 1government hospital, 4private hospital & 6clinics.

By developing with acceptable technology for the generated BMW. Furnace is one in every of the most effective ways among varied disposal facilities to detoxify medical waste. Associate in Nursing furnace has been designed to treat the medicine waste that is being generated in metropolis town with a capability of one hundred kg/hr with double of operation viz. one within the morning and one within the evening.

Key Words: medicine Waste, Primary Health centre, furnace, segregation.etc

I. INTRODUCTION

1.1 General: Bio-medical waste is waste which including its contaminations and which is generated during the diagnosis, treatment or immunization of persons or animals or research activities. BMW waste may also be Harmful to citizens and environment. The hospital and clinics are generating huge amount of hazardous waste. It contains highly toxic chemicals, bacteria and pathogenic viruses. These causes severe problems for people and animals and also environment. To avoid the causes by using proper procedure for collection, segregation, transportation and disposal of dangerous waste

1.2 Types of Biomedical Waste

Infectious waste- bacteria, viruses, parasites, or fungi.
Pathological waste- blood, body fluids, tissues, organs, body parts, human fetuses, and animal carcasses
Sharps-, blades, knives needles, hypodermic needles, saws, broken infusion sets glass.

1.3 Types of Biomedical Waste Disposal

Waste disposal are going to be important when it involves to medical filed, because BMW waste will be contaminated with diseases or dangerous pathogens
1. Autoclaving
2 Incineration
3 Chemicals
4 Microwaving

Incineration is take into account to be one of the simplest method of safe disposal of BMW. All the hospital and clinic should involve a BMW plan and Rules2018

II. OBJECTIVES

- To quantify the Bio- medical waste generated in ward No181(K S LAYOUT) & ward No 182(PADMANABHANAGAR) of Bruhath Bengaluru Mahanagara Palike(BBMP) Bangalore city.

- To know the technical options adopted to treat Bio-medical waste at source.
- To design appropriate technology for the generated BMW.
- To know the impact of Bio-medical waste on Health & Environment.

III. METHODOLOGY

3.1 overview ;

In our study the primary step was to get prior permission from the health officers (BBMP South zone) which are having responsibilities in biomedical waste management issues. Information was gathered from Bio-medical waste cleaning staff in hospital and clinics that was collected from private hospitals, clinics and PHC.Quantitative information was gathered by direct measurement and qualitative information was gathered by interviews

3.2 PLACE AND DURATION OF THE STUDY

The study was under taken in hospitals falling under Bangalore city limits during the time of March 2021 to April 2021. The study was a element of assessing overall system for waste management in hospitals and in various clinics in KS LAYOUT & PADMANABHANAGAR, Bangalore city. The study area covers 1government hospital, 4private hospital & 6clinics.

3.3 METHODS OF COLLECTION OF INFORMATION (DATA)

1. Prior permission was obtained from the hospitals for the study.
2. The waste management practices were documented in step with a pre-tested observation checklist developed for this purpose. Observation was documented separately by interacting with the concerned health care personnel.
3. Data's regarding waste management practices were obtained from environmental/clinical staffs of the hospital and from Site observation.
4. The private hospital of bed strength 270 numbers has been selected for a case study which has following studies.

- Generation
- Collection
- Segregation and storage
- Transportation
- Treatment

5. Apart from the Private hospital the PHC together with clinics were studied to search out the bio-medical waste management.

The survey on bio-medical waste management was conducted during March 2021 to April 2021. Then survey was conducted using formats shown in the table below. The results obtained were analyzed and effects of biomedical wastes generated, collected and disposal were discussed as shown within the table 1

3.4. CURRENT PRACTICES

The following are the various current practices followed in Bangalore general hospital

1. Segregation of the waste at the source itself.
2. Separation of wastes by color coding.
3. Transport waste to disposal site by cleaning staffs.
4. Burial of number of the waste.
5. Final disposal by open burning and by incineration method.

Yellow Bag= human tissues, Body parts, cotton swabs bag containing residual blood or body fluids sanitary napkins.

Red Bag= Plastics, turbings, vacationers, catheters, IV sets, syringes body, gloves.

Blue Bag= Glassware, broken, discard & contaminated glass, metallic body implants.

White Bag= needles, cut glasses, scalpels. Nails, lancets, blades.

3.5. BIOMEDICAL WASTE DATA

Average wastes quantification in KS LAYOUT city covering 1government hospital, 4private hospital & 6clinics.

Total wastes generated per month= 5986.77 kg/month.

*Total wastes generated per day= 199.55kg/day

3.6.1 DESIGN OF PRIMARY CHAMBER:

To design the Chamber (primary chamber) we want to search out the initial volume of primary chamber. To seek out the volume of 10kg of BMW waste is put as a heap and therefore the volume of the heap is consider. Assuming a acceptable depth of 2.2m, we are able to learn or find out the area of the chamber.

Assume length and breadth as 1.5:1, Dimensions of the primary chamber=L*B*H

B = 1.238m,

L = 1.857m &

H = 2.2m.

Sl no	Types of hospital	Quantity of waste generation /Year kg	Average Quantity of waste generation/ month kg	Average Quantity of waste generation /day kg
1.	PHC hospital	765	63.75	2.15
2.	Private hospital	68874.34	5739.52	191.31
3.	Clincs	2202	183.5	6.12
Total		71841.34	5986.77	199.55

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3.6.2. HEAT AND MATERIAL BALANCE SAMPLE CALCULATION:

The important a part of designing in a incinerators is a Heat and Material Balance. The process includes a mathematical evaluation of the input and output conditions of the incinerator. these will be used to find the combustion air and auxiliary fuel requirements for incinerating a given BMW waste.

ASSUMPTIONS:

An incinerator are designed to incinerate a combination of **70% yellow bag** (with a PVC contented 4%) and **30% red bag** biomedical waste. Totally its has to be 100 kg/h of BMW Waste. A auxiliary fuel is natural gas; the waste are ignited and also the secondary burner will be modulated.

Design requirements are summarized as follows:

Secondary chamber temperature: 1100°C

Flue gas continuance at 1000°C: 1 second

Residual oxygen in flue gas: 6% minimum.

STEP I: ASSUMPTIONS:

It involves the incineration of BMW which are usually supported number of assumptions. In these our design the chemical formula, the mass and also the higher heating value of ever of main component of BMW are taken as follows.

Note:

1. The Input Temperature of waste, fuel and air is 15.5^0C.
2. The Air contains 77% by weight N_2 and 23% by weight O_2..
3. The Air contains 0.0132kg H_2O/kg dry air at 60% relative humidity ratio and 26.7^0C dry bulb temperature.
4. For any gas 1kg mole is up to $22.4m^3$ at 0^0C and 101.3kpa.
5. Heat of vaporization of water at 15.5^0C is 2460.3kj/kg.

Components	Emphericall formula	Molecular weight	Higher heating value (KJ/Kg)
Tissue	$C_5H_{10}O_3$	118.1	20,471
Cellulose, swabs, bedding	$C_6H_{10}O_5$	162.1	18,568
Plastics-Poly-Ethylene 96%	$(C_2H_4)_x$	28.1*	46,304
PVC4%	$(C_2H_3Cl)_x$	62.5*	22,630
Sharps	Fe	55.8	0
Moisture	H_2O	18.0	0
Disinfectants, Alcohol	C_2H_5OH	46.1	30,547
Glass	SiO_2	60.1	0

Chemical characteristics:

STEP II: CALCULATION OFBMW WASTE INPUT: The yellow bag waste is usually composed of mainly human tissue as indicated in table 3A. supported an input of 30% of 100 following composition

*. Tissue (dry) $C_6H_{10}O_3$ 0.15 x 30 = 4.5 kg/h

*. Water H_2O 0.8 x 30 = 24.0 kg/h

*. Ash - 0.05 x 30 = 1.5 kg/h

Total Yellow Bag =**30.0 kg/h.**

The Red bag waste input is 70% of 100 kg/h (i.e. 70 kg/h) and was assumed to possess the subsequent composition:

*. Polyethyle $(C_2H_4)_x$ 0.35 x 70 = 24.50 kg/h

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*.Polyvinylchloride(C_2H_3Cl)0.04x70 = 2.80 kg/h
*. Cellulose($C_6H_{10}O_5$) 0.51 x 70 = 35.70 kg/h
*. Ash _ 0.1 x 70 = 7.0 kg/h
Total Yellow Bag = **70.00 kg/h**

STEP III: CALCULATION OF HEAT INPUT OF WASTES (kJ/h)
The HHV and heat input of ever component are tabulated.

Component	HHV kj/kg	Input kg/h	Total Heat in kj/h
$C_5H_{10}O_3$	20,471	4.5	92,119.5
H_2O	0	24.0	0.0
$(C_2H_4)_x$	46,304	24.5	1,134,448.0
$(C_2H_3Cl)_x$	22,630	2.8	63,364.0
$C_6H_{10}O_5$	18,568	35.7	662,877.6
Ash	0	8.5	0.0
		100.0	1,952,809.1kj/h

STEP IV: TO DETERMINATION OF C OXYGEN FOR BMW WASTES
The total theoretical amount of oxygen required to burn the BMW waste is decided by the reaction equilibrium equations of the individual components of the biomedical waste and are provided within the following:

1. $C_5H_{10}O_3$ + $6O_2$ = $5CO_2$ + $5H_2O$
118.1 6(32) 5(44) 5(18)
1.0 1.63 1.86 0.76
Tissue 4.5 7.32 8.38 3.43 (as fired)

2. $(C_2H_4)_x$ + $3O_2$ = $2CO_2$ + $2H_2O$
28.1 3(32) 2(44) 2(18)
1.0 3.43 3.14 1.2
Poly Ethylene (as fired)
24.5 83.7 76.7 31.4

3. $2(C_2H_3Cl)_x$ + $5O_2$ $4CO_2$ + $2H_2O$ + $2HCl$
2(62.5) 5(32) 4(44) 2(18) 2(36.5)
PVC 1.0 1.28 1.41 0.29 0.58
(as fired)2.8 3.58 3.94 0.81 1.64

4. $C_6H_{10}O_5$ + $6O_2$ = $6CO_2$ + $5H_2O$
162.1 6(32) 6(44) 5(18)
Cellulose 1.0 1.19 1.63 0.56
(as fired) 35.7 42.3 58.1 19.8

The theoretica oxygen required to burn the components of the BM waste (67.5kg/h) is 136.9kg/h oxygen (total of 7.32, 83.7, 3.58 and 42.3).

STEP V: DETERMINATION OF AIR FOR WASTE SUPPORTED ON 150% EXCESS
From step 4, stoichiometric oxygen is 136.9 kg/h. Therefore, stoichiometric air =136.98*100/23 =595.2kg/h air. Total air required for waste (at 150% excess) = (1.5*595.2)+595.2=**1488kg/h**

STEP VI: MATERIAL BALANCE
Total Mass In : Waste = 100.0 kg/h

Dry air = 1488.0 kg/h
Moisture in air = 19.6 kg/h (1488 x 0.0132)
Total Mass In = 1607.6 kg/h.

A. Dry Products from waste
Sub Total = 1351.1 kg/h(892.8kg/h+458.3 kg/h)
Total Waste Dry product = 1498.22 kg/h(8.38+76.70+3.94+58. 10)

B. Moisture
Total Moisture = 99.04 kg/h (24.0+55.44+19.6)

C. Ash Output = 8. 5 kg/h

D. HC1 formed from Wastes
HC1 formed from $(C_2H_3Cl)_x$ = 1.64 kg/h
Total Mass Out =**1607.4 kg/**h(a+b+c+d)

STEP VII: HEAT BALANCE
A.Total Heat in From Waste (Qi);
Qi = 1,952,809.1 kJ/h(from step 3)
B. Mass Heat content output Based on Equilibrium Temperature of 1100°C (Qo)
i) Radiation loss = 5% of total heat available
= 0.05 x 1,952,809.1 = **97,640.0 kJ/h**
ii) Heat to ash = mCp = (8.5) (0.831) (1084.5)= **7660.4 kJ/h.**
Where m = weight of ash = 8.5 kg/h
Cp = mean heat capacity of ash = 0.831 kJ/kg. °C (assumed average value)
dT = Temperature differen = (1100-15. 5) °C
= 1084. 5°C
iii) Heat to dry combustion products = mCpdT
= (1498.22) (1.086) (1084.5 = **1,764,554.1 kJ/h**

iv) Heat to moisture = (mCpdT) + (mHv)(mCpdT)+ (mHv)
= (99.04 x 2.347 x 1084. 5) + (99. 04 x 2460.3)
= 252,088.6 + 243,668.1
= 495,756.7 kJ/h
Where m = weight of water = 99.04 kg/h
Cp =mean heat capacity of water=2.347 kJ/kg°C
dT = (1100-15. 5) °C = 1084. 5°C
Hv = latent heat of vaporizations of water **=** 2460.3 kJ/kg

Total Heat Out (Qo) = sum of (i, ii, iii, iv) **= 2,365,611.2 kJ/h**
Net Balance=Qi **–**Qo = 1,952,809.1 - 2,365,611.2
= **-412,802.1 kJ/h** (deficiency)

fuel must be supplied to satisfy design temperature of **1100°C.** 1.2 m
STEP VIII: REQUIRED AUXILIARY FUEL TO ACHIEV
i) Total heat required from fuel = 412,802.1 + 5% radiation loss = **433,442.2 kJ/h**
ii) Available heat (net) from natural gas at 1100°C and 20% excess air = **15,805.2 kJ/m^3** (assumption)
Natural gas needed = 433,442 .2/15,805.2 m^3/h = **27.42 m^3/h**

STEP IX: PRODUCTS OF COMBUSTION FROM AUXILIARY FUEL
i) Dry materials from Fuel at 20% Excess Air = 16.0 kg [8] x 27.42 m^3 /h m^3 fuel = **438.7 kg/h**
ii) Moisture From Fuel = (1.59 kg (8)/m^{3}fuel) x 27.42 m ^{3}/h = **43.59kg/h**

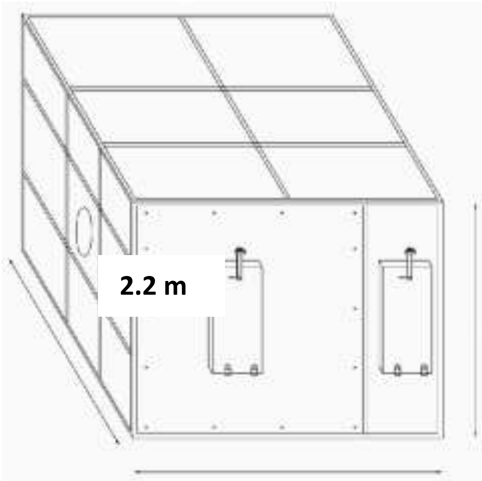
STEP X: RESIDUAL OXYGEN WITHIN THE FLUE GAS

The residual oxygen ($\%0_2$) are often to be determined using the subsequent equation:

EA (excess air) $= \% O_2/ (21\%-\%0_2)$

Therefore, (150 /100) $= \% O_2/ (21\%-\%O_2)$

$\%0_2 = 12.6$**%**



IV. CONCLUSIONS

Based on the study of biomedical waste management in Bangalore city, the subsequent conclusion are drawn

1) The biomedical waste management in Bangalore city wasn't properly managed according to Bio-Medical (Management and Handling) RULES,(2018).
2) In government hospital, the methods of BMWM the collection, segregation, transportation, treatment and disposal activities of Bio-Medical waste weren't as per the biomedical waste management and Handling rules.
3) In private hospitals and Clinics the Bio-Medical waste management was satisfactory and it absolutely was observed that these hospitals and Clinics were maintaining record regarding to biomedical waste management in accordance to rules and regulations.
4) Waste generation rate in government hospital varies from 3-5kg/day and just in case of private clinics the waste generation varies from 200-250kg/day
5) The disposal of Bio-medical waste in Government general hospital was done by open burning and by incineration
6) The liquid waste generated in Government hospital is diluted and chlorinepowder was added and discharged in to open area.
7) A number of the clinics were not maintaining records as per the Bio-Medical management and Handling rules
8) An Incinerator has been designed to treat the biomedical waste which is being generated in Bangalore city with a capacity of 100 kg/hr with two times of operation viz. one in the morning and one in the evening.

9) The design dimension of primary chamber obtained is 1.8*1.2*2.2 (L*B*H)

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