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PROPOSAL OF MULTI-HAZARDOUS WASTES FOR ON-SITE DISAMBIGUATION MANAGEMENT IN UJJAIN, INDIA

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ABSTRACT: The bio-medical waste generation in developing countries like India is about 1.59 Kg/day/bed which leads to a total of 4,05,702 Kg/day throughout India. Out of the total about 2, 91,983 Kg/day is been disposed safely with Biomedical norms 2016. This left us with 1, 13,719 Kg/day which is been transported, openly dumped or is been disposed with Municipal Solid wastes. This procedure is very hazardous as it is a Multi-hazardous waste and cause many types of health problems to people, plants and animals it came in contact as it is volatile and also a radioactive waste.

To overcome all these difficulties we in this paper are proposing Disambiguation techniques which are easy to apply and which will reduce the Multi-hazardous bio-medical waste to an extent so the large gap between generation and disposal can be filled. The untreated Bio-medical waste should not be kept beyond 48 hours so the residual after On-site treatment should be disposed as soon as possible for further industrial treatment of Infectious biomedical Waste.

Key Words – Disambiguation, Multi-hazardous, bio-medical waste, Infectious biomedical Waste, industrial treatment, Municipal Solid wastes.

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INTRODUCTION

As we all know that pollution is the biggest problem of 21st century and if it comes to Bio-medical waste pollution than various health hazards which it causes came in mind (Pruss et. al. 1999). Very few people knew that about 2% Bio-medical waste is Radioactive which further increases risk to health hazards (Dalal Parag, 2017). Even the Indian government now a day's launches a plan for Bio-medical waste management and so made a Bio-medical waste rule 2016 which gives us various criteria's for disposal and segregation. In India the approximate quantity of Bio-medical waste is considered 0.6 – 3.8 Kg/bed/day out of which 45% is municipal solid waste, 15% is anatomical waste, 8% is pharmaceutical waste, 5% is sharps, 15% is discarded instruments wastes, pathological waste is about 10%, and radioactive waste is about 2%.

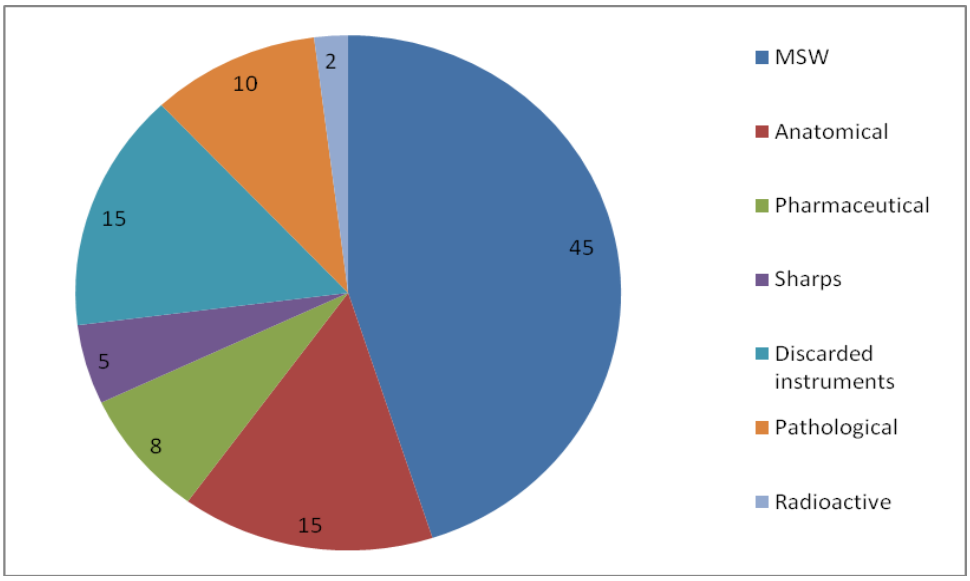


Figure-1: Graphical represent of Bio-medical waste

As per the Bio-medical waste Rules, 2016 and amendment thereof 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.
The liquid chemical waste should be neutralized before discharge into drains. According to schedule-III of above rules, standards for effluent generated from hospital are as in table-1.

Table-1: Chemical Waste with Permissible Parameters Limit

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.
Vermi-technique is also used for organic Bio-medical waste using various earthworms. These earth worms' breakdown complex substances into non complex water soluble substances. Earth worms are responsible for all this process (Hidalgo et al., 2006). The enzymes are also helpful in this reaction of present symbiotic microbes. Vermicast contain all essential nutrient including micro-nutrient which can be used as a bio-fertilizer in agriculture and gardening etc (Pramanik et al., 2007).

Now a day's 4 colored bins are placed in every hospital they are –

i. Yellow bins
ii. Red Bins
iii. White bins
iv. Blue bins and
v. Black bins

Figure-2: Biomedical waste usage bins

This segregation is done of Bio-medical waste easily and the waste not mixes with each other mainly with municipal solid waste whose disposal technique and health hazards are very different (Dalal Parag, 2013). We explain the bins with type of waste than it depicts as –

i. Yellow Bins – The Colour of the bin or the Plastic bag should be Yellow – in this type of bin generally the human tissues, body parts of humans, animal carcasses, organs including waste generation from animals in experiments and drug testing, items contaminated with blood, body fluids, dressings, plaster casts, cotton swabs and blood bags containing residual or discarded blood and blood components. Also in this bin expired life saving drugs, antibiotics, cytotoxic drugs along with their plastic ampoules should also be discarded, the chemicals used in biological actions of operation theater and discarded disinfectants have their place. These chemicals are the Silvers of X-ray developing liquids, formalin, infected syringes, aspirated body fluids, discarded mattresses and bed sheets contaminated with blood, laboratory cultures, micro organism specimens, stocks, live vaccines, human cells, residual toxins, dishes and devices used in laboratories and floor cleaners residues used by housekeeping.

ii. Red Bins – Red colored plastic bag or red container should be used – In this bin various contaminated wastes which can be recycled or reused easily makes their place such as tubing's, bottles, intravenous tubes, catheters, test tubes, syringes without needles, vacutainers with no needles, gloves etc, these all can be re-used after their treatment.

iii. White Bins – Puncture proof, leak proof, tamper proof White colour container should be used which can handle sharps. As in this type of bin various sharp objects as syringes, needles, needle tip cutter, burners, blades, scalpels and contaminated sharp objects used for puncture or cuts which are of no use or damaged, blunt blades are been discarded.

iv. Blue Bins – These bins can be cardboard boxes with blue colour or blue bags generally used for solid wastes and dry Bio-medical waste having no liquid in them these can be broken accessories, glasses, non volatile medicines etc.

v. Black Bins – These bins can be black garbage bags or black containers or trash bags which are present in every room of a hospital and every lobby. The purpose of them is to collect Solid Waste Management generated by nurses, patients and their attainders and the visitors of the hospitals.

MATERIAL AND METHODS

As we have segregated the Bio-medical waste we can further go for its treatment methods which are very much different than Solid Waste Management processes these are –

Incineration – This is a thermal process where the temperature of about 850°C to 1600°C is been used for 2-3 seconds which insures the proper breakdown of toxic organic substances liberated from the anatomical wastes. The flue gas is been liberated from incinerators and the heat can be used for electricity generation. The flue gases consist of carbon-di-oxide, oxygen, Nitrogen, Carbon-mono-oxide, Nitrogen oxides, Sulphur oxides and Particulate matters so this has to be passed through wet scrubbers for pollution reduction.

Autoclaving – The autoclave can be considered as big pressure cooker. It works at a temperature of 121°C and sterilizes various materials present inside it. At a high temperature it works for 15-20 mins so that all materials sterilizes and can be used again for same patient or different one. The size of autoclave depends on hospital size and its running capacity. These are of 3 types –

a. Gravity Type Autoclave
b. Vacuum Type Autoclave
c. Retort Type Autoclave

Out of all these Retort Type Autoclave is used for high temperature and pressure thus reduces the time taken to about 5 mins so is been preferred by hospitals more now a days.

Microwaving – It is an expensive but a green technology which allows a rapid processing of onsite Bio-medical waste generated. This process is cheap in running than incineration and pyrolysis and also is environmental friendly. This technique is based on generation of high frequency waves which increases the pressure and temperature of substrate from within which kill all pathogens. The temperature goes up to 300 °c and the pressure and vibration reduces the volume immediately to a large value.

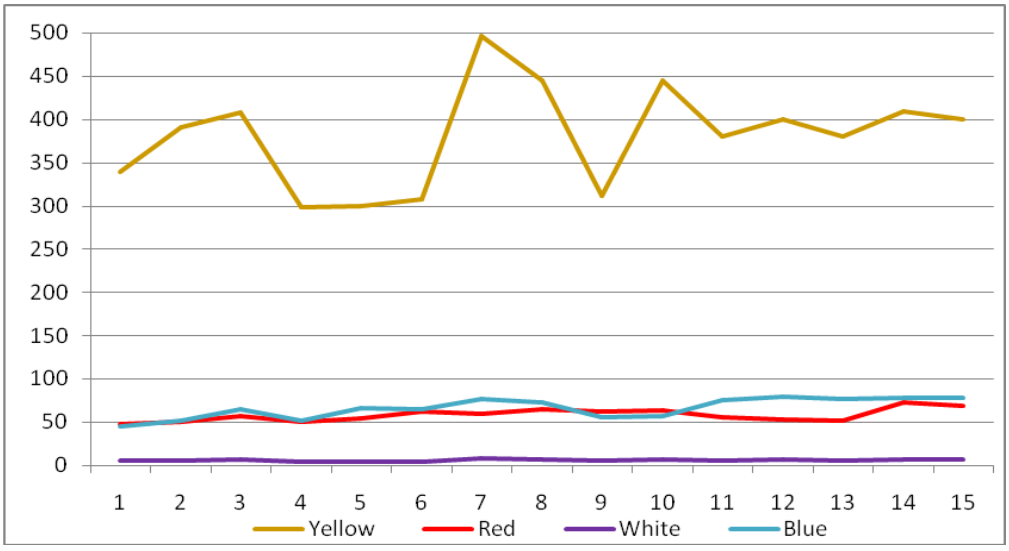
Hydro-clave – It is done in a jacketed vessel made of alloys which can handle a large pressure. The feed is from top and the output is from bottom of cylinder in large hydroclaves and in small ones both are at the top. The hydroclaves function is most like a autoclave but is more efficient, fast and dehydrates the waste and break it up into small fragments which helps us in reducing the volume of the waste significantly.

Plasma pyrolysis – Plasma pyrolysis is a extreme temperature treatment process which is used to convert organic matter to Syngas {Synthetic Gas}. There is a jelly in which the flaming torch flickers it is known as plasma. The materials also come between charged plates this anode and cathode has a large flux giving the waste material a large jerk this is known as Plasma Arc. We can attain a high temperature i.e. 1200 °c due to negative pressure on system. The gases can be used as fuel for generating electricity because of high temperature gas liberating out from system and Syngas can be stored and used elsewhere if needed.

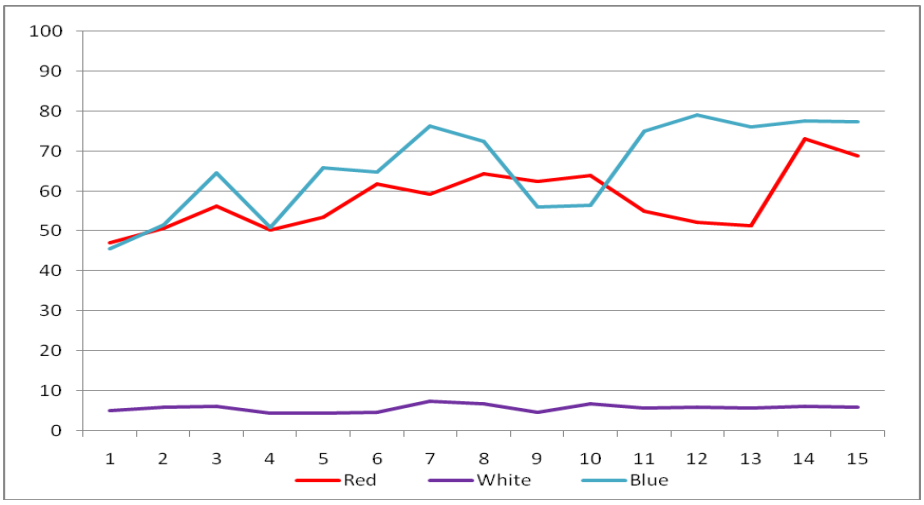
Chemical Methods

For treatment of various liquid hospital wastes various chemical methods are been used. Mainly chemical methods are used to de-contaminate the liquids which are highly susceptible to spills (Dalal Parag, 2012). Depending on type of Bio-medical waste chemicals like Chlorine, Sodium Hydroxide, Calcium Oxide etc are used so that volatility of waste is been lost and they lose their radioactivity. Also these chemicals act as solidifying agents for Bio-medical waste liquid waste so can help in waste removal techniques (Dalal Parag, 2011).

Results and Discussions – In Ujjain we set up 4 sites for Bio-medical waste analysis it will be just the estimate of total data as the government hospital has its own incinerator and some private hospitals give their waste to private company, we get the combined data in Table-2.



Graph 1 – Average Kg/day for 15 days of all wastes since value of yellow is too high we cannot see fluctuations of rest so are explained in graph 2



Graph 2 – Average fluctuations of waste generation of Red, Blue and White bins

Table-2: Bio-medical waste consumption data in Government Hospital and Private Hospital in Ujjain

S.No	Site 1	Site 2	Site 3	Site 4	Total /day	Avg/day	Site 1	Site 2	Site 3	Site 4	Total /day	Avg/day
	Yellow						Red					
	220	124	409	603	1356	339.00	18	5	78	87	188	47.00
1	150	134	671	611	1566	391.50	10	9	88	96	203	50.75
2	132	160	845	496	1633	408.25	15	9	118	83	225	56.25
3	186	141	410	457	1194	298.50	11	7	98	85	201	50.25
4	141	150	412	498	1201	300.25	12	9	112	81	214	53.50
5	182	156	411	480	1229	307.25	10	13	142	82	247	61.75
6	211	162	880	732	1985	496.25	15	12	130	80	237	59.25
7	230	120	720	712	1782	445.50	16	6	137	98	257	64.25
8	150	147	412	540	1249	312.25	10	8	150	82	250	62.50
9	246	115	740	680	1781	445.25	14	5	145	92	256	64.00
10	180	122	560	661	1523	380.75	10	6	114	90	220	55.00
11	230	104	632	632	1598	399.50	12	7	95	95	209	52.25
12	214	203	496	609	1522	380.50	11	11	100	83	205	51.25
13	286	175	561	615	1637	409.25	12	10	190	80	292	73.00
14	261	138	520	683	1602	400.50	11	12	170	82	275	68.75
15	231	125	687	664	1707	426.75	13	6	125	88	232	58.00
S. NO.	Site 1	Site 2	Site 3	Site 4	Total /day	Avg/day	Site 1	Site 2	Site 3	Site 4	Total /day	Avg/day
	White						Blue					
1	3.3	1.9	6.1	9.0	20.3	5.09	8	26	85	63	182	45.50
2	2.3	2.0	10.1	9.2	23.5	5.87	12	28	96	70	206	51.50
3	2.0	2.4	12.7	7.4	24.5	6.12	40	19	120	79	258	64.50
4	2.8	2.1	6.2	6.9	17.9	4.48	13	21	99	71	204	51.00
5	2.1	2.3	6.2	7.5	18.0	4.50	45	28	114	76	263	65.75
6	2.7	2.3	6.2	7.2	18.4	4.61	50	25	112	72	259	64.75
7	3.2	2.4	13.2	11.0	29.8	7.44	50	35	140	80	305	76.25
8	3.5	1.8	10.8	10.7	26.7	6.68	47	22	125	96	290	72.50
9	2.3	2.2	6.2	8.1	18.7	4.68	42	14	98	70	224	56.00
10	3.7	1.7	11.1	10.2	26.7	6.68	47	12	95	72	226	56.50
11	2.7	1.8	8.4	9.9	22.8	5.71	60	32	118	90	300	75.00
12	3.5	1.6	9.5	9.5	24.0	5.99	65	30	136	85	316	79.00
13	3.2	3.0	7.4	9.1	22.8	5.71	60	21	141	82	304	76.00
14	4.3	2.6	8.4	9.2	24.6	6.14	62	39	110	99	310	77.50
15	3.9	2.1	7.8	10.2	24.0	6.01	70	28	131	80	309	77.25

As the first graph depicts about generation of yellow bin waste as we can see there that the fluctuations are more as because it varies on birth and deliveries days also as the 7th day is Monday so the waste generation is much more as on Sundays only urgent deliveries were done rest all are been shifted to Monday.
The second graph depicts about red white and blue container wastes as waste of sharps do not alter much and remains in a range the red and blue container wastes varies much due to fluctuation of patients in the hospitals.

Proposal for On-site Cleaning Techniques –

The Bio-medical waste is a heterogeneous mixture of various wastes and if mixed with Solid Waste Management it is practically near to impossible to separate and manage that's why it's been transported separately. We in this paper are proposing the Incineration techniques in detail and this proposal can also be used in small hospitals and nursing homes. The incinerator can work from a load of 50 Kg/Hr to 400 Kg/Hr of Bio-medical waste. Generally the diesel fired incinerators are used now days but here we propose a LPG or a Natural gas incinerator so that the smoke pollution also do not cross limit of 1 Ringelmann scale.

i. **Construction of the body –** As in diesel fired incinerators there are two chambers
   a. Primary Combustion Chamber (PCC) and
   b. Secondary Combustion Chamber (SCC)

   Here in this proposal if we combine the two chambers it will help us in lapse time and also energy conservation. Here the brass frame of 10 mm diameter can be used. This will not initiate any heat loss through this chamber. The casting refractory bricks should have a proper thermal insulation cover suitable for a temperature of about 1500 °c. Also it should bear a outer surface temperature of 55 °c – 60 °c. The door fitted should have a quick release clamp and should get fit with approx no energy loss when closed. The door can be made up of mild steel refractory lined thermal insulation also in the door a viewing glasses to be hinged with protection flap and this glass should be heat resistant.

ii. **Burners –** the burners in the chamber should be auto ignited temperature controlled which can bear the temperature of 1500 °c. The burners are either LPG packed or natural gas fired burners with a control box censor, thermometer as it gets auto ignited if the temperature falls below 1000 °c, electrodes, combustion head, flame failure, checker device, direct drive fan. All these equipments should be easy for maintenance.

iii. **Air Supply –** The air jet should be injected in a low speed so that it do not affect the burner and inside temperature directly. This air supply should be present on both sides of the chamber so that the availability of air is maintained.

iv. **Energy Generator –** The flue gases with steam coming out of incinerator is at a very high temperature so this heat can be utilized to generate electricity. This can be done by See-back generator also known as Thermo electric generator. This device converts heat flux directly to electricity which can be used directly.

v. **Flue–Gas Scrubber –** Gases eliminating from the see-back generator are low in temperature so these can get pass through a washer system. This sprinkles the water to gases and then this mixture pass through filter which removes particulate matter from hot gases and water can be used again. The gases are liberated to atmosphere by stack.

vi. **Stack or Chimney –** The stack should be of aluminum steel mixture with a minimum height of 120 meters from ground level. This stack should be internally lined with insulation and externally it should be painted in bright heat resistant colors visible to air vehicles from a long distance. A carbon settler can also be fixed at endpoint of stack which collects soot. This soot now days are used as a pigment as it contains various heavy metals and carcinogens. This pigment produces ink known as Air Ink thus giving us the second useful by product of our proposal.

Despite of all these efforts and pollution control techniques we cannot achieve Zero discharge system some amount of pollution liberated from LPG or natural gas incinerator is in Table-3.

Table-3: Polluter with their concentration in Incinerator

S. NO.	Polluter	Concentration in mg/Nm^3
1.	Particulate Matter	30
2.	Carbon Monoxide	90
3.	Sulphur Oxides	230
4.	Hydro Chloric Acid	40
5.	Nitrogen Oxides	340
6.	Dioxins	0.50
7.	Furness	0.50
Inside a 100 Kg/m^3 incinerator we need		
1.	Water	15 L/Hr
2.	LPG	250 PSI
3.	Resistant time	2 sec

CONCLUSION

As per the above proposal we can fix incinerators easily at Bio-medical waste sources. For hospitals we can use a small incinerator of capacity 50 Kg/Hr as the daily collection waste of Ujjain do not exceed 2000 Kg/Day of all types of Bio-medical waste and also we can generate energy from incinerator which can run electricity of hospital for hours. We all know that the Bio-medical waste management is the biggest problem ahead of us and it troubled us from years. Here in this paper we tried to fix it out. Removal of heavy pollution loads and getting two useful byproducts are our biggest assets from this paper. Further we can work for portable incinerator like one; we proposed which can be fixed in a vehicle and which can run through a whole city so that it can collect the waste of medical shops, Laboratories and nursing homes too.

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