NATIONAL SOLID WASTE ASSOCIATION OF INDIA

Waste MONITOR

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HOUSEHOLD BIO-MEDICAL WASTE

WASTE MANAGEMENT PARK

Hydrothermal Carbonization : A Quick-fix Process to Dispose the Wet Waste Portion in MSW

NESPL's plunge into EPR Services

Citizen awareness on Household Bio-Medical Waste Segregation at source during COVID-19 Pandemic - India

Success Story of transformation of Waste Dump in Coonoor, Nilgiri hills into Waste Management Park.

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Waste MONITOR

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President's Note

The COVID-19 outbreak has put people from around the world at risk. The novel coronavirus has put a humongous pressure on not only the healthcare facilities but also on the waste management authorities which is an essential public health service. Inadequate MSW management during such crisis poses potential risks to MSW handling personnel and amplifies virus transmission among the people.

The current issues covers topics ranging from COVID-19 and Household Bio-Medical Waste, Hydrothermal Carbonization, Plasma Gasification to EPR: Trac and Calculator use of technology in improving in waste management, we invite you to an online release of this new publication of Waste Monitor from National Solid Waste Association of India.

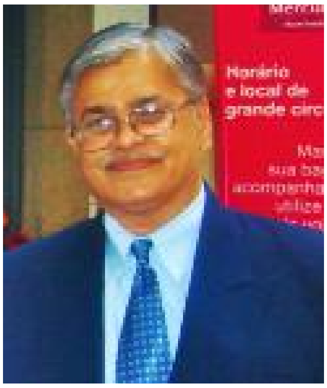
Waste Monitor intends to spread awareness about right practices by bridging the critical information gap in the waste management sector and assist industries, municipalities, NGOs and others by providing professional guidance from experts.

While it is a fact that we are currently inundated with information from various forms of media, Waste Monitor will attempt to bring in relevant information and meaningful intelligence on the sector for the stakeholders.

We will include news, analyses of current events, and success stories not just from India but also from across the globe that could be of interest to our readers. In this way, the bi-annual magazine will have an International outlook but with its concerns focussing on Indian reality.

Stay Safe and Stay Healthy !

Dr Amiya K Sahu
President



Editorial

Dear Readers, this is my last issue of Waste Monitor, as Editor in Chief; before I hand over the reins of editorial board to the new person.

Through the last three issues of Waste Monitor, we tried to present various types of information on waste management, with the idea that the same would be useful to the stakeholders in this subject.

While presenting this last issue on behalf of this editorial board, we are trying to present few success stories, some information on new technology in waste disposal & last but not the least, waste management during the most horrific event of this century, COVID 19 Pandemic.

The long drawn process of disposal of wet waste through biogas or composting, is altogether replaced by a short process of just few hours by a new & upcoming technology Hydrothermal Carbonization. Dr. Harshvardhan Modak is presenting this new & upcoming process to illustrate its great promise. Although it is commercialized at some places in the world, tremendous work is still going on to make it still better method for wet waste disposal with generation of value added energy generating product. If it is applied in India, wet waste management will hold better promise.

Extended Producers Responsibility [EPR] is a concept in plastic waste management, newly introduced by Government in India. It is supposed to fix the responsibility of disposal of plastic packaging on the brand producers themselves. Although essential, its introduction saw a tumultuous acceptance. NEPRA Environmental Solutions P. Ltd., stepped in to carry out the most essential part in this huge effort of implementation of EPR. Mr. Sandeep Patel of NEPRA describes the efforts especially taken for the same. They acted as necessary conduit between responsibility holders & implementation agency, for explaining the necessity, convincing the plastic producers about the same & ultimately guiding them towards successful disposal/recycle.

The year 2020 saw emergence of most dreadful pandemic of the century i.e. COVID19. On account of severe restrictions put on people for preventions of the spread of disease, significant amount of biomedical waste got generated in households. The incidences of mixing of such waste into municipal solid waste gave rise to more problems. It prompted a quick PAN India survey of the situation. The details of the survey & observations in the same have been described by Ms. Sravanti & Deepti Suri. I am sure the survey will raise quite an alarm.

Waste Dumps have been an environmental hazard present in every village, town, city or Metropolis throughout India. There are always attempts to rehabilitate the same for improvement in the situation. One such successful attempt at Coonoor Town near famous hill station of Ootakmund in Tamil Nadu is presented here by Dr. Sahu with the help of the local reporter Ms. Pankja Sriniwasan. It describes the transformation of an obnoxious waste dump into a beautiful waste management facility. The local NGO's efforts in this regard are pointer for many ULBs in India to follow.

Plasma gasification is well known for quite some time as the costliest process to dispose hazardous waste. However looking at its great potential to handle any type of waste, attempts are being made to substantially reduce is capital & operating costs. Such successful efforts are described by Dr. Sudha Bhoraskar & her team, from Savitribai Phule University of Pune, Pune, India. Once they are complete, plasma technology will create revolution in the waste management in India.

Dennis Pullimuthu, Managing Director of Zonta, a German company, describes the success story of implementing his waste solution (Zolutions) in some of the cities in India. Highlight is that the same were nominated for PM's Excellence Award.

Dr. B. L. Chavan & Dr. N. S. Zambre, describe the waste management profile of Sholapur city, in Western Maharashtra. Although they have quoted older version of MSW Rules in the article, the data of the profile is still valid for the new set of rules. There was an attempt to set up a waste to energy unit at Sholapur through biogas technology. It worked alright for a while, but there is a scope to improve.

I am sure the articles in this issue of Waste Monitor will be interesting for readers to understand & appreciate various aspects of waste management in India. I do hope that the same will be found useful for you as readers. Happy reading!

Dr. Harshvardhan Modak
Editor-in-Chief

Hydrothermal Carbonization :
A Quick-fix Process to Dispose the Wet Waste Portion in Municipal Solid Waste (MSW)

Hydrothermal Carbonization Technology, an alternate and a quick fix method to dispose wet waste portion of MSW, converts the residual liquid waste that biogas technology generates in just a few hours into coal, with good calorific value. The residual liquid waste needs no composting and water can be recycled.

Dr. Harshvardhan Modak, Vice President, NSWAI, Mumbai, India

Abstract: Traditional cumbersome & time-consuming methods of disposal of wet waste can be replaced by quicker & simpler method like Hydro Thermal Carbonization (HTC). Its land requirement is also very low compared to composting. It generates value added product like bio-coal for energy generation. The resultant ash has significant phosphorus content & can improve soil quality.

The total MSW in any urban local body (ULB) is to be on minimum level segregated into Wet Waste & Dry Waste. This is the minimum expectation from any citizen. Everyone is aware that almost 40% portion of Indian MSW comprises of wet waste. It arises from food waste, vegetable cuttings etc. Wet waste itself contains about 80% moisture & the balance is organic carbon & other elements.

Usually the tradition everywhere is to dispose wet waste by processing it through direct composting or through biogas technique. In biogas technique, it is mixed with significant quantity of water, which is digested for several hours. About 60% of the organic content of this mixture is converted into biogas, which is either directly used as fuel or its converted into CBG, another form of the fuel equivalent to CNG. The substantial liquid waste left behind is directly used as a fertilizer or is converted into compost (if not surreptitiously thrown into sewage.)

Now if one looks at this sequence of reactions, viz. wet waste to biogas to liquid residue to compost; then it is realized that it takes lot of time & space to completely dispose the original portion of wet waste in MSW. It requires few days to complete digestion to biogas & convert the liquid residue after biogas to compost. The process of compost (even if closed vessel technique is used), will require significant quantity of land for process to complete.

Looking at huge quantities of MSW being produced in any ULB everyday, for efficient & conclusive disposal of wet waste, huge amount of land & time is required. In view of the burgeoning population & its pressure on urban growth, the land availability in & around any ULB is getting scarcer. As a result the cost of land too is getting higher & higher. Eventually the land cost will prevent proper disposal of wet portion of MSW.

Under the circumstances, is it not justifiable to replace this age-old process of biogas/composting to be replaced by a simpler & quicker process, which converts wet waste into a valuable product, with good calorific value? Biogas technology has earned a respect on account of its potential to generate energy. In this energy hungry world, when a fuel is perpetually obtained from a raw material like MSW, which is anyway to be disposed, then it is always worthwhile. Biogas technology fulfilled the same so far. But now if the residual liquid waste it generates, needs to be disposed through composting technology, then the amount of time & land it requires, becoming an burden.

On the other hand, Hydrothermal Carbonization Technology converts the same waste in just few hours into coal, with good calorific value. The residual liquid waste needs no composting. Water can be recycled. The whole activity requires fraction of the land that it required for biogas combined with composting. Thus in comparison it becomes very attractive.

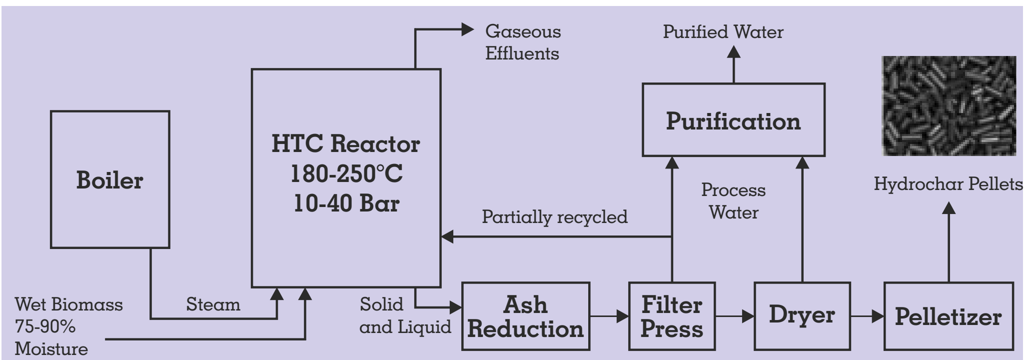
Hydrothermal carbonization (HTC) (also referred to as "aqueous carbonization at elevated temperature and pressure") is a chemical process for the conversion of organic compounds to structured carbons. Technically the process imitates, within a few hours, the brown coal formation process, which takes place in nature over enormously longer geological time periods of 50,000 to 50 million years. It was investigated by Friedrich Bergius and first described in 1913.

The carbon efficiency of most processes to convert organic matter to fuel is relatively low. I.e. the proportion of carbon contained in the biomass, which is later contained in the usable end product is relatively low :

Process	Carbon Efficiency
Alcoholic fermentation	67%
Gasification to H2 or CH4	60%
Gasification and Fischer-Tropsch synthesis	50%
Anaerobic conversion to biogas	50%
Wood charcoal production	30%
Production of humus by composting	5% to 10%
Hydrothermal Carbonization	About 100%

Hydrothermal carbonization makes it possible to use almost all of the carbon contained in the biomass for fuel generation.

Hydrothermal carbonization (HTC) is another looming WTE technology specially designed for conversion of wet biomass feedstock with no dependency on energy input, which otherwise is needed for drying of the feedstock in other techniques. Pretreatment for drying of biomass is not needed in HTC. The resulting by-product ash (after burning the product coal) can be applied as a plant nutrient enhancer because of its phosphorus content, and also a liquid by-product produced by the HTC plant can be used for watering plants as it is loaded with potassium content.



HTC GENERAL PROCESS

Thermo-chemical reactions are involved in conversion through HTC, which transforms unprocessed waste into a hydro-char bearing a high calorific content and complemented with elevated levels of carbon content. A feedstock with 75%–90% moisture content is considered ideal for this process. HTC comprises three processes, namely, dehydration, decarboxylation and decarbonylation, for which pretreatment or drying of the feedstock waste is not needed.

The hydro-char, rich in carbon, can be utilized as fuel, as an alternative for coal thus replacing a fossil fuel or as feedstock for gasification or even as a soil additive for nutrient enrichment or as an adsorbent or precursor for activated carbon.

The process works by submerging material in water and heating to temperatures in the range of 180-250°C, for a period between 3 hours to 8 hours, while maintaining sufficient pressure to keep the water liquid. Under these conditions the physico-chemical properties of water change and water becomes both the catalyst, reagent and reaction media to a series of transformative reactions. These reactions convert the material into a coal like material (hydro-char) using the same process chemistry that formed our geological coal deposits. Due to the coal like properties of the hydro-char the material is now often called a bio-coal when used in energetic applications.

Thus Hydro Thermal Carbonization (HTC) holds tremendous promise not only for disposal of wet waste portion of MSW; but also for conversion of various waste biomass in a city (tree leave, twigs, branches, grass & cuttings etc.) into useful products.

HTC Scheme

In recognition of this tremendous potential, world over significant research is going on to shorten the period of conversion & lowering the temperature of reaction using various catalysts.

The process has already been commercialized & conversion is being carried out on large quantities of wet waste material. It is also being applied to industrial wet waste in food processing sector. Many companies are offering the technology at commercial levels. It is also excellent method to convert the sewage sludge into useful product like coal. For such conversion, sewage sludge need not be dried & can directly be taken up for processing. The resultant product does not contain any pathogens.

In view of all these positive attributes of Hydro Thermal Carbonization, let us try to implement it for disposal of wet waste portion of MSW in India & do away with cumbersome & age old technique of digestion & composting. It is surely a quick fix method for wet waste portion of Indian MSW.

NESPL's plunge into EPR Services

> ***NESPL realises that apart from manual effort and knowledge, technology's role is important in regularising the system and makes constant efforts to drive the change by right technology and therefore designed the EPR Trac and Calculator to calculate EPR liability, execution, allocation and reporting.***
>
> **Mr. Sandeep Patel,** Founder and CEO of NEPRA

Sustainable waste disposal is a global challenge and it is the duty of the State and individual citizens to preserve the environment and maintain its well-being. In recent times, there has been a growing concern with respect to Plastic use in packaging and its sustainable end disposal. India has addressed the issue through several initiatives and regulations such as the Swachh Bharat Mission, launched in 2014 and Plastic Waste Management Rules 2016.

Prior to laws, most plastic waste would get landfilled

The Plastic Waste Management Rules, 2016 introduced the concept of Extended Producers Responsibility (EPR) policy to the plastic sector.The policy places a responsibility on the State Governments to monitor the Producers, Importers and Brand-Owners (PIBO) to meet compliance. It lays emphasis on the concerned stakeholders to meet targets of collection and of sustainable disposal of plasticsas per the rules. The principle of the policy is simple,just as its name, i.e. the responsibility of the producer of plastic waste extends even after the use of the product by the consumer.Prior to laws, most plastic waste would get landfilled.

At the time of the policy's introduction in the plastic sector, there was a vague and unclear understanding of it amongst the stakeholders such as brand-owners, producers, manufacturers, large waste generators, waste management companies/ start-ups, recyclers, cement industries, urban local bodies, etc. This led to many challenges and obstacles in its implementation.

The foremost challenge was to be able to address the large quantum of plastic waste that is generated, given its diversified types and end disposal methods. Also, a few products have complex structure comprising of multi-layers reducing its recyclability. Secondly, there lacked clarity regarding registration, calculating liability and curating an action plan. Thirdly, given the varied types of stakeholders involved, coordination among them was a challenge.

Apart from these, issues arose because of the lack of value chain for non-recyclable plastics such as (Multi Layered Plastic/Packaging) MLPand lack in number of Producer Responsibility Organisations for plastics that help in EPR take-back and submission of documents to the concerned authorities. NESPL Vehicle engaged in Plastic CollectionLaunch of NESPL's EPR Connect.

Identifying the gap,"NEPRA Environmental Solutions Pvt. Ltd." (NESPL), an established

Launch of NESPL's EPR Connect

name in the waste management industry, stepped in to mitigate the hurdles in the implementation of the policy.NESPL burgeoned in the sector of EPR providing advisory as well as take back services to producers and brand owners. It took upon itself to aid the PIBO comply with the norms and regulations and played the role of a Producer Responsibility Organisation (PRO).NESPL has always devoted itself to assisting businesses to achieve their sustainability goals in the field of Environment and Waste Management, right from the planning of operations, execution to result in measurement.

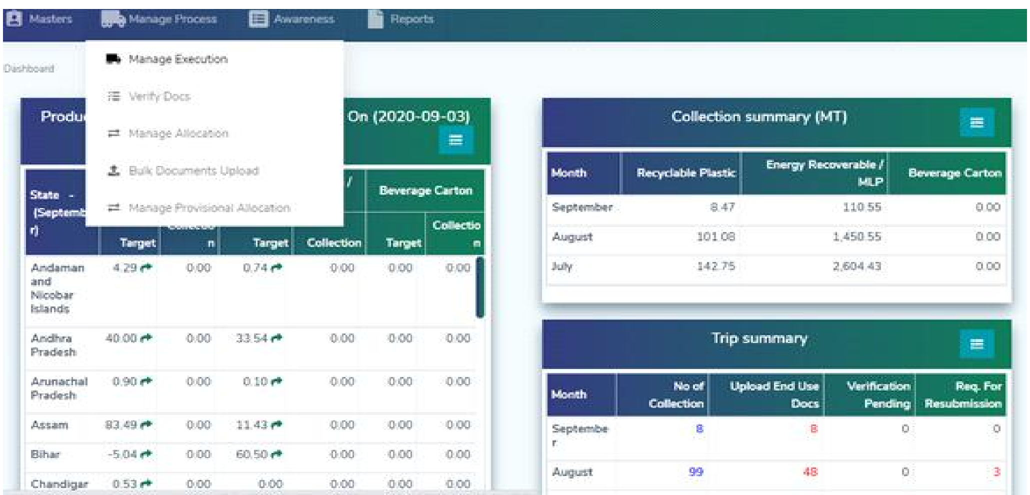
NESPL Vehicle engaged in Plastic Collection

NESPL facilitates sustainable end of life disposal of post-consumer plastic packaging waste. It launched its initiative, EPR Connect helping different stakeholders understand the importance of the system and creating an ecosystem that led to its smooth implementation. It through its network of recyclers, ensured that the collected recyclable plastics is duly processed.

Awareness Session in a School

For non-recyclables such as MLP, it created a sustainable value-chain, mitigatinga problem faced by most brands. It did so by establishing a demand and supply value chain through waste picker incentivisation and tying up with cement plants, encouraging waste to energy. To promote waste management in the recycling sector, NESPL has collaborated with many schools, NGOs and start-ups to spread awareness and also for the collection of recyclable plastics and MLPs. Through this way, it ensured implementation of the policy and Zero Waste to Landfill.

NESPL realised that apart from manual effort and knowledge, technology's role is important in regularising the system. Thus, the company's constant efforts have also been to drive change through the use of right technology. TheEPR Connect's software(such as EPR Trac and Calculator)facilitates calculation, execution, allocation, management and reporting of EPR goals, compliances and achievements.



Dashboard Screenshot of EPR Credit Allocation

Thus, the EPR Trac and Calculator has been designed to help not only to calculate EPR liability, but also in EPR execution, allocation and reporting. The processes employed at NESPL are such that it ensures transparency, giving one full access to the process through its software and renowned Dashboard Screenshot of EPR Credit Allocation third party audit report.

The first project under EPR Connect was for an FMCG brand in the year 2017. Since then, EPR Connect has served 100+ PIBO. Given NESPL's experience and knowledge, it has also been instrumental in suggesting policy changes in the Waste Management Rules to MOEFCC.

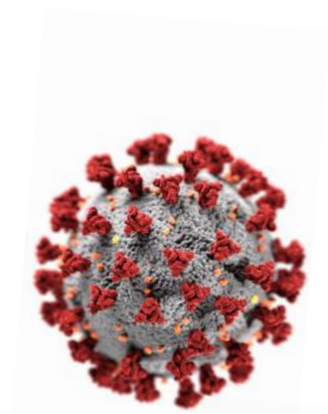
EPR Connect's success is credited to NESPL's model of efficient enviro-legal advisory, digitalisation, social inclusion and awareness measure. Its team is also equipped with knowledge and tools for legal registration and documentation. This helps bring success in the implementation of the policies and in helping improve environmental well-being.

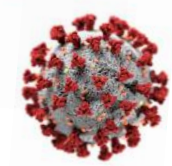
Citizen awareness on Household Bio-Medical Waste Segregation at source during COVID-19 Pandemic - India

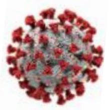
Ms. Sravanthi Rallabandi,
Founder and MD,
Urban Planner & SWM Expert,
Imbyzmo Consulting Pvt. Ltd.

Ms. Deepthi Suri,
Urban Planner and
Sustainability Consultant

> ***The absence of proper disposal methods, especially for household Bio-Medical Waste can cause huge environmental impacts and can lead to serious health problems. The success of any waste management is awareness on components of such waste and the responsibility towards segregation at source by the waste generators***







Introduction

The ongoing COVID-19 pandemic has led to an increase in demand for various Personal Protection Equipment (PPE) both in medical care and homecare settings. Use of mask and gloves in daily life is a new norm until a vaccine is made available.

The fact that waste generated from households are potential carriers for the virus is often neglected (Shukman, 2020), (Anon., 2020), (Mock, 2020) (Park, et al., 2020). In addition, the sudden rise in the use of PPEs amongst citizens in homecare settings has raised a concern for disposal.

The country has separate Solid Waste Management (SWM) Rules for households & commercial institutions & Bio-Medical Waste (BMW) Management Rules for healthcare institutions. However, the Household Bio-Medical Waste (HBMW) Management is seldom acknowledged separately and the waste is not segregated at source.

According to a Central Pollution Control Board (CPCB) report, India is generating about 101 Metric Tonnes per day (MT/day) of COVID-19 related bio-medical waste. This quantity is in addition to the regular bio-medical waste generation of about 609 MT per day (CPCB, 2020). The CPCB has further directed the States to track Covid-19 waste disposal, check spillage and ensure proper segregation of the waste in individual households. The absence of proper disposal methods can cause huge environmental impacts and can lead to serious health problems.

It will be interesting to see the behavioural attitudes of citizens across India on HBMW segregation at source. The disposal methods being adopted for the PPEs used by the citizens in homecare settings require attention. The results add to the body of knowledge that is currently available for understanding the status of HBMW segregation at source in India.

Literature Study

Solid Waste Management Rules, 2016

The Solid Waste Management Rules, 2016 focus on segregation of waste at its source. All commercial institutions and resident welfare associations are required to partner with the Urban Local Body (ULB) and segregate waste into different categories – biodegradable, non- biodegradable, construction-demolition, domestic-hazardous, horticulture, sanitary, etc. Also, they need to process biodegradable waste through on-site composting and handover recyclable waste to authorised recyclers or waste pickers. Nevertheless, HBMW usually gets mixed with other household wastes (Aarthy & Sambit, 2019).

Despite, the Bio-Medical Waste Management Rules, 2016, the country has been struggling with waste management issues. Further, the sudden outbreak of pandemic has exposed lack of preparedness to fight such battles especially in managing bio-medical waste. The Government of India has implemented several measures in managing the same.

The CPCB had prepared the guidelines for handling, treatment and disposal of COVID-19 waste generating from quarantine-homes and homecare. These guidelines are being constantly revised depending on the ground situation and evolving technical guidance as well as the information submitted by state pollution control boards / pollution control committees as well as daily data received from the COVID-19 waste tracking app (COVID19BWM).

Guidelines for Handling, Treatment, and Disposal of Waste Generated during Treatment /Diagnosis/Quarantine of COVID-19 patients-Rev.2

As per the revision-2 of the guidelines, dated 18.04.2020, for handling, treatment, and disposal of waste generated during treatment/diagnosis/quarantine of COVID-19 patients (CPCB, 2020), the definitions of quarantine home, homecare facilities and the responsibilities of the persons operating these are detailed in the below sub sections:

1.1. Definition of Quarantine Home:
The places where suspected people or the contacts of suspected / confirmed cases who have been directed by authorized hospitals or local authorities to stay at home for at least 14 days or more for observation for any symptom of COVID-19, if any and

1.2. Definition of Homecare Facility:
Home where care is to be provided to a COVID-19 positive patient at home.

1.3. Responsibilities of persons operating quarantine homes and homecare facilities:
It is anticipated that in such places, less quantity of biomedical waste is expected from quarantine homes and homecare facilities. However, the persons responsible for operating a quarantine home for suspected COVID-19 persons need to follow the below mentioned steps to ensure safe handling and disposal of waste:

- General solid waste (household waste) generated from quarantine homes should be handed over to waste collector identified by Urban Local Bodies or as per the prevailing local method of disposing general solid waste;
- Persons taking care of quarantine homes / homecare should deposit biomedical waste if any generated from suspected or recovered COVID- 19 patients, by following any of the following methods as may be arranged by ULBs;
- Hand over the yellow bags containing biomedical waste to authorized waste collectors at doorsteps engaged by local bodies; or
- Deposit biomedical waste in yellow bags at designated deposition centres established by ULBs. The bag again be stored in yellow bag or container; or
- Handover the biomedical waste to the waste collector engaged by Common Biomedical Waste Treatment Facility (CBWTF) operator at the doorstep.
- Persons operating quarantine homes/ homecare should report to ULBs in case of any difficulty in getting the services for disposal of solid waste or biomedical waste.
- Used masks and gloves generated from home quarantine or other households should be kept in paper bag for a minimum of 72 hours prior to disposal of the same as general waste. It is advisable to cut the masks prior to disposal to prevent reuse.

COVID – 19 Pandemic Lockdown Scenario in India

A series of lockdown periods were ordered by the Government of India as a preventive measure against the COVID-19 pandemic spread. It was declared after a 14-hour voluntary public curfew on 22 March, followed by an enforcement of a series of regulations in the country's COVID-19 affected regions.

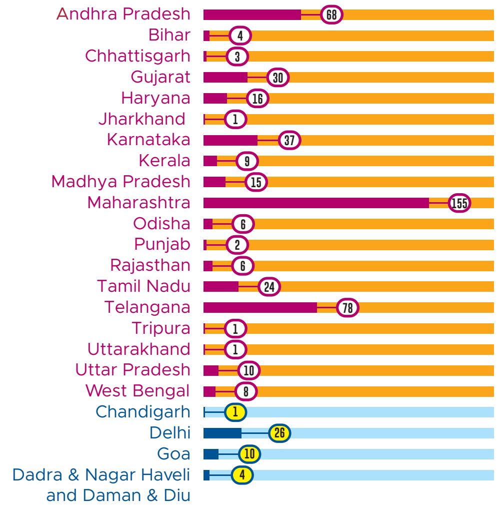
Reaction to the Situation by the Citizens:
It is understood that the pandemic has created a panic amongst citizens globally. Lack of awareness and information about the behaviour of the virus, has led people to secure themselves with whatever PPEs that were readily available at their disposal. This has led to an increase in purchasing of different types of PPEs especially disposable masks and gloves, which in turn led to the rise in HBMW generation.

Consequently, investigation of the attitudes of the citizens towards household waste segregation with a special emphasis on bio-medical waste and the disposal methods adopted for PPEs used in homecare settings is of utmost importance.

Questionnaire Design and Survey Method:

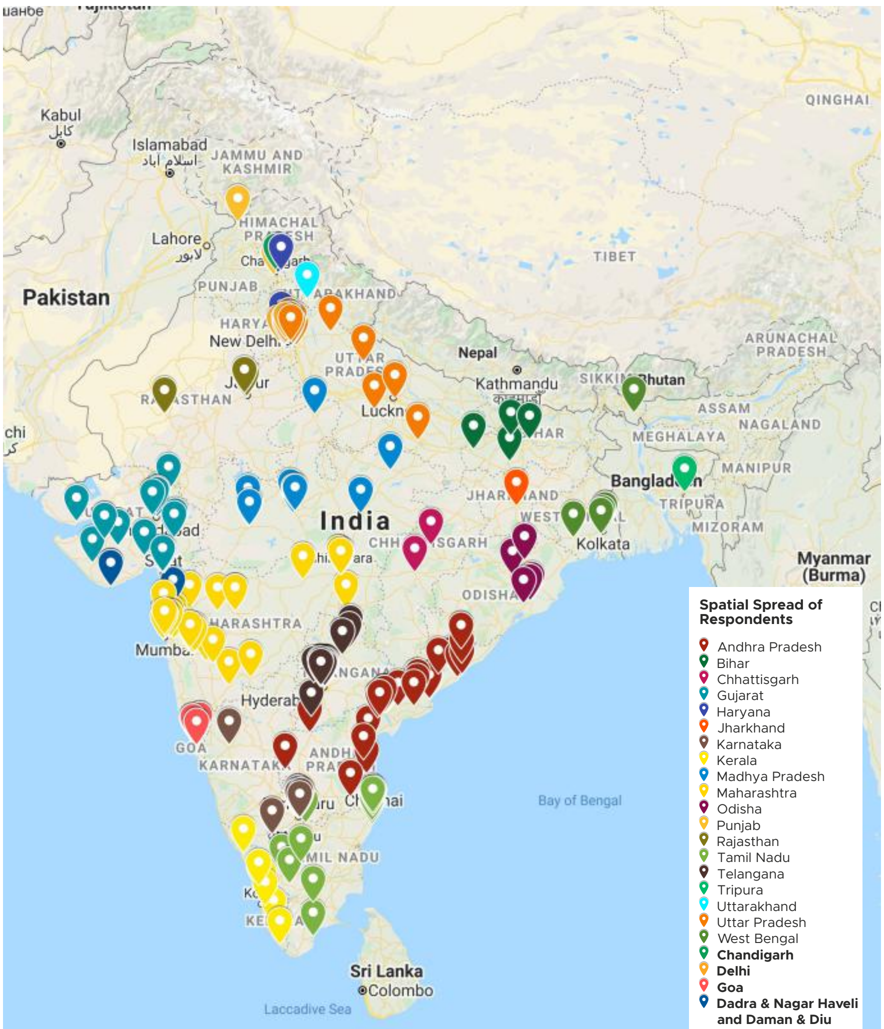
The survey was conducted between 8 May 2020 and 18 September 2020 through an online, self-report questionnaire. It examined a broad range of attitudes on the awareness about Solid Waste Management Rules 2016, current practises in household solid waste management, and opinion towards conducting segregation at source with a special focus on bio-medical waste due to the ongoing pandemic. Although the results were derived from a relatively small sample and so cannot justifiably be generalized, they do however add to discourse on HBMW segregation at source in India.

The study findings are based on data provided by 515 respondents from cities and towns spread across 19 States and 4 Union Territories.



Graph 1 State and UT wise number of respondents

While the spatial spread can be seen in the map presented below, distribution of the respondents is included in the graph below. The respondents include diverse age-groups, educational backgrounds and employment from various cities and towns.



The respondents were asked to identify the types of segregation that they currently practice or likely to practice in the future; and that they considered most appropriate for better waste management. A query that specifically targeted about knowing the potential barriers for segregating waste at source was also raised. Moreover, the respondents were asked to identify various PPEs used in homecare settings from the COVID -19 virus and the corresponding disposal methods adopted at source.

While the survey captured a broad range of behavioural attitudes towards waste management, the aspect of the research reported here focuses on responses to two research questions. They are:

1. What are the behavioural attitudes of citizens on household solid waste segregation at source with a special focus on bio-medical waste?
2. What are the various safety products, the citizens are using, for protection during the pandemic and their disposal methods?

Survey Findings:

The survey results are analysed in two sections. They are:

Part – I: Citizens behavioural attitudes towards HBMW handling

Part – II: Types of PPEs used in homecare settings and their waste disposal methods

The following sections give details of the survey findings.

Part – I: Citizens behavioural attitudes towards HBMW handling

Under the Swachh Bharat Mission, after its launch in 2014, the states and districts have put in a lot of efforts in creating public awareness through IEC campaigns and capacity building programs. These emphasize on sensitizing citizens about types of household waste, segregation categories and importance of solid waste segregation at source, etc., which in turn establish a base for developing behavioural attitudes towards household solid waste management. Hence, the enquiries focus on understanding the behavioural attitudes.

1. Awareness

Existence of Solid Waste Management Rules, 2016

Nearly, half of the respondents confirmed that they are aware of the Solid Waste Management Rules, 2016. About 13% stated they have a fair idea and the rest denied about the awareness on existence of the Rules.

Rules for Waste Generators in the Solid Waste Management Rules, 2016

It is noted that almost 43% of the respondents are aware of the rules applicable for waste generators in Solid Waste Management Rules, 2016 and 15% have fair idea. Whereas, about 42% are not aware of the Rules.

Waste categories and segregation types

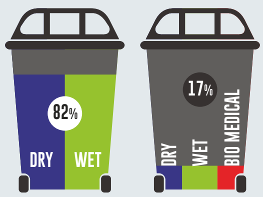
The findings reflected that a little over half of the respondents are knowledgeable about the waste categories and their segregation types. About 41% are somewhat aware and of which 13% of the respondents said that they will find out if necessary. Interestingly 2 respondents said they are do not have intent in knowing about the matter.

2. Household Collection System and Citizen's Practices

Door-to-Door Waste Collection System:

84% of the respondents from both States and UTs claim that there is door to door waste collection system in place. However, only 70% of them confirmed that they follow waste segregation at home.

Type of Waste segregated at source:



Out of 70% respondents who segregate waste at source, only 78% segregate their waste into wet waste and dry waste and about 17% segregate their waste into dry, wet and bio-medical waste.

The survey also found a remarkably interesting fact that the pandemic led to segregation of only bio-medical waste at source by a very negligible number of respondents i.e. 1%.

Reasons for not segregating waste at source:

When enquired about the reason for not segregating waste at source, it is found that approximately two-third of the respondents believe that the waste collector anyways mixes it despite of doing so. The other reasons stated are lack of compulsion from ULBs, lack of intention and lack of awareness.

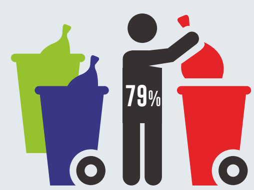
3. Citizens Perspectives:

Waste segregation should be done at source:

Two - thirds of the respondents believe that all the three types of wastes namely, dry, wet and bio-medical should be segregated at source and less than one-fourth of the respondents think only dry and wet waste should be segregated. However, a negligible number of the respondents stated that they are not sure of it. Only 2% think that the waste need not be segregated at source and it is the responsibility of the ULB.

Need for segregating bio-medical waste at source:

About 79% of the respondents from States and UTs agreed that segregating bio-medical waste at home is important and should be a general practice. A mere 11% respondents consider doing so at home should be carried out only during such pandemics. The remaining 10% opined that they are not sure.



Knowledge about the waste disposal methods being adopted by the ULBs:

Nine in ten respondents think it is important as a citizen to know about the disposal methods being adopted by the ULB as it helps in bringing the clarity behind segregation making them more responsible.

Part – II: Types of PPEs used in homecare settings and their waste disposal methods

At the onset of survey, it is understood that the use of disposable PPEs used in homecare setting has increased the HBMW quantities many folds. Hence the survey question targeted to understand the user-behaviour about these products.

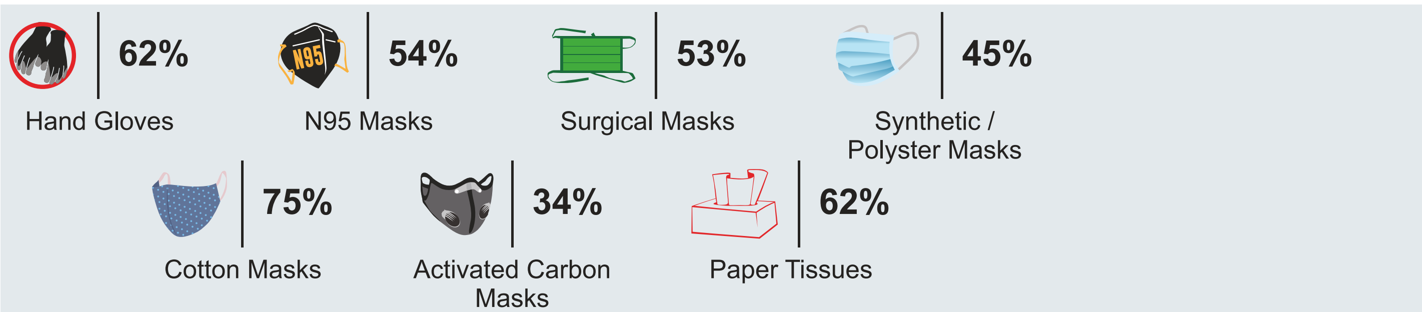
1. Types of PPEs used during COVID – 19 in homecare settings:

A variety of safety products are being used as a preventive measure from COVID -19 by the citizens. Most of these products are cotton masks, hand gloves, and paper tissues which are easily available in the market.

As per the Centers for Disease Control and Prevention[1] (CDC), N95 masks and Surgical masks are meant for healthcare workers and first responders and is not recommended for use of general public. Further, the CDC recommends the use of only cloth face coverings such as cotton masks, synthetic and polyester masks for the General Public.

It is noted that the N95 is used by nearly half of the survey respondents due to lack of awareness, information and fear.

The below visual representation captures the percentage of respondents using the protective equipment:



2. Usage of PPEs used in homecare settings:

The survey findings present that, many respondents, due to unawareness and high prices of the masks, are reusing the N95 masks and surgical masks which are meant for healthcare workers and first responders and one-time use only. Amusingly, some respondents said, they are sanitizing and reusing and some of them said they are washing and reusing the one-time disposal masks.

The Government has many times urged citizens to use cotton masks that can be sanitized, washed and reused multiple times to avoid shortage of medical masks and control the burden on the waste being generated due to one-time disposal PPEs.

It is also noted that some of the respondents are reusing hand gloves after washing or sanitizing.

The below visual representation captures the consolidated information on the usage of PPEs by the respondents :

[1]Guidelines for using the PPEs are brought out by WHO, MoH & FW, ICMR, CDC and other concerned agencies from time to time.

3. Measures being taken before disposing one-time usable products

The survey shows that, the one-time usable products used in home care settings, are being disposed off in various ways due to lack of awareness and information dissemination. Only a negligible number of respondents are sanitizing/washing the PPEs and throwing it separately in a bio-medical waste bin.

Nearly half of the respondents are disposing it off unwashed which is a major threat to the humankind in spreading the infection as well as negatively impacting the environment. Of them, about 21% are disposing it in mixed waste and 32% are separately placing it in dry waste.

Recommendations

Considering these findings, we offer four recommendations:

R1 **Capacity Building and Awareness :**
While the states are concentrating on creating awareness on segregating dry and wet waste, it is necessary to educate them on the importance and segregation of household bio-medical waste and its components including PPEs used in homecare settings under such pandemics.

R2 **Increase Transparency and Build Trust :**
A transparent dialogue between an ULB and its citizens help in building awareness on the technologies being adopted to dispose various types of waste and educate on their responsibilities towards waste segregation at source.

R3 **Sturdy Household Bio-Medical Enforcement Framework :**
It is indeed necessary to not only include household bio-medical waste in the waste management plans/rules/guidelines but also a strict enforcement by-law must be designed to ensure its implementation.

R4 **Keep leading through collaborations and address Infrastructure Gaps :**
Bringing in advanced technologies and leveraging in tracking bio-medical waste aids in bridging the infrastructure gaps. The learnings from mapping and tracking the best bio-medical waste management practices will help in strengthening the system from grassroot level.

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Success Story of transformation of Waste Dump in Coonoor, Nilgiri hills into Waste Management Park.

Citizen's initiative: ***Clean Coonoor*** *and the urban Local body:* ***Coonoor Municipality*** *together came up with an initiative to transform the town's landfill into the impeccably well-kept facility. A perfect example of collaborative efforts.*

Ms. Pankaja Srinivasan, Journalist

Municipal Solid Waste Management (MSWM) in a town is a simplistic story. Traditionally all over India, it has been a practice to collect waste from household in a city or town & transport it to a point away from population & dump it in a form of heap. Years together this practice goes on & what you get is cauldron of diseases, foul odor etc, from which obnoxious water flow onto the adjoining ground & hazardous gases emanate into atmosphere. Such picture prevails all over India, whether it is metropolis or a small village. Many urban local bodies are attempting to change this scenario, under Swachh Bharat Mission (Clean India Mission).

Coonnoor, a picturesque sleepy town near Ooty, the famous hill station in Nilgiri Range, had a similar story over the scores of years. Someone thought of changing it altogether. This very will in the minds of administrators of the town is the key to the story, which follows.

A joint effort by local inhabitants, the Coonoor municipality and the district administration of the Nilgiris in Tamil Nadu has converted a waste dump yard into a beautiful waste management facility where 110 tonnes of plastic and nearly 96 tons of paper waste have been recycled since last November.

Till a couple of years ago, at Ottupattarai, a foul, fly-infested, festering municipality city dump was situated less than four kilometers away from Coonoor town, a hill station in the Nilgiris, Tamil Nadu, about 550 km from its capital Chennai.

Today, the Ottupattarai waste dump yard that is spread over 3.237 hectares can easily pass off as a tourist destination. It occupies a vantage point and overlooks Coonoor town, a part of the Coonoor Pass, the historic fort of Hulical Droog that in the 18th Century was used by Tipu Sultan, and Ketti valley and the Kundah ranges in the distance. It is now called as "Ottupattarai Waste Management Park"

A lot of tender, loving care has gone into cultivating flower beds and lawns over a hectare of the land with splashes of colour where dahlias, petunias, a few pansies, daisies, honeysuckle, delphiniums and zinnias bloom. Nearly 40 bottle brush and erythrina saplings are slowly growing into trees.

All this began less than a year ago in November 2019, when the waste management project was launched. The challenge of transforming the waste dump into the impeccably well-kept facility, was taken up by a citizen's initiative called Clean Coonoor, that registered itself as a non-profit last year and signed a Memorandum of Understanding with the Coonoor Municipality in January 2020, to deal with the nearly 97 tons of dry waste generated in town.

A few months prior to that, on World Environment Day, June 2019, Clean Coonoor along with the Coonoor Municipality, had undertaken the cleaning of a stretch of the Coonoor river and removed nearly 12,000 tons of sludge and garbage from it. The sludge was deposited at Ottupattarai and the Municipality requested if the non-profit would clean up the area and landscape it. Thereafter, Clean Coonoor offered to handle the dry waste that came there and look after the facility.

As work began, villagers from and near Ottupattarai began trickling in looking for a job at the facility. In January this year, there were six people in the facility. Now it employs 20 people. These include 14 sorters like Sivagami and Ilakiya villages, who are paid Rs 9,000 each every month. There is an incinerator operator, one baler operator, a night watchman Pughal, who is a loader and a part time guard. Together they deal with the nearly-100 tonnes of waste that ends up at the facility. The sorters segregate the dry waste that is brought there by the municipality lorries.

"Before November, the municipality dumped the dry waste at Ottupattarai, that is all. Only when Clean Coonoor came into the picture did the segregation and the real clean-up happen," Commissioner, Coonoor Municipality, K Balu, told a local newspaper.

"It has speeded up the process of streamlining the waste collection to an extent, and we hope the people of Coonoor will appreciate the hard work and be more proactive in segregating their waste before handing it over to our sanitary workers. It will only clean up their town better and quicker," he added.

The municipality tries to ensure segregation at source. Coonoor generates about 13 tonnes of waste per day. Of that, on an average, three tonnes of dry waste per day comes to Ottupattarai and about six tonnes go to Reilley Compound, about three and a half kms away where it is composted. The remaining wet waste is handled and dealt with in local parks.

Clean Coonoor has a core team of 20 members with many volunteers who come and go. One of its trustees Vasanthan Panchavarnam, along with another volunteer Navin Joseph, oversees the waste management park while the others are working with sprucing up Coonoor town.

"There is a remarkable change in the way the inhabitants are treating their garbage. Most of them are segregating at source, and that positive attitude has helped us take the project forward more efficiently," founder member and managing trustee of Clean Coonoor Samantha Iyanna commented to the local newspaper. "It is the same spirit of wanting to give back to the town that is inspiring other cleaning projects", she added. "The younger generation that had returned home in the past few months is now involved in cleaning up bus shelters and painting graffiti on the walls," she said.

Gandipet Welfare Society, a non-profit that does similar work in villages in Telangana to make them plastic-free, has funded the river cleaning and the Ottupattarai project. "Many of us who own homes in the Nilgiris have contributed nothing to it, and I have been coming here for more than 35 years, and when I heard of Clean Coonoor, and its plans to clean up the hill station, I thought it was a project worth supporting," Rajshree Pinnamaneni, member of the Hyderabad-based non-profit, told local newspaper. The nonprofit has contributed nearly Rs 50 lakh and continues to pay about Rs. two lakh per month for the running of the facility.

In the first two weeks of September alone, dry waste, weighing 41.868 tons has been deposited at the facility. Plastic waste accounts for 5.6 tonnes of it. The recovered plastic, almost all of it, is compressed into bales weighing 250 kgs each and transported to Hyderabad about 850 kilometres away where a solid waste management organisation called Pyrogreen Energy Pvt Ltd. extracts fuel from it that can be used as furnace oil. The company pays to transport the plastic.

PYROGREEN
ENERGY PRIVATE LIMITED
http://www.samkigroup.in

Segregating, sorting, recycling and upcycling has a huge positive impact on the environment. "Consider this. By recycling the amount of plastic we have done in the past eleven months, it is tantamount to saving 120 barrels of crude oil and 630 megawatts of electricity."

Recovering and recycling the paper waste also has a huge impact, said Panchavarnam. "The facility has had a hand in saving 1,682 trees and 2.5 million litres of water, besides preventing 95 tonnes of carbon equivalent in greenhouse gas emissions," he explained. Companies in Pollachi and Erode take away the paper and cardboard to turn them into paper boards.

This unique waste management project, besides handling the growing waste problem in Coonoor, is also providing livelihoods to many local villagers.

Clean Coonoor is considering setting up a plant to extract fuel from waste plastic. The district administration has sanctioned land and the non-profit has found someone who has agreed to fund 20 per cent of the cost (the total estimate is two crore rupees). We are hoping we will get the rest of the 80 per cent from CSR funds," said Panchavarnam. If the plant comes up, Clean Coonoor believes it can handle the plastic waste of the entire Nilgiris district, not just of Coonoor. "Imagine how much of the waste we can prevent ending up at landfills and water bodies," exclaimed Panchavarnam. Setting up of the plant would also mean more employment to local inhabitants, who are having an especially hard time of it, with this year's tourist season being completely washed out.

Another outcome of the spruced-up Ottupattarai garbage dump is that real estate in the area has gone up. A real estate promoter attributes this almost entirely to the cleaning up of the area. According to him, five years ago, the plots that were selling for approximately Rs 1.5 lakh a cent are today valued at anything up to Rs 5 lakh a cent.

"Clean Coonoor is bringing dignity into what is considered 'dirty work'. I hope the hard work the non-profit is putting in and the novel waste management park it has developed will make people pause before they discard garbage outside their homes," says the collector of the Nilgiris District, Tamil Nadu, India.

 # (Based on report from Pankja Sriniwasan in Gaaon Connection, Coimbtoor, Tamil Nadu. [https://en.gaonconnection.com/taking-trash-to-task-local-inhabitants-the-municipality-and-a-non-profit-in-coonoor-tamil-nadu-convert-a-dumpyard-into-a-waste-management-park/

Plasma Gasification : A promising solution for Municipal Solid Waste Management

> ***Traditional waste management methods are slowly being abandoned due to environmental problems & land requirements and the increasing problems with disposal technologies have given impetus to redevelop plasma technology with an aim to reduce capital & operating costs and the fact that it can also produce valuable co-products is an added advantage.***

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"Over the past few decades the plasma-waste treatment has become a more prominent technology. The increasing problems with existing waste disposal technologies have given impetus to redevelop plasma technology with aim to reduce capital & operating costs. The fact that it also can produce valuable co-products is an added advantage. A pilot plant, based on indigenously developed air plasma torch, is being developed at University of Pune, India in collaboration with BARC, Mumbai, India. The main aim is to develop it for gasification of MSW at an R&D scale.

a. Savitribai Phule Pune University. Pune;
b. L & PTD , BARC, India

Preamble

A sustainable and successful treatment of MSW should be safe, effective, and environment friendly. Many countries including India are actively working towards addressing the issue of disposal of municipal solid waste. However an efficient and viable, but cost effective technology for Indian sites is still a distant dream. .

Traditional waste management methods, such as landfills/dumps are slowly being abandoned due to environmental problems & land requirements. Many countries, including India have introduced tighter regulations that stop practice of dumping. Dumping give rise to global warming by releasing CH_4, which is 21 times more dangerous as a greenhouse gas than CO_2. Therefore, we must find a more environment friendly alternative to treat MSW. Figure 1 shows an example of the disaster arising from such a waste dumping cite in Mumbai during recent years. The fire could not be controlled for days.

Effect of Dumping The MSW : at Deonar, Mumbai

Figure1 . Problems arising from the dumping of MSW, with an outbreak of fire. [From the Net]

Three basic thermal disposal processes are: Pyrolysis, Gasification, and Incineration. In the first case, the processing is done without any external supply of oxygen. On the other hand the method of incineration (process of combustion in excess air), which is increasingly being used in practice for reduction of the waste. However, high flow rates of the off-gases including dioxins & large amount of residues makes it less suitable. Furthermore, many wastes have a low calorific value, whose combustion requires additional sources of fuel. In our country the uncontrolled incineration in open creates heavy pollution as seen in Figure 2.

Incineration produces pollution

Figure 2. Incineration of solid waste in open air.

Plasma Gasification and its benefits

Alternatively a better process is known as Gasification, which is defined as the thermo-chemical conversion of carbon-containing materials to Syngas, in atmosphere of gasifying agents providing insufficient oxygen. Various gasifying agents are air, hydrogen, steam, and their mixtures. Gasification of MSW in such media can prevent dioxin and reduce acidic gas formation due to the higher temperature and reducing conditions. The products of the gasification of MSW are gases, which are mainly carbon monoxide, hydrogen, carbon dioxide, and hydrocarbons.

Following Table shows the comparison between the plasma gasification and incineration processes.

PLASMA GASIFICATION	INCINERATION
No harmful air emissions during syngas production	Air emissions can include high levels of greenhouse gases, other air pollutants and dioxins and furans
No smoke at stack	Requires high volume smoke stack
Solids may reduce to inert slag that has commercial value	30% of solids remain as ash that is solid waste and potentially hazardous solid waste
Occurs in an oxygen starved reactor	Excess air is added to the incinerator
Plasma generator provides all the energy required for the process	Supplementary fossil fuel is required to sustain the process
Decomposition of waste into syngas or energy-rich fuel	Burning : all energy converted to heat (part of it is harvested as steam & rest is wasted in flue gases.)

The best solution lies in the use of Thermal Plasma assisted gasification for treatment of wastes, which is known to be most suitable, efficient and environmentally friendly technique, for last few years. This is because of the ability of plasma to vaporize anything and destroy any chemical bonds. This process does not need a major segregation of the waste and thus a non-segregated MSW is acceptable as a feedstock. Typically, most organic compounds are thermally unstable and at high temperatures, the chemical bonds of organic molecules break, producing smaller molecules such as hydrocarbon gases and hydrogen gas. At high temperatures, the mixture of generated gases consists of stable syngas (CO and H2).

The principal advantages of the plasma process are:

1) It has high energy densities and high temperatures (>50000 C), enough to convert any kind and all kind of un-segregated waste materials into constituent atoms which can be re-assembled into less harmful materials 2) Allows rapid heating 3) High reaction transfer rates 4) Smaller installations compared to other incinerators 5) Melting of high temperature materials 6) High quench rates to obtain non-equilibrium compositions or meta-stable materials 7) The thermal energy content from the off-gases can be used for generating electricity.

Therefore plasma gasification of wastes has once again attracted interest as a source of energy for the treatment of even the municipal solid wastes.

Actual MSW consists (Fig. 3) of a series of heterogeneous materials, including inorganic and organic components. Over three quarters of municipal waste consist of relatively harmless household waste made up of paper, card, glass, plastics (of various kinds), metals (mostly iron and aluminum) and food waste. In many countries, much of this is separated and recycled or (in the case of food waste) composted or fed into an anaerobic digester. In plasma gasification the waste input is pyrolyzed by the high temperature into its constituent elements: H2, O2, C, N2 etc. The reactor conditions are controlled so that prior to exit, the elements reform into the desired syngas. The materials that cannot be converted into syngas, such as metal, glass, rock and concrete are vitrified to produce an inert slag. The slag is 1/250th of the volume of the processed solid waste, in contrast to 1/30th of the volume in case of conventional incineration. The slag is used as vitrified ceramic as a construction material. In incineration, excess O_2 is added to the input waste so that at low temperature it burns. The result is heat and an exhaust of CO_2, H_2O and other products of combustion or partial combustion. Ash is about 30% of the original solid. This is a solid waste and could be categorized as hazardous solid waste.

Approximate Composition of Municipal Solid Waste

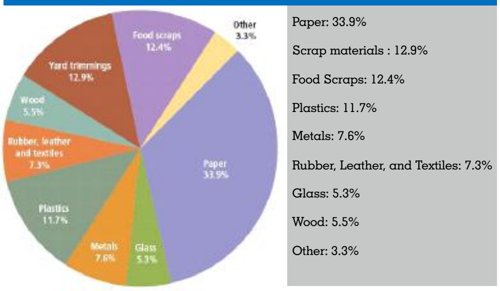

Figure 3. Municipal Solid Waste consists of varieties of materials.

Thermal Plasma Torches

Most thermal plasmas are generated by either an electric arc or by a radio-frequency induction (RF) discharge. In waste treatment, arc plasmas dominate because they are relatively insensitive to changes in process conditions. The arc-generated plasma is used in two configurations, viz. a transferred & Non-transferred. Transferred arc is where one of the electrodes is usually the material to be treated. Non-transferred arc plasma is where the arc is contained inside a plasma torch and the plasma jet exiting the torch is used for processing.

In the transferred arc configuration, the waste material is exposed to the arc plasma, which typically has peak temperatures of 12000deg K to over 20000deg K, depending on plasma gas, location in the arc and the cooling of the arc. The most frequently used plasma gas is air, for economic reasons and for providing oxygen for reactions with carbonaceous materials.

Steam and carbon dioxide are also used as plasma gas because the higher arc voltages increase the jet power. However air has the greatest energy efficiency, so if the goal is to deal with MSW using the lowest amount of energy, without considering the products, the air gasifying agent is the best choice. In a simplistic view, a plasma torch generates heat, via the passage of an electric current through a gas flow.

Plasma technology has been used for a long time for surface coating and for destruction of hazardous wastes but its application to MSW has still to be explored fully because of the high cost of using electricity as a source of energy. Analysis shows that the capital costs of plasma-assisted "waste to energy" (WTE) are higher than the traditional WTE plant, especially due to the cost of the plasma torches. Different types of plasma torches and open arcs, their fundamental differences in architecture, jet behavior, operational constraints, and evolution of interesting electromagnetic forces inside them have been published elsewhere (3).

Plasma - Plume can melt any metal

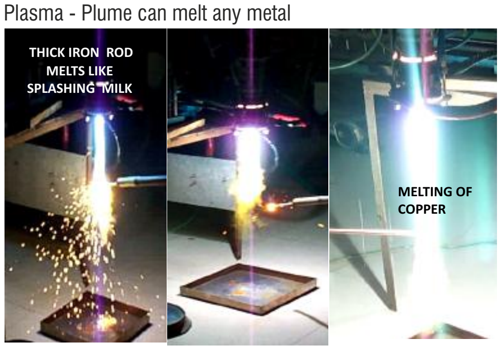

Figure 4 .The plasma jet from air plasma Torch (Developed in BARC)

Features of Thermal Plasma based Gasifier

A plasma based gasifier plant is capable of completely disintegrating the feedstock consisting of MSW in total, which needs to be shredded for the ease in feeding. The main reactor consists of a refractory brick-lined vessel fitted with one or more properly designed Thermal Plasma Torches. The waste is fed into the vessel and there are two outlets, one for the off-gases and other for the flow of the heavier slag. The vessel can also be partially filled with cock-bed so as to improve the performance by proper design of heat balance inside the reactor. The off gases consist of syngas, CO_2, CH_4 along-with fractions of NOx, and SOx. The fractions of Dioxin can be controlled to negligible amount by proper control of high temperatures inside the reactor chamber. The off gases are made to pass through secondary refractory combustion chamber, where a DC or RF ignition produces the required combustion of the Syngas with added air to the chamber. This produces CO_2 and H_2O. The out flowing gases pass through a heat exchanger (quencher) which produces high temperature steam which can be used for generating electricity. The off gases from this section are then made to flow into a properly designed scrubber, which is capable of purifying all the toxic gases by chemical reactions. The major byproduct at this stage is clean CO2, which can be used for the catalytic reactions. Remaining exhaust gases consist of nitrogen water vapor and air and a small fraction of carbon dioxide. The slag removed from the primary plasma reactor is made to flow into a water tank for its further use as vitrified blocks.

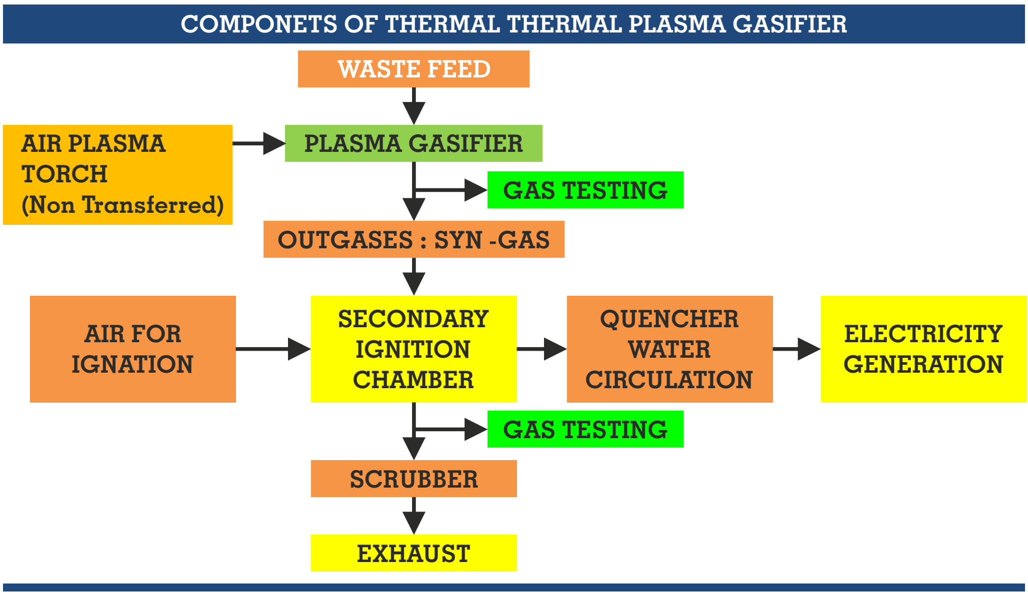

Figure 4 .The plasma jet from air plasma Torch (Developed in BARC)

In plasma-based waste treatment, depending on the interest, there might be different objectives: a) destruction of waste alone with highest volume reduction; b) objectives as in the first along with conversion of residue into useful material; and c) objectives in the first two cases along with the generation of electricity.

How popular is Thermal Plasma Gasification Technology?

Plasma gasification of wastes has attracted interest as a source of energy and numerous plasma waste treatment installations have been in operation for many years. Few to be mentioned are 'Swindon company Advanced Plasma Power' at UK, 'Tectronics', a sister company based in Faringdon, 'Pyro Genesis' at Canada, 'Garbage in Energy out' at Hurlburt Field Air Force base in Florida. In Japan, two plants using MSW as a feedstock are commercially operating in Japan, built and operated by Hitachi Metals, in Utashinai and Mihama-Makita, using the Westinghouse Plasma. These units handle upto 150 tpd of MSW. The EcoValley facility in Japan can process up to 220 tpd if it is processing only MSW. A plant of similar size, designed to process industrial waste and wood chips, has been installed in Morcenx, in southern France. Pyrogenesis Corp. at Canada has been working for the shipboard waste with a higher regulation for ocean water pollution. The reactor has a small volume and has a power requirement of 300 kWh/t- for medical waste, generating enough electricity for waste throughputs of 6-10 tpd. Several commercial systems treating up to 17tpd are in operation, including one in Richland, WA, for treating LLRW. Atkin Plasma Gasification Assessment has carried out an extensive research. The Ottawa Canada demonstration plant processed its first municipal solid waste in 2008.The Plasco Energy Group at Canada have safeguarded all the environmental regulatory norms during its demonstration of the Plasma Gasification plant. They burn 75 to 85 tpd of MSW and produce 5.2MW of electricity. Various other companies like Pyrolysis Systems Inc., Canada, Siemens Germany, Plasma Energy Applied Technology Inc. USA, Plasmapole France etc. are active in the development of plasma systems using plasma-arc technology. Westinghouse Environmental Services, USA demonstrated a prototype unit of dc arc incinerator in 1987. Electrical Industry Research Institute in Hungary developed a plasma reactor pilot plant in 1988, for the destruction of halogenated six chemical-industry waste. Retech Incorporation of California and US Department of Energy initiated a collaborative program to destroy a variety of waste using plasma-arc technologies in 1989 and later, in 1994.In South Korea GS Platech, the daughter company of GS Caltex – Korea oil refinery and energy company, has originally developed key technologies of Plasma Gasification & Vitrification . This company is operating with a capacity of 100tpd and also producing electricity.

In India Facilitation Centre for Industrial Plasma Technologies (FCIPT) Gandhinagar, Gujrath; have developed Plasma arc technology for the plasma pyrolysis reactor and have studied the plasma incineration processes in details. They have used Arc between consumable graphite electrodes in their pyrolyzer unit. Maharashtra Enviro-Power Corporation, Pune had started a project with Westinghouse Plasma. However, it was not every successful in terms of electricity generation. Laser & Plasma Technology Division of Bhabha Atomic Research Centre, Mumbai and S. P. University of Pune are working with the air plasma based waste gasification. In general, a plasma gasification facility can process more tonnage of lower calorific value feed stocks than higher value feed stocks.

Scope and Facts

Although plasma treatment of waste by gasification can provide clean and quick solution, it has some disadvantages. First issue is the high cost of electric power, which it needs and the second is the cost of plasma torch and its maintenance. Since this being energy-intensive, plasma plants operating with an objective of only reducing the waste may not earn any revenue because of the issue of high process cost per kg of waste. Economic consideration makes such plants fail, as alternative technologies exist to offer lower process cost. **However, if the system operates with the objective of providing the by-products like the useful gases; it can reduce the process cost by eliminating landfill and earning revenue from the residue.** However, if the objective meets the ultimate goal of producing enough electricity to supply to the grid after meeting the requirement for the process itself, it will prove itself as a smart management solution for a smart city. Such units may survive by generating revenue from the electricity alone. However, with optimistic view, even if such a plant generates enough electricity for its own operation, it is a better option to treat the MSW at local areas of corporation to generate a clean environment in thickly populated Indian cities.

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Contribution of Zonta Global Infratech GmbH, Germany to waste management in India for sustainable climate protection with circular economy principles

> ***The combination of today's demand on modern town planners and varying conditions on location make it necessary to consider customized solutions utilizing the sub surface in emerging cities. The separate collection of residual waste and organic waste etc. is increasing among the population and also in most of the Indian cities today.***

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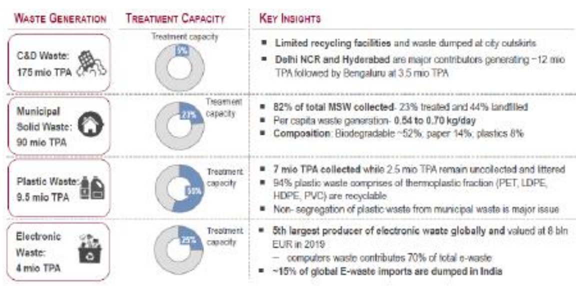
Solid Waste Management [SWM], which is already a mammoth task in India is going to be more complicated with the increase in urbanization, changing lifestyles and increase in consumerism. Financial constraints, institutional weaknesses, improper choice of technology and public apathy towards Municipal Solid Waste (MSW) have made this situation worse. The current practices of the uncontrolled dumping of waste on the out-skirts of towns/cities have created a serious environmental and public health problem. The focus of this article is to present possible solutions, in view of the circular economy principles, which shall help in mitigating the climate challenges with affordable and state of the art systems.

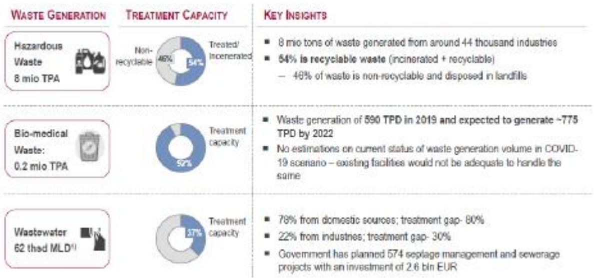
Most people underestimate extensive recycling and waste management activities as a means of achieving the environmental and climate targets. When talking about solid waste recycling in India, people have so far limited themselves to the topic of "plastic waste, e-waste etc". Although officially the Rules & Regulations are in place since long time, so far, implementation on how to deal with and handle such waste more precisely is absent. Due to lack of strict monitoring, recyclables including plastic waste, e-waste are getting mixed up in regular streams of municipal solid waste and are dumped un-controllably into dump yards or in the so-called landfills. The main contribution to greenhouse gases comes from methane emissions from landfills. This poses a serious threat to the society. Without recycling quotas and maximum landfill quotas, no circular flow economy can be established, which means that the ambitious climate targets are moving further away. Thus waste industry can be a potential reducer of greenhouse gas (GHG) emissions. The good news is that in the meantime active and intensive approaches have been initiated in all directions in India by various initiatives such as Swachh Bharat Abhiyan (SBM), AMRUT Mission, Smart City Mission and steps towards Extended Producer Responsibilities (EPR) etc.

India is still in its infancy when it comes to the implementation of proper waste management treatment practices. India's



solid waste is estimated in 2019 at 287 million TPA; municipal and construction waste accounts for 92% of total solid waste generation (Others: Plastic (9.5 million TPA), Hazardous (8.0 million TPA), Electronic waste (4.0 million TPA) and Bio medical (0.2 million TPA)). There is no significant infrastructure for handling this amount of waste.

This is exactly where ZONTA brings fast and effective integrated smart solutions (termed as ZOlutions) with often adaptations to changing conditions. Active climate protection starts with waste separation or segregation of solid waste at homes/source.



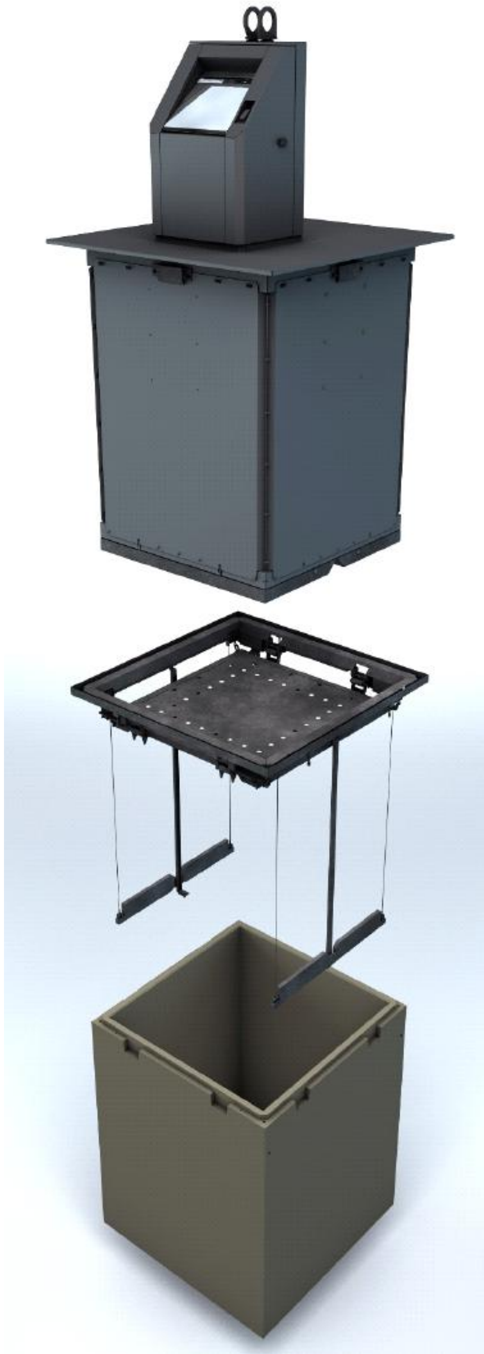
Zonta's ZOlutions, i.e. collecting recyclable materials/waste, recycling it materially and energetically and, as a result, using modern technical processing technologies to obtain climate-friendly energy from waste materials, help in managing the waste professionally and are consistent and forward-looking. Particularly to support splendor of the urban cities, Zonta delivers sustainable and eco-friendly infrastructure.

Our services are basically divided into Industrial/Commerce Services for private companies and Public Services for Municipalities and Smart Cities. However, the limits here are seamless. With our comprehensive public services and industrial private services we guarantee maximum performance and optimal availability of build-in assets. From the production of the various smart waste collection and storage containers to the design, construction, maintenance and operation of Material Recovery Facilities (MRFs), Energy from Waste (EfW) / Anaerobic Digestion (AD) technologies and Scientific Landfills, we perform numerous tasks at various levels of value creation. Our ZOlutions are built around these core technologies and supporting competences. They include all aspects of a project from financing, material analysis and project feasibility studies, to technical design, installation, commissioning, automation, maintenance and operations. Whether the customer requirements are based on a particular fuel type or the need for expert, objective analysis, our detailed knowledge and experienced teams offer the most appropriate solutions and objective advice in the Infrastructure. The goal is always the same: more quality and efficiency.

Zolutions: Smart Underground Bins and Fill Level Sensors

The waste problem is most severe in urban regions and developing countries, where disposal services almost do not exist or cannot cope with increasing amounts of waste. As a result, waste is either disposed in open and uncontrolled dumpsites or openly burned. These practices have deleterious impacts on public health, the environment, and the wellbeing of waste workers and nearby residents. ZOlutions are proven solutions worldwide to improve waste management practices that will reduce emissions from the sector and lead to cleaner, more sustainable cities. Zonta creates such an eco-friendly infrastructure, by designing, manufacturing and operating waste management, that they deliver long term sustainable benefits.

The combination of today's demand on modern town planners and varying conditions on location make it necessary to consider customized solutions utilizing the sub surface in emerging cities. The separate collection of residual waste and organic waste etc. is increasing among the population and also in most of the Indian cities today. If the systems are not adapted to the collection behavior, volumes and local conditions, side effects, such as overfilling, visual obstruction, noise and odor nuisance etc. will arise.



These underground collection containers are laid completely under the subsurface of the ground. Above the ground, depending on the design, differently designed throw-in columns are mounted on ground level plateaus, which can also be easily reached by wheelchair users and children. The containers are located in underground concrete structures from which they are pulled out for emptying. The use of underground space is today a key issue for achieving environmentally friendly and sustainable development, particularly in urban areas. It allows activities or infrastructure whose installation above ground is difficult, ecologically undesirable or even less profitable to be moved underground, freeing valuable surface space for other uses and improving living conditions in cities.

These systems are nominated for the Prime Ministers Excellence Award 2020 and are currently operational in 20 cities across India. Due to the high collection and storage capacities these bins are ideal solutions in high voluminous waste generation areas

across the cities and also are helpful in avoiding the so called "Blackspots" in emerging cities. Furthermore the underground bins are also equipped with Fill level Sensors, called ZenZit, A self-learning algorithm will independently create the most efficient collection routes from the fill level data from bins. The routes are then transferred directly to the truck driver's navigation device. This combination would give a considerable degree of flexibility, security and transparency. The analysis of the long-term data would also allow to make recommendations for new container locations. These intelligent and smart containers and sensors would benefit the citizens, the city and the environment in the long term. The logistic movement of waste collection would be reduced thus by about 15 percent and this would also mean a significant reduction in CO_2 and nitrogen oxide emissions for the cities concerned.





Crane Mounted Trucks used for some of the over ground bins or containers ensuring NO MANUAL HANDLING of waste and fully mechanized emptying.

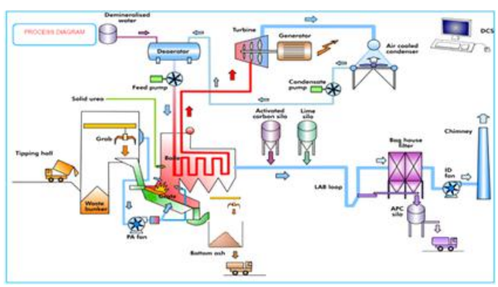
Skip Loader


Hook Loader

Along with the change in the aesthetics at the locations, it is also have observed that with the introduction of Underground Systems even the perception of the users has changed and the collection efficiency and the segregation awareness has also started to increase.

ZOlutions: Material Recovery Facilities, EfW and AD Plants

By providing an environmentally and socially responsible means of managing solid waste, Zonta's Energy from Waste [EfW] and material processing facilities help cities move up the waste hierarchy, recover resources in the form of materials and energy, and provide critical local and community waste management infrastructure, all while helping reduce GHG emissions from waste management. Material recovery and sorting/pretreatment facilities are the first step for most waste. Depending on the client's needs, the type of waste, the business model and market economics, there are different custom made solutions (variable throughput, automation levels) to recover or treat valuable materials from Municipal Solid Waste, Industrial and Commercial Waste or Construction and Demolition Waste. Furthermore our ZOlutions comprises efficient and environmentally responsible transformation of all types of solid waste - agricultural, forestry, industrial or household - into a productive resource, using the most advanced and efficient EfW (Combustion and AD based) technologies. Smart interventions and adaptations are our standards, for e.g. Common EfW combustion technologies utilize Rankine cycle to produce electrical power. The cycle operating media is water being within the cycle compressed and heated to superheated steam and on the other side after led through steam turbine condensates to liquid state. Our proposition



of EfW plant will be configured using simple non-reheat Rankine Cycle concept with

Steam Boiler, Air Cooled Condenser (ACC), Condensate extraction pumps, Deaerator and Boiler Feed Pumps and associated auxiliaries and ancillaries, piping, control, and instrumentation. Often non-reheat Rankine cycle is adapted as the cycle efficiency gains due to reheat cycle is economically not justified while regenerative cycle can be considered for medium sized plants whenever feasible.

Furthermore as an interim ZOlution we help cities in remediating and managing un-controlled dumping of waste by scientifically and engineered capping the dump yard thereby releasing valuable urban spaces in order to structure a formal waste management infrastructure. Post closure of the dump yard we help in capturing landfill gas to prevent methane from entering the atmosphere and contributing to local smog thus again mitigating towards climate change.

In short Zonta' strength lies in a powerful combination of the most advanced, proven technologies; high depth of expertise; and a cost effective team with global exposure that delivers highly efficient, scalable solutions that are technically reliable. This tailor-made full service approach, from conceptual design to planning, production, modernisation, optimisation, assembly, start-up, conversions, operation & maintenance, can only be successful when there are viable commercial models in the budgets of the customers. To attract long-term investments, the private player needs reliable and stable commercial models and political framework conditions.

There are no shortcuts to success. One cannot negotiate with physics and one cannot compromise with nature. We live in a society of surplus, with throw away attitude. We must find our way into a circular economy, use resources more efficiently and produce as little waste as possible. Here the waste management industry, via ZOlutions and city administrators, via smart business models, can impact tremendously towards a positive Climate Change and achieve circular economy practices. **The first and foremost action is to avoid land-filling cum uncontrolled dumping of waste.** The climate killer greenhouse gases come from methane emissions from dumpsites, which are formed by anaerobic decomposition of organic material. Methane has been found to be over 21 times more potent a greenhouse gas than carbon dioxide, according to the International Panel on Climate Change (IPCC). As per our experience, countries such as Mexico, Turkey and Tunisia, have similar climate-impacting effects as India. Scientific waste management measures can make a significant contribution to the cost-effective reduction to help mitigate climate change. Our ZOlutions are smart tools, which significantly help city administrators to restructure waste management. They convert it into "climate-friendly" indigenized and integrated waste management system with proven and reliable recycling and waste treatment techniques. An integrated project (www.malabarwaste.com) with a sustainable business model as mentioned above is currently under Implementation in the City of Kozhikode, Kerala State. If the so called land filling of untreated waste is also phased out by proper waste management, such as in the Kozhikode cluster, with increased recycling rates and energy-efficient treatment of residual waste, immediate success in reducing greenhouse gases will be achieved. **Active redesign of the currently followed waste management system and clever adaptation of new solutions are the imperative at this hour.**

A Case Study on Municipal Solid Waste Management in Solapur City, Maharashtra, India

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Solapur, one of the leading cities in India, lacks a scientific management and disposal of solid waste creating a serious environmental problem. The article is an investigation of Municipal Solid Waste Management (MSWM) in Solapur city on the basis of Municipal Solid Waste (Management and Handling) rules, 2000.

ABSTRACT
The problem of solid waste is influencing the environment of Solapur city. The present study was under taken to enlist the causes of solid waste generation and possibilities of associated problems. The study was mainly concentrated to investigate the present status of Municipal Solid Waste Management (MSWM) in Solapur city. The relevant data was obtained from Solapur Municipal Corporation and individual field visits. The study reveals that there are several lacunae in existing solid waste management system in Solapur city on the basis of Municipal Solid Waste (Management and Handling) rules, 2000.

I. INTRODUCTION

Waste management of a city involves the collection, transportation, processing, recycling or disposal and monitoring of municipal solid waste (MSW). It is also carried out to recover resources from it. [1].

The sources of MSW include that generated in domestic, institutional, commercial activities, garden and municipal services. They are high in quantities and vary with time and season. It is comprised of organic and inorganic portions.
The problem of municipal solid waste management in major cities has acquired alarming dimensions in India especially during the last decade. It is fraught with many inadequacies in terms of treatment methods and techniques. Illegal dumping is a major problem with regard to human health, safety and quality of life of urban societies. In addition it imposesa major economic burden on local government responsible for waste dump sites. A poor collection and disposal practice promotes breeding of insects, rodents and pathogens that can cause and transmit various diseases in society. [2].

II. STUDY AREA - SOLAPUR CITY

The city of Solapur, Maharashtra is a Municipal Corporation, near the Karnataka border. It is famous as a textile capital. It is on the border of three states namely, Maharashtra, Andhra Pradesh and Karanataka. In year 2001, its population of was 8,73,009. Solapur is an important junction situated on the north-south Railway line and provides connectivity between Maharashtra, Andhra Pradesh and Karnataka. It is also connected by both road and rail to most of the cities around and districts and provides easy access to Solapur, and the reason for its flourish in industries and fast growth.

Solapur has cotton mills and power looms. Products produced in Solapur have earned a special reputation in the international market. The city has the largest industry in Maharashtra for Beedi (handmade cigarettes) production, a cottage industry.

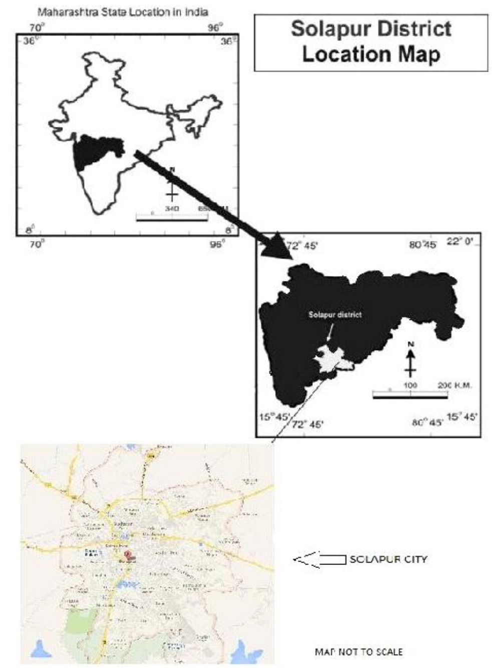

Fig. 1 Map of Solapur City

III. METHODOLOGY

The methodology is based on existing guidelines comprised of the following distinct features:

a) Collection of Data
The data has been obtained from Municipal Corporation and other reliable sources, studied and correlated with the present investigation.

IV. RESULTS AND DISCUSSION

1. Population-The population of Solapur is 8,73,009 as per 2001 city census.
2. Waste Generation - Solapur city has in all 98 wards. These are divided in six Zones. Each zone consists of 16 to 17 wards. The existing solid waste management in Solapur city is scheduled zone wise [9]. Total waste generated in Solapur corporation area is 420MT/day. About 51% of the total solid waste collected from entire city is biodegradable with energy potential through anaerobic digestion technology.
3. Institutional arrangement - The total work manpower involved in solid waste collection is 736 and is controlled by the department incharge of SWM unit.

4. Zone wise Details of collection System - To enable citizens to dispose waste, community bins are provided at reasonable distances depending on local requirement. There are 949 community bins and 553 open spaces where people throw the waste.

5. Waste Collection- Generation of waste in Solapur is 420 MT /day out of which 347 MT/day is collected by the Corporation solid waste management authorities and 73 MT /day remain uncollected which constitutes about 20% of the waste generated that remains uncollected daily. It causes the environmental problems and affects human society many ways.

6. Efficiency of collection of Municipal Solid Waste - The city generates solid waste to the tune of 420 MTD of which 364 MTD is collected. Out of this 12 MTD is collected through door-to-door collection and 154.52 MTD is collected from community bins. Waste collected through other sources and street sweeping, market waste, commercial establishments is 201.28 MTD.

7. Vehicles and transportation- The waste generated is collected daily with the vehicles like truck, dumper placer, Compactor, tempo, etc. The transportation adds to the city air pollution of planned properly. Most of these vehicles carry the waste in open manner creating nuisance of odor and smell.

8. Disposal - The waste is disposed daily to the dump site located on Tuljapur road and Bhogaon. The disposal is open giving rise to environmental problems & any other treatment process is not followed. The dump sites are not well maintained & threaten groundwater through leachate contamination. It serves as breeding ground for disease vector such as flies, mosquitoes, cockroaches, and rats affects the other pests. (A treatment plant of anaerobic digestion implemented to extract energy from organic waste generating the biogas. However it is not very successful.

9. Impact on workers - Workers, who are associated with the process solid waste management at different level, are vulnerable to health hazards due to constant and long time direct contact with solid waste. The accidental injuries like individual cuts from scrap waste materials leads to the poisoning from chemical wastes. Eye and skin infections due to exposure to infected dust are also reported in workers. Apart from these, workers also face problems like asthma, T.B., and some respiratory diseases. Sweepers suffer from back-ache due to regularly sweeping for a considerable distance per day. The workers loading garbage into trucks face eye problems. During waste loading processes dust

particles spread in the surrounding air creating air pollution.

10. Impact on Ragpickers - The Ragpickers are people involved in segregating anything of value from the waste collected. They suffer from pathogenic diseases and they do not get any medicals facilities for health problems.

V. CONCLUSION

Solapur is one of the leading cities in India. The management and disposal of solid waste there is not scientific and it creates serious environmental problems. Method of waste disposal is also a serious health concern, particularly in rainy season. Leachate increases the risk of health problems. The combined effects of uncollected wastes, poor handling and inadequate disposal have impacted public health leading to transmission of diseases.

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