

A Study of Solid Waste Management in Indore and a Potential Solution to Treat Incineration Bound Waste

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Abstract— Waste management is a big concern in the modern world. There are several factors which are affecting it like population, carelessness of people and government, lack of solutions, etc. But a city that has set an example for the whole world in managing the waste is Indore. Its waste management model has been very successful till now but still, some loopholes are indirectly affecting our environment and in turn our lives. All waste cannot be recycled and reused. That waste either goes to landfills or to cement industries where it is incinerated. Incineration might seem a good idea initially but it too has its major drawbacks.

Gasification of incineration-bound waste could be a sustainable and long-term solution for extracting energy from this waste without harming the environment. This study discusses the prospect of incorporating this technology in the present Waste management model of Indore and how it can become a good solution for taking the life out of the waste which otherwise would have lived for thousands of years.

Index Terms— Gasification, syngas, incineration, waste management system.

I. INTRODUCTION

Indore has been separated into 19 zones and 85 wards. Each ward has on average 6,000 families and 600 commercial foundations. Indore guarantees 100 percent inclusion of wards through its house-to-house waste collection framework. The gathered waste is taken to 10 depots across the city, where the staff ensures the waste is appropriately segregated. From these depots, the waste is taken to the waste handling facility. At the facility, 300 tons of recyclable waste is day to day moved through and isolated by 300-odd laborers. The recyclable waste is offered to either the reusing business or to organizations that utilize reused material. However, 420 tons of natural waste are created every day. It is changed over completely to compost which is offered to ranchers and greens keepers as manure. Sometimes it is given for nothing as farmers consent to ship the manure at their own

expense. Non-recyclable waste is shipped off to a concrete plant at Neemuch for incineration and to the M.P. Country Road Development Corporation to be utilized in the development of streets. This model seems perfect and it is for organic waste but the non-recyclable inorganic waste is incinerated which has its drawbacks like the poisonous smoke generation which can lead to respiratory problems, increased cancer rates, reproductive abnormalities, and other health effects.

An effective and sustainable solution to this problem would be a process that could efficiently extract energy and in turn, does not have any byproduct which harms our environment in any way. This can be achieved by Gasification.

Gasification is an old technology that was used to create Hydrogen out of biomass, but recently we have learned to repurpose it to create synthesis gas out of the water and waste that consists of carbon and gives out metal-based inert stones as a byproduct. In gasification, we do not burn garbage as we do in incineration. Instead, we convert non-recyclable carbon-based garbage into hydrogen and Carbon monoxide mixture. This mixture of gasses comes out with steam and other gasses which can be removed to purify it into Synthetic gas or Syngas for short. This gas can be further refined into Biodiesel, Hydrogen fuel, ethanol, Electricity, Fertilizer, and other valuable products. The bi-product of the process is in the form of solid rock and aggregate material which can be further used in construction with no hazardous side effects. This process is very flexible and profitable.

This study explores a possible solution to the problem of dealing with non-recyclable waste.

II. INDORE WASTE MANAGEMENT SYSTEM

Indore has been segregated into multiple sections and subsections called zones and wards. Each of these sections has a similar population and waste generation

capacity. Waste generation sources in these sections are houses, shops, clinics, small cafes, and lodgings. These generators of waste are considered in the low garbage generation category. These small waste producers are covered by Vans with multiple compartments for different types of garbage. Indore Municipality guarantees 100% collection from such sources through the door-to-door collection framework. For bulk waste producers like hotels and industrial waste producers, the waste is collected using bigger trucks or is treated on site. The waste from all the dustbins spread across the city and other hotspots is collected separately. People use dustbins and segregate their waste on the source to make waste management that much more efficient.

The waste is segregated into various types like dry, wet, electronics, and domestic hazardous/ medical waste. Every garbage collection vehicle is equipped with multiple compartments for these sources of segregated garbage. People of Indore take their waste segregation very seriously and this primary segregation helps a lot in further processing the waste in the material recovery or bio methanation plants. Secondary segregation is done in 2 major sections



1. Door-to-door waste collection vehicle.

A. Wet Waste (Biodegradable waste)

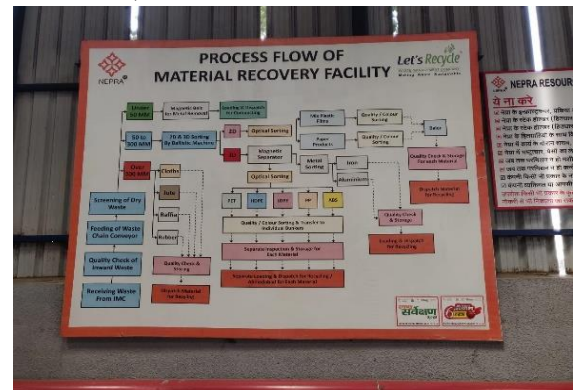


2. Biodegradable waste management facility, Indore

All the wet waste is sent to onsite digesters or collected and sent to Asia's largest biomethanation plant. There it is homogenized and fed to aerobic digesters. The methane that is produced from these digesters is cleaned and compressed to produce CNG. This CNG is used to run public transport buses around Indore. This is a very clean process, all the bi-product is converted and sold as manure to farms around Indore. 0.05% of the gas produced from digesters is cleaned during the CNG-making process.

B. Dry Waste (Recyclable / Non-Biodegradable waste)

Dry waste is transferred to a Material recovery Plant. In this plant, various methods are used to separate the valuable waste from ones that we cant recover. Magnetic, Air based, AI-based, mechanical, and manual picking is used to separate materials like HDP, LDP, Glass, Rubber, Cloth, Paper, Various, Metals, Electronics, and Thermocol



3. Process flow of material recovery facility.

S.No	Item	Monthly Target	Recycling Target	Actual	Shortfall	Remarks
01	White LD	6300	2000	0	6300	
02	MTR LD	23000	2300	0	23000	
03	MTR LD	23000	2300	0	23000	
04	MTR LD	16000	4000	0	16000	
05	PP	18000	4000	0	18000	
06	PP	15000	4000	0	15000	
07	HDP	15000	4000	0	15000	
08	Mix Plastic	16000	4000	0	16000	
09	Comp Ground	29000	15000	0	29000	
10	Mix Paper	43000	15000	0	43000	
11	Rubber	10000	3500	0	10000	
12	Aluminium (low)	800	350	0	800	
13	Wire Cable	2000	350	0	2000	
14	LED Bulbs	1000	350	0	1000	
15	LED Bulbs	400	150	0	400	
16	LED Bulbs	400	150	0	400	
17	LED Bulbs	400	150	0	400	
18	LED Bulbs	400	150	0	400	
19	LED Bulbs	400	150	0	400	
20	LED Bulbs	400	150	0	400	
21	LED Bulbs	400	150	0	400	
22	LED Bulbs	400	150	0	400	
23	LED Bulbs	400	150	0	400	
	Total	1012304	36946	43600	978694	

4. Daily goals of Indore's waste segregation plant.

The recovered material is sold to recycling plants. These recycling plants deal with the waste separately

and generate their bi-products, some of which cannot be further processed. This is sent back. Also, a large amount of the waste comes out of the material recovery plant which has no value other than as a fuel source for cement factories. 130-150 MT/ day waste is sent to incineration plants on the outskirts of Indore to be used as fuel.

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III. DRAWBACKS OF CURRENT WASTE MANAGEMENT SYSTEM

A. Incineration

- **Pollutes the Environment**
The process of burning produces smoke. The smoke consists of corrosive gasses, cancer-causing agent dioxin, particulates, toxic metals, nitrogen oxide, and other pollutants.
- **Damaging Public Health**
As per various researches, in the networks where incinerators plants, their drawn-out impacts come as wellbeing perils. For example, diseases like malignant growth, birth surrenders, regenerative brokenness, neurological issues, and other well-being impacts are known to happen at extremely low openings.
- **The Possibility of Long-term Problems**
Burning doesn't support reusing and squandering decreases. This is certifiably not a determining system for any general public. The place of spotlight ought to be on diminishing waste and reusing its vast majority.
- **Toxic fly ash is produced**
Although the waste that remains after incineration is relatively little in amount. But it contains a lot of toxic substances and heavy metals which require further treatment. On the off chance that not discarded in the wrong way. It can hurt the general population and the climate.
- **It is Expensive**
The establishment of a plant for incineration is a costly project to undertake. Plus, a burning plant requires a prepared workforce and committed staff to man its activity.

B. Recycling

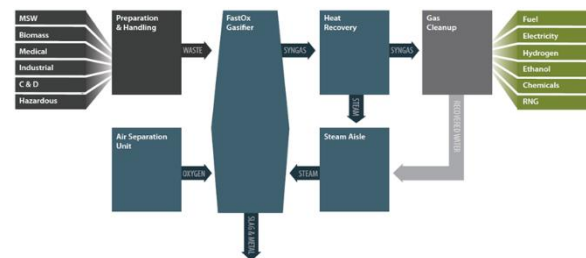
The total waste generated in Indore is about 720 metric tons per day out of the total waste 58.25% by weight is the wet organic garbage and 41.75% is the dry inorganic waste and .5% is the household hazardous and sanitary waste. And when we talk about recycling all this waste there is a lot of nonrecyclable bi-product from things like

- Electronics
- Rubber
- Paper
- Colored plastics
- Colored glass
- Layered packaging

And also there are life cycles associated with recycling after which it ends up in landfills or incineration plants where it creates toxins. This is another major drawback of Inorganic waste management for Indore.

IV. GASIFICATION PROCESS

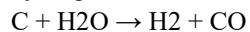
Considering the loopholes and the waste that is left in the process of segregation and recycling, from the chemical composition of the waste that remains, we can see the major elements that make up the molecules are carbon and some metals, Which are valuable resources if we can take them out using some chemical process. This process needs to be environmentally friendly and also profitable so that it has fast adoption in the private or even public waste management industry. Gasification of the inorganic waste solves this problem very appropriately. It's an exothermic process where we pass steam and oxygen through carbon compounds and convert the compounds into basic elements and molecules which can be used in a wide variety of product creation. The byproduct is an inert rock made from all the toxic / not toxic metals left which can be used for construction.



1. Process Flow Chart

Gasification is the conversion of waste into Synthetic gas. In which the gas which we are converting waste

into is syngas which is carbon monoxide and hydrogen.



the waste that we can treat includes Municipal solid waste, Biomass, construction and demolition waste, industrial waste, medical waste, Complex ways such as hazardous waste, and toxic waste without any additional pre-treatment, we can convert them into valuable products.

In the gasification process, The breakdown of waste happens at the molecular level. The waste is fed through an airlock in the gasifier vessel and from the base Oxygen and steam are injected. In The gasifier vessel, the reaction happens at a very high temperature of around 4000-degree Fahrenheit and as the waste goes down it goes to the hottest area which is the base after several reaction zones. the reaction is exothermic which means it releases a huge amount of heat.

In the gasifier, Syngas exit from the top of the vessel, and then heat is recovered. At the base, all the inorganic material and metals are collected in the molten state and then cool down to convert them into stones. the key innovation includes optimizing the rate and positioning of Oxygen and steam injector which helps to drive a complete conversion of waste into molecular constituent by not leaving any sort of major by-product which require additional disposal also pure oxygen ensure that there is no emission of any sort of harmful gasses during the entire process.

Gasifier vessels can digest any sort of waste except radioactive and explosive material. With the minimal pre-treatment of feedstock, the delivered waste is shredded and dried up to 20% of moisture by weight. Syngas is collected from the top of the vessel. the extraction of excess heat happens and the heat is recycled

Further, the particulate and the gas contaminants are removed from the syngas synthesis process and cleaned to meet up environmental regulations.

To converts gas into valuable products such as diesel hydrogen Celsius and other important product the additional gas cleaning is done

Several conventional catalytic technologies are used such as the Fisher Trosch process and back and methods such as microbial fermentation are used to convert syngas into valuable product

V. ADVANTAGES OF GASIFICATION

The advantage of gasification is that it can handle any sort of waste with minimal preprocessing because of the high temperature it is run on organic material is vaporized and inorganic material is converted into stone

It's designed to run continuously and has very few moving parts which reduces the cost of maintenance and increases the efficiency of the process

These entire gasification systems required very less amount of land is compared to other renewable energy technology of project this project is very cost-efficient in both the terms whether it is the capital needed or operation cost for the life of the system

At the end of this classification, we generate very high-value products such as electricity diesel hydrogen fuel RNG LPG which can be sold at a very high price, and also Residue that is stone and metal tapped can be sold

I. AMOUNT OF CARBON IN WASTE COLLECTED

Type Of Waste	Amount of C (%kg)
Wet waste	78
Mix Paper	80
PET	65-70
HDP	70-80
LDE	70-80*
Metals	0
Glass	17.7
Rubber	74
Refuse Derived fuel	70

II. REVENUE ESTIMATES

System Size (metric tons/day)	100
Estimated Carbon Content (kmol)	2418-3272
Hydrogen Created (kg/day)	4837-6544
Price of hydrogen (Rs. /kg)	350
Tipping fee (Rs.)	(Negative)
Annual Sales of Hydrogen (Rs.)	60 crores
Annual Resold Material Value (Rs.)	3 crores
Estimated Annual Revenue (Rs.)	63 crores (MAX)
Impact on Environment(Greenhouse gas Eliminated per year)	215140 MT CO2 Equivalent

VI. FUTURE SCOPES

- This process can be used to treat waste currently existing in landfills. Although Indore does not have one, cities like Mumbai and Delhi can successfully incorporate this technique to clear their lands as there is no need for segregation of waste which would have been a big challenge for landfill waste.
- The Government of India advised the first period of its Green Hydrogen Policy as a stage forward toward the National Hydrogen Mission. The

mission intends to make India a green hydrogen center and help to meet its environmental targets. It targets the creation of 5,000,000 metric tons for every annum of green hydrogen by 2030. This process can play a huge role in achieving this target by producing Hydrogen from waste.

- Cities in which waste segregation is not done at an effective level can use this technology to sustainably deal with the garbage generated every day.
- This technology can be used to produce carbon-neutral biodiesel that can help us run the current infrastructure of transportation and get more life out of it.
- The fly ash produced in other industries can be added to the inert stones to help us get rid of these harmful toxins in the future without much hassle.

VII. CONCLUSION

This paper aimed to propose a solution for dealing with the waste which was not recyclable, which eventually was ending up in Incinerators and landfills. we have discussed this problem in the context of a city that has been the cleanest city in India for the last 5 years. if this process is incorporated after complete sorting of dry waste, then it can eliminate non-recyclable waste from the system while simultaneously producing valuable products like hydrogen. the goal of this paper is to provide a solution for making Indore a completely waste-free city.

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