

# Waste Utilization using Thermal Engineering

**K. D. Ugale<sup>1</sup>, M. A. Kelkar<sup>2</sup>, S. S. Mahale<sup>3</sup>, T. L. Pagar<sup>4</sup>**

Professor, Department of Mechanical Engineering<sup>1</sup>

Students, Department of Mechanical Engineering<sup>2,3,4</sup>

Guru Gobind Singh Polytechnic Nashik, Maharashtra, India

kanchan.ugale@ggsf.edu.in<sup>1</sup>, maitreyeebabar@gmail.com<sup>2</sup>, mahalesakshi8@gmail.com<sup>3</sup>,

tejashreep2002@gmail.com<sup>4</sup>

**Abstract:** India deals with major environmental challenges related to waste generation. India generates 62 million tonnes of waste each year. About 43 million tonnes (70%) are collected of which about 12 million tonnes are treated and 31 million tonnes are dumped in landfill sites. Current systems in India cannot cope with the amount of waste generated by an increasing population and this impacts the environment and also public health. On the other hand, India is also facing a power crisis and states are warning of power blackouts. States across India have issued coal supplies to thermal power plants, which convert heat from coal to electricity but are running low. To deal with these issues we can simply use the waste to energy utilization technologies, using thermal engineering. We can use the waste as fuel and burn them to generate electricity. This can be done using the boiler system in thermal engineering. In this research paper, we have presented the ideal waste management system in which there is the utilization of waste and minimum pollution.

**Keywords:** Waste utilization, thermal power plant, waste to energy

## I. INTRODUCTION

India is growing country. It is increasing day by day, in the form of population, industrialization, etc. The need is also increasing, the need of jobs, the need of electricity, the need of waste management. Although not all the needs can be fulfilled by us, there are some which we can fulfill. The need of electricity and the need of waste management. Electricity use in India has doubled since 2000, with 80% of demand still being met by coal, oil and solid biomass [1]. India produces 1,598 TWh including (utilities and non utilities) of electricity per year . An average household in India needs 250 kWh per month. Thus per year an average household in India will require 3000 kWh. Also the population in India is growing rapidly. Thus the electricity demand is going to keep on increasing.

To fulfill this requirement we need to use some innovative technologies. As per 1st law of thermodynamics, energy can neither be created nor be destroyed. It can only be transferred.[2] Thus we need to find some techniques which can help us transfer some type of energy to electricity.

## II. WASTE IN INDIA

India is suffering from waste management for the past few decades. In India the annual waste per year is 62 million tonnes. It is estimated that India's annual waste generated is likely to touch 387.8 million tonnes in 2030 and 543.3 million tonnes by 2050.[3] In this there are some major types of waste which have different management rules in India. These methods are mentioned in the table 1.1.

Sr. No	Types of Waste	Origin	Rules
1	Municipal Waste	Generated from commercial and household activities.	Solid Waste Management Rules, 2016
2	Plastic Waste	Come in different forms and the single-use plastics, like the plastic bags, straws, bottles etc	Plastic Waste Management (Amendment) Rules, 2018
3	E- Waste	Discarded electrical and electronic	E-Waste (Management) Rules, 2016

		products like computers and their peripherals, home appliances, audio or video devices	E-Waste Management Amendment Rules, 2018
4	Biomedical Waste	Generated during the treatment or immunization of humans or animals in a medical or a research laboratory.	Bio-Medical Waste Management (Amendment) Rules, 2019 Guidelines on Dead Body Management, 2020
5	Construction and Demolition (C&D) Waste	Generated due to activities related to construction or demolition of roads, buildings, bridges, subways etc.	Construction and Demolition Waste Management Rules, 2016
6	Hazardous Waste	Generated by industries involved in the manufacturing of petroleum, paints, pharmaceuticals etc	Hazardous and Other Wastes (Management and Trans-boundary Movement) Rules, 2019
7	Battery Waste	The used or depleted batteries from cars, electronic equipment and industries	Battery Waste Management Rules (Proposed), 2020 Batteries (Management and Handling) Rules, 2010
8	Radioactive Waste	Radioactive elements come from mining activities and nuclear power plants	Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987

Table 1.1 Types of Wastes and their Management Rules [4]

As mentioned above we should follow these rules to reach our ultimate goal of perfect waste management. But although there are rules for almost every types of waste, there are some which can not be recycled under some circumstances. Or some type of waste which has been recycled so many times in the past that now it is beyond the recycling process. In such cases we can use the WTE techniques to reuse this waste. WTE simply means Waste To Energy. Currently we have two demands first one is to get rid of the excess waste piled up for so many years without affecting the environment. Second one is that we need to increase the production of electricity.

### III. WTE PROCESS

WTE technologies deals with waste treatment process that creates energy in the form of electricity, heat or transport fuels from a waste. Waste is directly combusted in large waste to energy incinerators as a fuel with minimal processing known as mass burning. The heat energy generated from the combustion process is used to turn water into steam, which is then used to power steam-turbine generators to produce electricity. Some different technologies are mentioned in the table 1.2

No.	Name	Description (Equipment used)
1	Municipal solid waste incineration plant with flue gas cleaning	1) Waste delivery 2) Incineration 3) Flue Gas Cleaning 4) Energy Recovery
2	Cement kiln form the type pre-Columbian	1) Clinker cooler 2) Rotary Kiln 3) Reciprocal 4) Raw Meal Preheat 5) Raw mill 6) Bag filter or Electrostatic Separator
3	Landfill gas capturing system with electricity production	1) Landfill 2) Gas extraction and cleaning equipment-Gas collection wells, Landfill gas

		3) Gas engine and electric generator-Transformer 4) Grid.
--	--	--

Table 1.2 Different WTE methods. [5]

**IV. THERMAL ENGINEERING**

In thermal engineering there are some thermal power plants which can be used in the WTE process. One of the most critical and biggest part of thermal power plant is a Boiler. The boiler is also known as steam generator. Boilers are used in power plants in order to produce high pressure steam, so that the plant can generate electricity. The primary heat source will be combustion of coal, oil, or natural gas. [6] The fig 1.1 shows a simple construction of boiler.

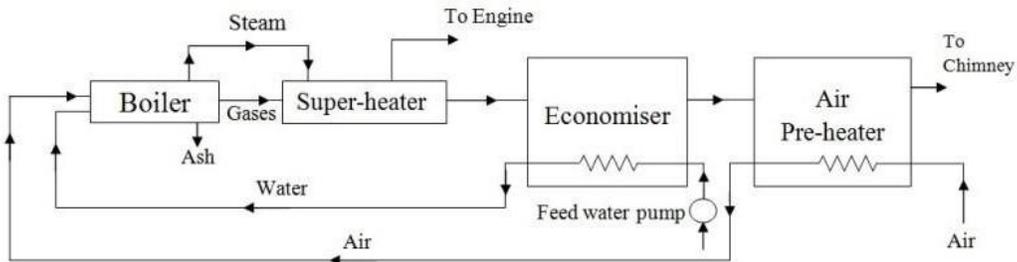


Figure: Diagram of boiler plant [7]

**4.1 Working of the Boiler**

1. The fuel is burned and the water starts converting to steam.
2. This high temperature and high pressure steam is supplied over the turbines and then the turbines will start rotating. The turbine is connected to a shaft which is connected to a generator. Thus giving us electricity.
3. After this the steam coming from the turbine is supplied to the condenser, where this steam is turned into liquid or condensate form.
4. This condensate form is again supplied to the boiler where again it will turn to steam and the cycle will go on continuously.

The boiler consists of various mountings and accessories such as, economiser, super heater, steam stop valve, water level indicator, air extraction pump, etc.

There are different types of boilers based on different designs such as, Babcock and Wilcox boiler, Lamont boiler, Cochran boiler, etc

We can use the waste as fuels and burn them to heat the water. But we have to be very attentive not to use the waste which we can recycle easily. We only have to use those waste which can not be recycled and are beyond the recycling process meaning they are recycled too many times in the past. To control the air pollution which is caused by burning of these waste or fuels we can use the flue gas cleaning mentioned in the table 1.2.

**V. WASTE AROUND THE WORLD.**

There are a lot of countries which generate waste more than or near to India. Let's take a look at their waste management techniques.

Name of country	Waste amount	Techniques
Canada	1.33 billion metric tonnes	Waste-to-Energy, Waste as Feed stock, Bio energy. [8]
United States	80 million tons	Land filling, recycling, and energy recovery. [9]
Finland	116 million tonnes	waste sorted, recycling is easily done once sorted correctly. [10]
china	10.1 million	Waste Incinerators. [11]

Germany	39.6 milliontonnes	Germany's Waste Management Act - prevention, reuse, recycling,energy recovery, and finally waste disposal. [12]
France	17.1 millionmetric tons	preference, prevention, preparation for re-use, recycling. [13]

## VI. CONCLUSION

Each country has its own methods, its own techniques to solve this common issue. India too has very methods and rules of its own. We however are looking for some more solutions.

Solutions which can easily be applied in the practical field. Those which cause less pollution, and those which will work efficiently. Solutions which takes into account WTE alternatives according to economic, technical and environmental . WTE methods and techniques are giving a 100% waste free result in some countries. One such popular example is Sweden.

Sweden is 99.9 % waste free. Only 1 or less than 1 % of waste lands on the land fills. This shows that WTE is an effect way for waste management.

## REFERENCES

- [1]. <https://www.iea.org/reports/india-energy-outlook-2021>
- [2]. <https://www.sciencedirect.com/topics/chemistry/first-law-of-thermodynamics#:~:text=The%20first%20law%20of%20thermodynamics%20states%20that%20energy%20can%20neither,heat%20transfer%20across%20the%20boundary.Fdhj>
- [3]. <https://theprint.in/india/pm-calls-for-week-long-garbage-free-country-but-india-is-the-worlds-highest-waste-generator/478889/>
- [4]. <https://delhigreens.com/2020/05/15/8-types-of-wastes-and-their-management-rules-in-india/>
- [5]. Waste to Energy guidelines 2017. Link- [https://www.giz.de/en/downloads/GIZ\\_WasteToEnergy\\_Guidelines\\_2017.pdf](https://www.giz.de/en/downloads/GIZ_WasteToEnergy_Guidelines_2017.pdf)
- [6]. [6] [https://en.wikipedia.org/wiki/Boiler#:~:text=A%20boiler%20is%20a%20closed,\(generally%20water\)%20is%20heated.&text=The%20heated%20or%20vaporized%20fluid,generation%2C%20cooking%2C%20and%20sanitation.](https://en.wikipedia.org/wiki/Boiler#:~:text=A%20boiler%20is%20a%20closed,(generally%20water)%20is%20heated.&text=The%20heated%20or%20vaporized%20fluid,generation%2C%20cooking%2C%20and%20sanitation.)
- [7]. [https://4.bp.blogspot.com/-rt9g5thBeZ0/Vu\\_4DEpeStI/AAAAAAAAAVM/HOuFUa5JDPE2nYf4nCSHKP2eXTEDK-4AQ/s1600/Schematic%2BDiagram%2Bof%2Ba%2Bboiler%2Bplant2.jpg](https://4.bp.blogspot.com/-rt9g5thBeZ0/Vu_4DEpeStI/AAAAAAAAAVM/HOuFUa5JDPE2nYf4nCSHKP2eXTEDK-4AQ/s1600/Schematic%2BDiagram%2Bof%2Ba%2Bboiler%2Bplant2.jpg)
- [8]. <https://rwsenvironment.eu/subjects/from-waste-resources/projects/canada-waste/>
- [9]. <https://www.statista.com/topics/2630/waste-management-in-the-united-states/#:~:text=There%20a%20several%20waste%20disposal,than%20a%20quarter%20is%20recycled.>
- [10]. <https://www.infofinland.fi/en/living-in-finland/housing/waste-management-and-recycling>
- [11]. <https://gadgets.ndtv.com/laptops/news/worlds-e-waste-unsustainable-says-un-report-citing-china-india-and-us-2256324#:~:text=the%20report%20said,-,China%2C%20with%2010.1%20million%20tonnes%2C%20was%20the%20biggest%20contributor%20to,world's%20e%2Dwaste%20last%20year.>
- [12]. <https://www.umweltbundesamt.de/en/topics/waste-resources/waste-management#:~:text=The%20centrepiece%20of%20Germany's%20Waste,recovery%2C%20and%20finally%20waste%20disposal.>
- [13]. [https://sustainabledevelopment.un.org/content/documents/dsd/dsd\\_aofw\\_ni/ni\\_pdfs/NationalReports/france/Waste\\_management.pdf](https://sustainabledevelopment.un.org/content/documents/dsd/dsd_aofw_ni/ni_pdfs/NationalReports/france/Waste_management.pdf)