International Journal of Multidisciplinary Research and Growth Evaluation.

Thermal waste management

Harsh [1*], **Nikhil Gupta** [2], **JP Kesari** [3]
[1-3] Delhi Technological University Formerly Delhi College of Engineering, Bawana Road, Delhi, India

* Corresponding Author: **Harsh**

Article Info

ISSN (online): 2582-7138
Volume: 03
Issue: 02
March-April 2022
Received: 22-03-2022
Accepted: 11-04-2022
Page No: 537-539

Abstract
Thermal waste treatment refers to the processes that use heat to treat waste materials. Thermal methods for waste management aim at the reduction of the waste volume, the conversion of waste into harmless materials and the utilization of the energy that is hidden within waste as heat, steam, electrical energy or combustible material. They include all processes converting the waste content into gas, liquid and solid products with simultaneous or consequent release of thermal energy.
Thermal treatment is any waste treatment technology that involves high temperatures in the processing of the waste feedstock. Commonly this involves the combustion of waste materials.

Keywords: Management, methods, thermal waste

1. Introduction

Methods of Thermal Waste Treatment:

Following are some of the most commonly used thermal waste treatment techniques

- **Incineration** is one of the most common waste treatments. This approach involves the combustion of waste material in the presence of oxygen. This thermal treatment method is commonly used as a means of recovering energy for electricity or heating. This approach has several advantages. It quickly reduces waste volume, lessens transportation costs and decreases harmful greenhouse gas emissions. Incineration with energy recovery is one of several waste-toenergy technologies such as gasification, pyrolysis and anaerobic digestion. While incineration and gasification technologies are similar in principle, the energy produced from incineration is high-temperature heat whereas combustible gas is often the main energy product from gasification. Incineration and gasification may also be implemented without energy and materials recovery.

- **Pyrolysis** refers to the thermochemical decomposition of organic materials caused by external heat supply in the absence of either oxygen, other oxidizing agents or other reactants, in practice, introduction of small amounts of oxygen or air with input materials cannot be avoided.

Low temperature pyrolysis (LTP) $T < 500$ °C ■ Medium temperature pyrolysis (MTP) 500 °C $< T < 800$ °C ■ High temperature pyrolysis (HTP) $T > 800$ °C Recently, pyrolysis at temperatures between 250 and 300 °C is referred to as torrefaction. This low-temperature type of pyrolysis is traditionally applied in processing and refining of food and is currently discussed and tested as a means to customize biomass fuels, especially to raise calorific value and optimize physical properties (grindability, hydrophobicity).

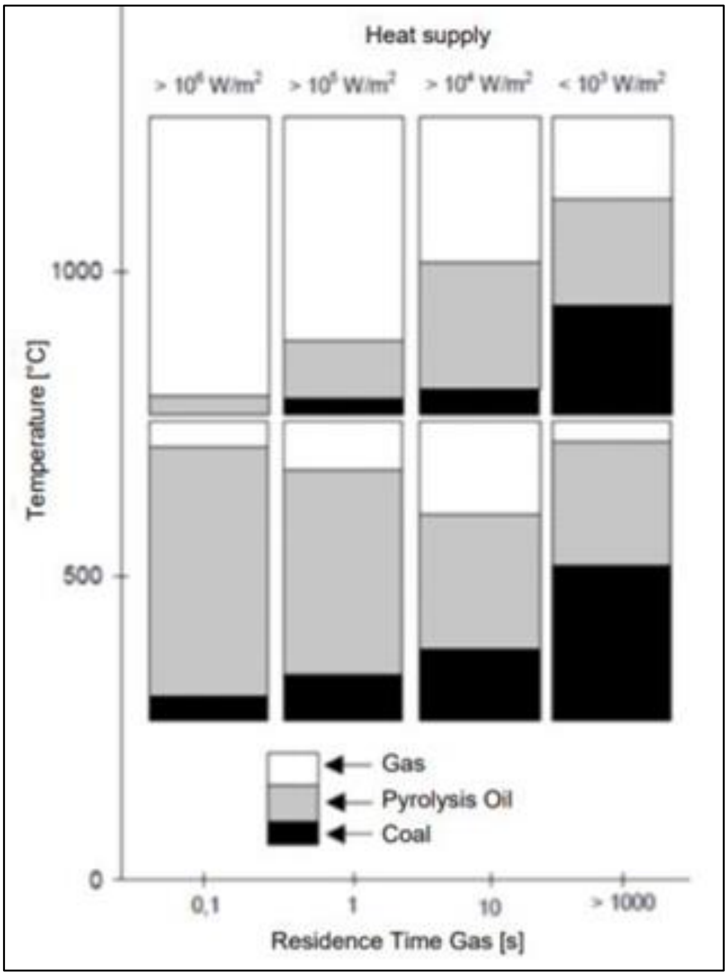

Fig 1: Pyrolysis of wood: product range as a function of temperature and residence time [Gerdes 2001; translated] (schematically)

For thermal treatment of waste, intermediate and slow rate pyrolysis methods in the medium and high temperature range are relevant. Products stripped under these conditions are mainly gaseous. Yet with sufficiently long residence time, aromatization and polymerization may lead to (re-)composition of liquid or solid reaction products. The gas mainly consists of CO2, CO, hydrogen, methane, ethane and ethene. Product properties are determined by waste composition. For example, different dominating plastic fractions in the input material cause a significantly altered composition of product gas. Another important factor influencing the product range of pyrolysis is the water content of input waste, because higher humidity leads to increasing relevance of the heterogeneous and homogeneous water-gas reaction.

- **Gasification** processes aim to convert mostly solid, sometimes also liquid or paste-like materials to a fuel or synthesis gas with the highest possible calorific value, hereby creating added value in comparison to the original solid material. The solid material is brought into contact with a reactive gasification agent which carries oxygen or – in the case of steam as agent – hydrogen into the process. Possible gasification agents are
- Air
- Oxygen
- Steam
- Carbon dioxide

Gasification is defined as autothermal when the gasification agent causes partial oxidation of the fuel, as is the case when using oxygen or air as gasification agent. Therefore, the necessary heat of reaction for the mainly endothermic gasification reaction is generated by the fuel. Energy content of the gas is reduced accordingly (cold gas efficiency usually about 80 % at most). The limitation of oxygen supply is crucial for gasification in order to prevent energy loss or complete oxidation of feedstock. Usual conditions imply an oxygen supply of 30 to 40 % of the total oxygen demand, synonymously given as air ratio of 0.3 – 0.4.

- **Open Burning** is a legacy thermal waste treatment that is environmentally harmful. The incinerators used in such process have no pollution control devices. They release substances such as hexachlorobenzene, dioxins, carbon monoxide, particulate matter, volatile organic compounds, polycyclic aromatic compounds, and ash. Unfortunately, this method is still practiced by many local authorities internationally, as it offers an inexpensive solution to solid waste.

- **Mechanical Heat Treatment (MHT)** is an alternative waste treatment technology. This technology is also commonly termed autoclaving. MHT involves a mechanical sorting or pre-processing stage with technology often found in a material recovery facility. The mechanical sorting stage is followed by a form of thermal treatment. This might be in the form of a waste autoclave or processing stage to produce a refuse derived fuel pellet. MHT is sometimes grouped along with mechanical biological treatment. MHT does not however include anaerobic digestion or composting.

- **Thermal depolymerization (TDP)** is a depolymerization process using hydrous pyrolysis for the reduction of complex organic materials (usually waste products of various sorts, often biomass and plastic) into light crude oil. It mimics the natural geological processes thought to be involved in the production of fossil fuels. Under pressure and heat, long chain polymers of hydrogen, oxygen, and carbon decompose into shortchain petroleum hydrocarbons with a maximum length of around 18 carbons.

- **Waste autoclave** is a form of solid waste treatment that uses heat, steam and pressure of an industrial autoclave in the processing of waste. Waste autoclaves process waste either in batches or in continuous-flow processes. In batch processes, saturated steam is pumped into the autoclave at temperatures around 160 °C. [1] The steam pressure in the vessel is maintained up to 6 bar (gauge) for a period of up to 45 minutes to allow the process to fully 'cook' the waste. The autoclave process gives a very high pathogen and virus kill rate, although the fibrous products which come from the process are susceptible to bacteria and fungus as they are high in starch, cellulose and amino acids.

- **Advantages and Disadvantages** On the one hand, several benefits of incinerators helped to manage the Municipal Solid Waste (MSW) in the past. In areas with limited availability of land and high transport costs, incinerators could be the best option to treat MSW and convert it into energy. Combustion of waste in incineration could also help the municipality to reduce the amount of landfill, which in return helps to minimize the gas emissions and groundwater pollution. The mass burn process in an incinerator has no pre-processing of solid waste before feeding it into the combustion unit. However, incinerators have some drawbacks that could impact the environment. Incinerators produce ash that includes a high level of organics and smoke, which is taken to a landfill. The efficiency of steam production depends on the quality of the fuel, as the high level of moisture could reduce the amount of steam that is used to feed turbines. Several health issues have been raised due to the incineration process. Fine particulate (PM2.5) pollution, heavy metals, and a large variety of organic chemicals are found in incinerator emissions. These substances include endocrine disrupters, carcinogens, and materials that can damage the immune system and decrease intelligence. On the other hand, Advanced Thermal Treatment (ATT) technologies can recover more value from waster than mass-burn incineration. ATT technologies are flexible because they are modular and include several small units. This advantage makes ATT plants expand or reduce the size, depending on the amount of waste. ATT plants are easy to build and comply with local regulations. However, ATT technologies need to facilitate the pre-sorting stage or pre-treatment process. They can be considered more expensive than traditional incinerators since ATT technologies need higher capital and operational costs. The heterogeneous nature of MSW has a significant impact on the pyrolysis units that increases their potential for failure.

Acknowledgement

In carrying out our project work, we had to accept the help and guidance of other dignitaries, for which we are most grateful. Completing this assignment gives us great joy. We would like to express our gratitude to J.P. Kesari, our project consultant, who provided us with excellent feedback and extensive presence to encourage and enlighten us with his in-depth knowledge on this subject and to recommend us. Project development. We would also like to extend our deepest gratitude to everyone who directly and indirectly assisted us in completing our work.

Many people, especially our classmates, and the team members themselves have also commented on important suggestions for this proposal that has inspired us to improve our project. We thank all the people for their direct and indirect help to complete our assignment.

In addition, we would like to thank the Department of Mechanical Engineering, Delhi Technological University for giving us the opportunity to work on this topic.

About Thermal Waste: Thermal waste treatment refers to the processes that use heat to treat waste materials. Thermal methods for waste management aim at the reduction of the waste volume, the conversion of waste into harmless materials and the utilization of the energy that is hidden within waste as heat, steam, electrical energy or combustible material. They include all processes converting the waste content into gas, liquid and solid products with simultaneous or consequent release of thermal energy.

Thermal treatment is any waste treatment technology that involves high temperatures in the processing of the waste feedstock. Commonly this involves the combustion of waste materials

References

1. Astrup TF, Tonini D, Turconi R, Boldrin A. Life cycle assessment of thermal Waste-to-Energy technologies: Review and recommendations. Waste management. 2015;37:104-115.
2. Moustakas K, Loizidou M. Solid waste management through the application of thermal methods. Waste Manage; c2010.
3. Senapati MR. Fly ash from thermal power plants–waste management and overview. Current science; c2011 .p. 1791-1794
4. Massarutto A. Economic aspects of thermal treatment of solid waste in a sustainable WM system. Waste Management. 2015;37:45-57.
5. Lu X, Jordan B, Berge ND. Thermal conversion of municipal solid waste via hydrothermal carbonization: Comparison of carbonization products to products from current waste management techniques. Waste management. 2012;32(7):1353-1365.