Govt. Engineering College, Ajmer

E- Lecturer-1 (PPT)

On

Treatment and Disposal of Solid Waste

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Biological Waste Treatment

- Composting and anaerobic digestion of organic waste, such as food waste, garden (yard) and park waste and sludge, is common both in developed and developing countries. Advantages of the biological treatment include: reduced volume in the waste material, stabilisation of the waste, destruction of pathogens in the waste material, and production of biogas for energy use. The end products of the biological treatment can, depending on its quality, be recycled as fertiliser and soil amendment, or be disposed in SWDS.
- **Composting**
- **Vermicomposting**
- **Biogas**
- **Sanitary land filling**

COMPOSTING

- Composting organisms require four equally important things to work effectively:
- Carbon — for energy; the microbial oxidation of carbon produces the heat, if included at suggested levels. High carbon materials tend to be brown and dry.
- Nitrogen — to grow and reproduce more organisms to oxidize the carbon. High nitrogen materials tend to be green (or colorful, such as fruits and vegetables) and wet.
- Oxygen — for oxidizing the carbon, the decomposition process.
- Water — in the right amounts to maintain activity without causing anaerobic conditions.

COMPOSTING

- Compost is organic matter that has been decomposed and recycled as a fertilizer and soil amendment. Compost is a key ingredient in organic farming. At its most essential, the process of composting requires simply piling up waste outdoors and waiting for the materials to break down from anywhere between 5-6 weeks or even more.
- Modern, methodical composting is a multi-step, closely monitored process with measured inputs of water, air and carbon- and nitrogen-rich materials. The decomposition process is aided by shredding the plant matter, adding water and ensuring proper aeration by regularly turning the mixture. Worms and fungi further break up the material.
- Aerobic bacteria manage the chemical process by converting the inputs into heat, carbon dioxide and ammonium. The ammonium is further converted by bacteria into plant-nourishing nitrites and nitrates through the process of nitrification.
- Compost can be rich in nutrients. It is used in gardens, landscaping, and agriculture. The compost itself is beneficial for the land in many ways, including as a soil conditioner, a fertilizer, addition of vital humus or humic acids, and as a natural pesticide for soil.
- In ecosystems, compost is useful for erosion control, land and stream reclamation, wetland construction, and as landfill cover. Organic ingredients intended for composting can alternatively be used to generate biogas through anaerobic digestion.
- Anaerobic digestion is fast overtaking composting in some parts of the world including central Europe as a primary means of down cycling waste organic matter.

Vermicomposting

- Vermicomposting is carried out by introducing earthworms on semi-decomposed organic waste. Earthworms can consume five times of organic matter per day as compared to their body weight. Initially, biodegradable organic matter is decomposed through microbial enzymatic activity
- It is a method of disposal of kitchen and plate wastes, which serves the dual purpose of disposing off the garbage as well as proving eco-friendly.
- Here a suitable area is chosen which is bound by a 2 to 3 feet high brick wall and few hundred earthworms are introduced in it.
- The waste is dumped in this area and water is sprinkled daily on this dump.
- The waste matter is broken down by the worms and compost, which could be used as bio-fertiliser, is produced in 2 to 3 months.
- The process does not generate any explosive gases or leachate and can be used in agriculture and organic farming.
- It enriches the soil due to the deep burrowing worms and bacteria in the organic matter.
- The process could generate green areas and is used in small scale disposal of waste matter.

BIOGAS PRODUCTION

- The animal excreta generated in the rural areas are fairly large in quantity and could be utilised to generate bio-fuels and thus be recycled.
- In the rural areas this excreta is mixed with straw to make dung cakes which are used as fuel for cooking purposes.
- Animal excreta also carry an enormous potential of fly breeding and thus its sanitary disposal is required. This could be achieved by disposing them in bio-gas plants or through landfills or by composting.
- A technically more advanced method for bio-chemical conversion of biodegradable waste is anaerobic decomposition or biomethanation. With the action of microbes in the absence of oxygen, the organic matter is broken down with the release of biogas which contains methane. The gas can be used in place of conventional fuels like LPG or CNG. It can also be concentrated and bottled into Compressed Biogas (CBG) which in turn can be converted into electricity with the use of generators yielding 30 per cent electricity conversion efficiency. However, almost 70 per cent of the energy is lost as heat in the process of conversion. A by product of biomethanation is slurry which is an excellent liquid manure for agriculture. Biomethanation therefore not only produces energy but also delivers nutrients for soil.
- As in the case of composting, biomethanation can also be practiced locally at small scale or at large centralised plants.

Thermal waste treatment

- Thermal treatment of segregated waste is an appropriate and important method for management of waste. Thermal waste treatment comprises waste incineration, pyrolysis (degassing), gasification The goals of thermal treatment are:
- The incertization of the waste residue or contamination concentration
- Volume reduction
- Energy recovery
- Production of marketable secondary raw material
- Pyrolyzation and Gasification of Waste Comparing to the other processes, Pyrolyzation and Gasification have following advantages:
- Uncomplicated and cost effective processes
- A potential for energy and resource recovery
- The recoverable product (energy) is easily stored
- Flexibility with respect to various wastes and changing waste compositions,
- Almost complete prevention of environmental pollution

Incineration for MSW

- In modern waste management is by far most important thermal process. It is used to treat no recyclable and no reusable materials. The purposes of incineration are:
- Making inert any hazard waste residues while minimizing the emission into the air, water and soil
- Destroying organic contaminants and concentrating inorganic contaminants
- Minimizing the quantity of waste requiring disposal, especially its volume
- Recovering the waste's heat value by burning as energy resources in combination of heat recovery and power generation.(energy cycle)
- Transforming the residues into usable secondary products-slag to replace raw materials and resources.(resource cycle)
- A conventional MSW incinerator consists of the following components:
- Waste receiving • Storage, preprocessing • Charging and incineration unit • Slag removal, residue treatment, storage • Boiler with steam recovery • Air pollution control system • Stack

Pyrolysis

- During pyrolysis, some of these incomplete processes can be operated in separate reactors, which makes pyrolysis and gasification separate waste treatment processes.
- Pyrolysis means the thermal decomposition of organic materials without gasification aids such as oxygen, air, CO2, steam, etc.
- In the temperature ranges between 150 and 900 °C, volatile compounds are expelled, and complex carbohydrates are converted into simpler ones.
- Depending on the operating parameters, the products are pyrolysis gas, pyrolsis coke, oil, and tar. The main product is normally pyrolysis gas.
- The recovery of oil fractions by distillation is only economical if the inputs are plastics, discarded tired in large quantities.
- The solid residue consists of pyrolysis coke which contains varying amounts of residual carbon that is not converted to gas in the process.

Gasification

- Gasification means that the carbon-containing materials are converted at high temperatures into gaseous fuels, whereby reactive gases are added to oxidize the residual carbon from the glowing embers of the pyrolysis coke at temperatures above 800 °C with sub-stoichiometric oxygen and further convert carbonized residues into additional gaseous products. Steam, carbon dioxide, oxygen or air are often used as gasification agents.
- Gasification is an independent process and the continuation of the pyrolysis process but still a part of combustion process. The quantity and composition of products are determined by the type of agent, lean gas, water, gas, etc.
- The following chemical reactions take place in the gasification of carbon-containing materials, and depend on the gasification agents (oxygen, air, steam, hydrogen, carbon dioxide).

C+ O2 CO (reaction 1), C+O2 CO2 (reaction 2),

C+2 H2O CO2+2 H2 (reaction 3) C+H2O CO+H2 (reaction 4)

- The immediate use of these gases in a secondary combustion chamber is desirable and efficient at most, since this is how the existing heat can also be recovered. The gas had a lower heat value than pyrolysis gas. But after cracking, the gas can be readily burned. The solid residues from the gasification process are similar to those from incineration and have a high percentage of ash and a low percentage of carbon. In contrast to pyrolysis, gasification slag is so vitreous that it does not leach contaminants into the environment. Therefore, this material is suitable for use in trail and road construction or as sanding material for winter road service.

Thank