

# Reference Material

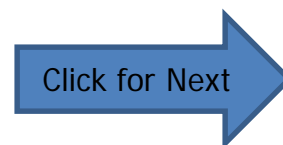


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|              |                                      |
|--------------|--------------------------------------|
| <b>Title</b> | <b>Transformation of Solid Waste</b> |
| <b>Ref</b>   | Tat_RL_2017_505                      |



# Component Separation

- Process of separating the identifiable components from commingled MSW by:
  - Manual and /or
  - Mechanical means
  
- Used to transform a heterogeneous waste into a number of more or less homogenous components.

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- In a necessary operation:
  - ❖ In the recovery of reusable and recyclable materials from MSW In the removal of contaminants from separated materials to improve specification of separated material.
  - ❖ In the removal of hazardous waste from MSW.
  - ❖ Where energy and conversion products are to be recovered from process waste.



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# Mechanical Volume Reduction

- Process whereby the initial volume occupied by a waste is reduced, usually by the application of force or pressure. Is also called densification,
  - ❖ In many cases, vehicles used for collection of solid wastes are equipped with compaction mechanism to increase the amount of waste collected per trip.  
Compaction

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- Paper, cardboard, plastics and aluminium and tin cans removed from MSW for recycling are baled to reduce storage and handling cost and shipping cost to processing centers. Bailing
- High pressure compaction systems have also been developed for various alternative uses such as production of fire place logs from paper and cardboard.
- To reduce the cost of transportation to the landfill, transfer stations are also equipped with compaction equipment

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# Mechanical Size Reduction

- Used to reduce the size of waste material.
- Objective is to obtain a final product that is reasonably uniform in size in comparison with its original form.
  - ❖ At LF: minimizes odour / flies / rodents; facilitates waste spreading and compaction; accelerates biodegradation, reduce equipment and tire damage.

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- Does not necessarily mean volume reduction. In some cases, the total volume of material after size reduction may be greater than that of original volume (e.g. shredding of office paper):

- ❖ Shredding
- ❖ Grinding
- ❖ Milling

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# Chemical Transformation

- Involves a change in phase e.g. solid to liquid, solid to gas.
- To reduce volume/ weight and/ or to recover conversion product.
- Includes:
  - Combustion (chemical oxidation)
  - Pyrolysis
  - Gasification
  - The above are also called thermal processing or thermal conversion technologies.

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# Combustion

- Chemical reactions of oxygen with other organic material, to produce oxidized compounds.
- Used to destroy organic fraction of waste = reduce volume and threat to environment (by destroying toxic compounds).
- In the presence of excess air and under ideal conditions, the combustion of organic fraction of MSW can be represented by:  
Organic matter + Excess air  $\rightarrow$   $N_2$  +  $CO_2$  +  $H_2O$  +  $O_2$  + ash + heat
- Excess air is used to ensure complete combustion.

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- The end products derived from combustion of MSW include hot combustion gases (composed primarily of  $N_2$ ,  $CO_2$ ,  $H_2O$  and  $O_2$ ) and non-combustible residue.
- In practice, small amount of  $NH_3$ ,  $SO_2$ ,  $NO_x$  and other trace gases could be present depending on nature of waste.
- Stoichiometric combustion (or perfect combustion).
- Excess air combustion.
- Incineration: Controlled combustion of combustible liquid, gaseous and solid waste to gases and residue = Excess air combustion



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# Pyrolysis

- Combustion in the absence of oxygen. Or
- To split through combustion of thermal cracking and condensation reactions in an oxygen free atmosphere, into gases, liquids and solid fractions.
- Also called destructive distillation.
- Is highly endothermic in contrast with the combustion process which is highly exothermic.

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- Most organic substances are thermally unstable; they can be destroyed by Pyrolysis.
- End products include
  - ❖ A gas stream containing mainly  $H_2$ ,  $CH_4$ ,  $CO$ ,  $CO_2$  and other gases (depending on organic characteristics of waste).
  - ❖ A tar or oil stream that is liquid at room temperature and contains chemical such as acetic acid, acetone and methanol.
  - ❖ A char consisting of almost pure carbon plus inert material that may have entered the process.

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# Gasification and other Processes

## ➤ Gasification

- Partial combustion (or sub-stoichiometric combustion) of a carbonaceous fuel so as to generate a combustible fuel gas rich in CO, H<sub>2</sub> and some other saturated hydrocarbons, mainly CH<sub>4</sub>.
- The combustible fuel gas can then be combusted in an IC engine or boiler.

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- When a gasifier is operated at atmospheric pressure with air as the oxidant, the end product of gasification process include:
  - ❖ A low Btu gas typically containing  $\text{CO}_2$ ,  $\text{CO}$ ,  $\text{H}_2$ ,  $\text{CH}_4$ , and  $\text{N}_2$
  - ❖ A char containing carbon and inert originally in the fuel
  - ❖ Condensable liquids resembling pyrolytic oil

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## ➤ Other Chemical Transformation Processes

- Hydrolytic conversion
- Wet air oxidation
- Other public and proprietary processes

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# Biological transformation

- The organic fraction of MSW will undergo biological decomposition, if left unattended.
- The period of time over which decomposition occurs depends on:
  - Nature of waste
  - Moisture content
  - Available nutrients
  - Other environmental factors
- Under controlled conditions, biological decay can be made more effective and efficient.

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- Used to:
  - Reduce weight / volume of the organic fraction of MSW.
  - To produce compost (a humus like material that can be used as a soil conditioner)
  - To produce methane
- Aerobic composting
- Anaerobic digestion
- Others (e.g. high solid anaerobic digestion)

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# Aerobic Compositing

- To biologically (by action of mos naturally present in the waste) convert organic fraction of MSW into stable organic residue (known as compost) over a responsible short period of time (4-6 weeks).
- Compositing under aerobic conditions can be represented by the following equation:
  - Organic matter + O<sub>2</sub> + Nutrients → New cells + Resistant organic matter + CO<sub>2</sub> + H<sub>2</sub>O + NH<sub>3</sub> + SO<sub>4</sub> + Heat

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# Anaerobic Digestion

- The biodegradable portion of the organic fraction of MSW can be converted biologically under anaerobic conditions to a gas containing  $\text{CO}_2$  and  $\text{CH}_4$ .
- The principal end products are  $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{NH}_3$ ,  $\text{H}_2\text{S}$  and resistant organic matter.
- Organic matter +  $\text{H}_2\text{O}$  + Nutrients  $\rightarrow$  New cells + resistant organic matter +  $\text{CO}_2$  +  $\text{CH}_4$  +  $\text{NH}_3$  +  $\text{H}_2\text{S}$  + Heat
- Generally,  $\text{CO}_2$  and  $\text{CH}_4$  constitute over 99% of the total gases produced.

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# Importance of Waste Transformation in MSW

- To improve efficiency of SWM system; e.g.
  - Mechanical transformation: to reduce storage volume, reduce haulage cost, improve efficiency at disposal site.
  - Hand separation to remove hazardous waste from MSW.
  - Biological transformation to reduce volume / weight
- To recover reusable and recyclable materials
  - Used for material for which market demand exists
  - Includes paper, cardboard, glass, material etc.

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# Questions or Concerns?

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*Thank  
you*

