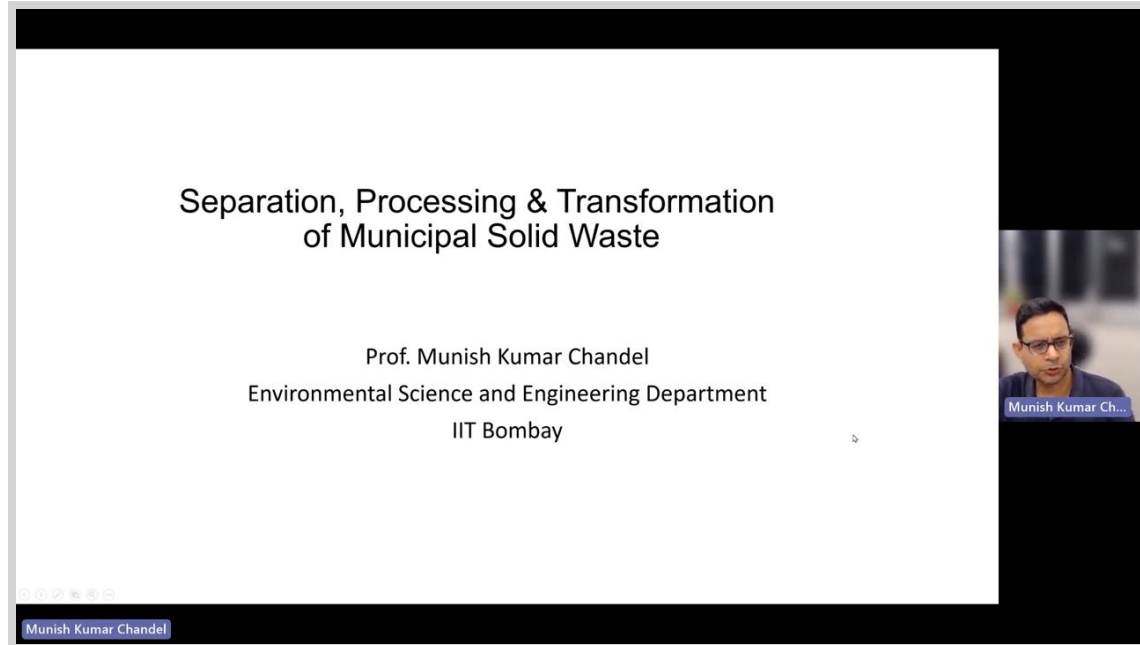
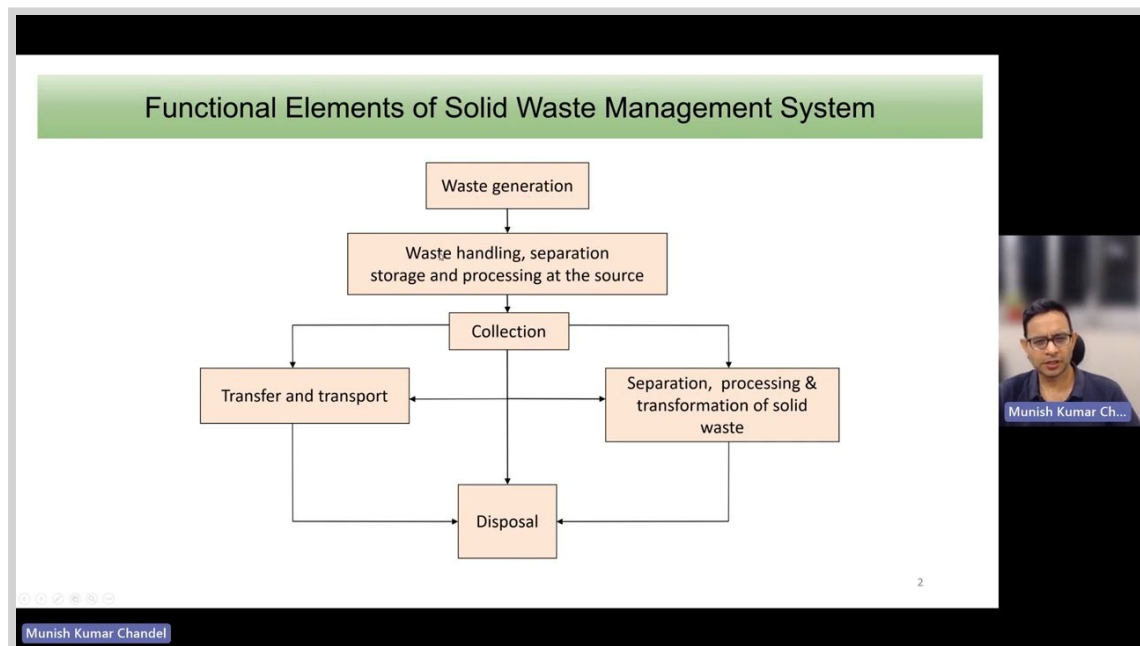


00:13

**Separation, Processing & Transformation
of Municipal Solid Waste**

Prof. Munish Kumar Chandel
Environmental Science and Engineering Department
IIT Bombay

00:2601:08

Separation, Processing & Transformation

- Physical method
- Chemical method
- Biological method

3

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01:20

Physical Method

| Transformation Process | Transformation Method | Transformation Products |
|-------------------------|--|---|
| 1. Component Separation | Manual and/or Mechanical separation | Individual components of MSW |
| 2. Volume Reduction | Application of energy in the form of force or pressure | Original waste component altered in form and reduced in size |
| 3. Size Reduction | Application of energy in the form of shredding, grinding, or milling | The original waste components altered in the form of and reduced in size. |

4

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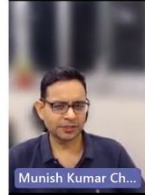
02:46

Chemical Method

| Transformation Process | Transformation Method | Transformation Products |
|------------------------|--------------------------|---|
| 1. Combustion | Thermal Oxidation | Carbon dioxide (CO ₂), Sulfur dioxide(SO ₂), other oxidation products, and Ash |
| 2. Pyrolysis | Destructive distillation | A gas stream containing a variety of gases, tar and/or pyrolytic oil, and char |
| 3. Gasification | Starved air combustion | A low calorific value synthetic gas, charcoal containing carbon and the inerts originally in the fuel, and oil. |

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05:04

Biological Method

| Transformation Process | Transformation Method | Transformation Products |
|---|---------------------------------|--|
| 1. Composting | Aerobic biological conversion | Compost (Humus like material used as a soil conditioner or organic fertilizer) |
| 2. Anaerobic digestion (low or high-solids) | Anaerobic biological conversion | Methane (CH ₄), Carbon dioxide (CO ₂), trace gases, digested humus or sludge |

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05:56



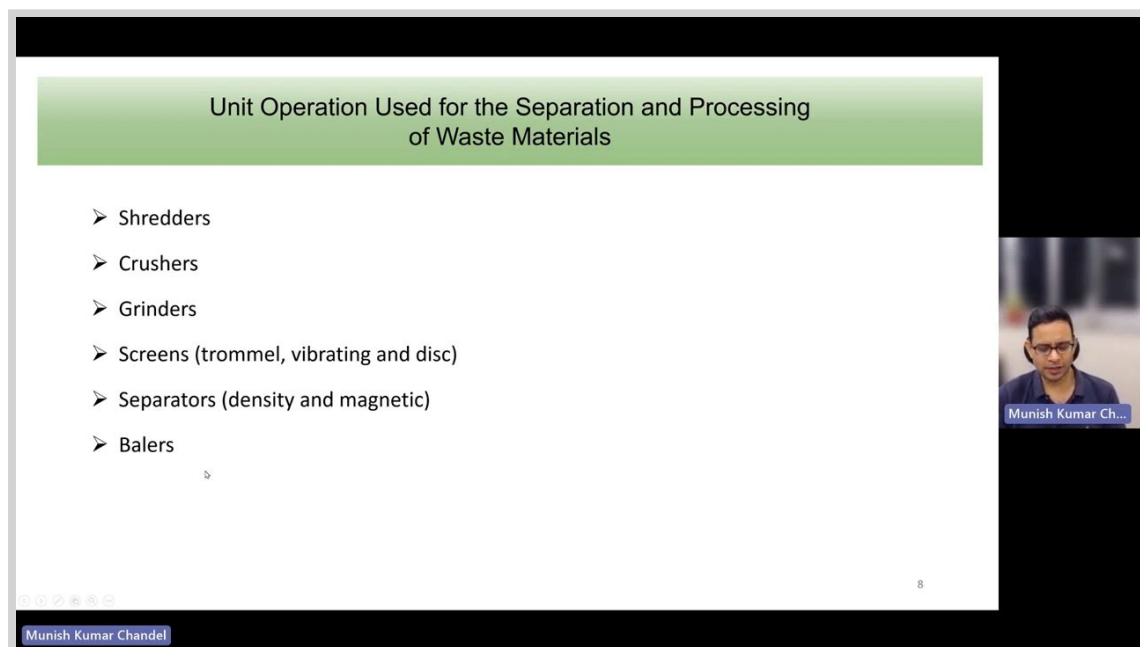
The slide features a green header with the title "Waste Separation & Processing". Below the header, the slide number "7" is visible in the bottom right corner. A small video inset on the right shows a man with glasses, identified as "Munish Kumar Chandel".

Waste Separation & Processing

7

Munish Kumar Chandel

06:13



The slide features a green header with the title "Unit Operation Used for the Separation and Processing of Waste Materials". Below the header, a list of unit operations is presented with right-pointing arrowheads. The slide number "8" is visible in the bottom right corner. A small video inset on the right shows a man with glasses, identified as "Munish Kumar Chandel".

Unit Operation Used for the Separation and Processing of Waste Materials

- Shredders
- Crushers
- Grinders
- Screens (trommel, vibrating and disc)
- Separators (density and magnetic)
- Balers

8

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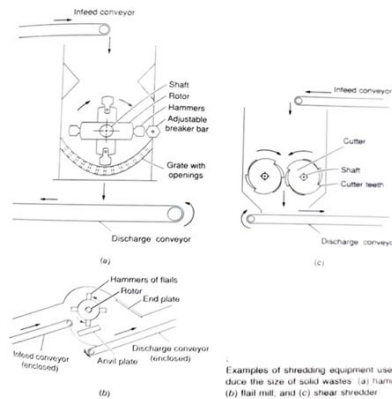
06:25

Unit Operation Used for the Separation and Processing of Waste Materials

Shredders

- Three most common types of shredding devices used to reduce the size of MSW are:

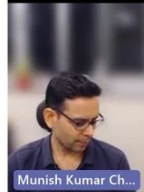
- Hammer mill
- Flail mill (also used as bag breaker)
- Shear shredder (also used bag breaker)



Source: Integrated Solid Waste Management: Engineering Principles and Management Issues
George Tchobanoglous, Hilary Theisen, Samuel Vigil, McGraw-Hill Companies, Incorporated, 1993

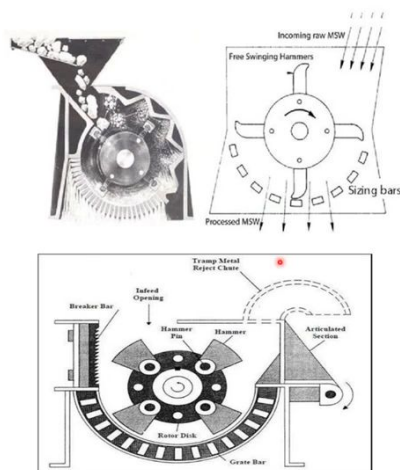
9

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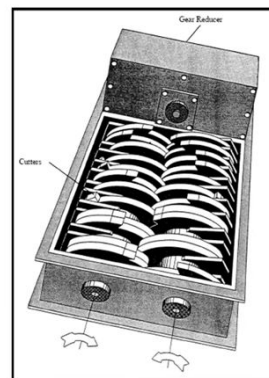


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08:11



Horizontal Hammer Mill



Shear Shredder

Source: Integrated Solid Waste Management: Engineering Principles and Management Issues
George Tchobanoglous, Hilary Theisen, Samuel Vigil, McGraw-Hill Companies, Incorporated, 1993

10

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08:44

Unit Operation Used for the Separation and Processing of Waste Materials

Glass crushers

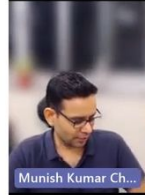
- Glass is often crushed after it has been separated to reduce storage and shipping costs
- In some mechanical separation operation, glass is crushed after one or more separation steps to effect its removal by screening.
- Crushed glass can also be separated optically by color. However, because the equipment of the optical sorting of glass is expensive and on-line reliability of such equipment has not been good, optical sorting is not used commonly at present.

Wood grinders (wood chippers)

- Used to shred large pieces of wood into chips, which can be used as a fuel and finer material which can be composted.

11

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10:00

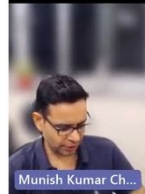
Unit Operation Used for the Separation and Processing of Waste Materials

Screening

- Screening is used to separate mixtures of materials of different sizes
- The principal applications of screening devices in the processing of MSW include:
 - Removal of oversized and undersized materials
 - Separation of waste into light combustible and heavy combustible
 - Recovery of paper, plastic and other light materials from glass and metal
 - Separation of glass, grit and sand from combustible materials
 - Removal of oversized materials from combustion ash

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11:13

Unit Operation Used for the Separation and Processing of Waste Materials

Screening

➤ Most commonly used screens:

1. Vibrating screens
2. Rotary screens (Trommel screen)
3. Disc screens
 - Self cleaning
 - Adjustability with respect to the spacing of the discs on the drive shafts

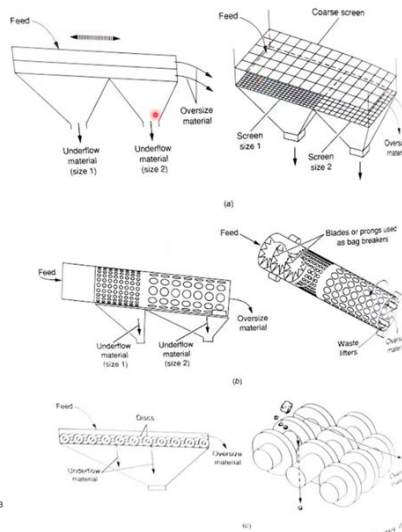
13

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11:40

- a) Vibrating screens
- b) Rotary screens (Trommel screen)
- c) Disc screens



Source: Integrated Solid Waste Management: Engineering Principles and Management Issues
George Tchobanoglous, Hilary Theisen, Samuel Vigil, McGraw-Hill Companies, Incorporated, 1993

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13:13

Unit Operation Used for the Separation and Processing of Waste Materials

Trommel screen



15

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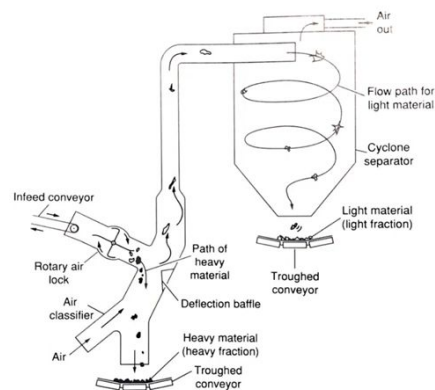


13:31

Unit Operation Used for the Separation and Processing of Waste Materials

Density separation (air classification)

- Air classification is used to separate light materials from heavier material, based on the weight difference of the material in an air stream.



Source: Integrated Solid Waste Management: Engineering Principles and Management Issues
George Tchobanoglous, Hillary Theisen, Samuel Vigil, McGraw-Hill Companies, Incorporated, 1993

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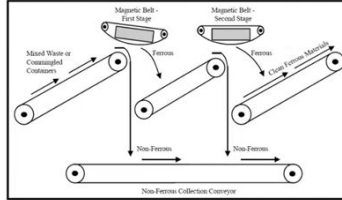


14:38

Unit Operation Used for the Separation and Processing of Waste Materials

Magnetic separation

- Magnetic separation is a unit whereby ferrous metals are separated from waste materials (Source – separated, commingled and shredded MSW) by utilizing their magnetic properties.
- The specific location (s) where ferrous materials are recovered will depend on
 - The objectives to be achieved such as the reduction of wear and tear on processing and separation equipment
 - The degree of product purity to be achieved
 - The required recovery efficiency



Source: Integrated Solid Waste Management: Engineering Principles and Management Issues
George Tchobanoglous, Hilary Theisen, Samuel Vigil, McGraw-Hill Companies, Incorporated, 1993

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15:52

Unit Operation Used for the Separation and Processing of Waste Materials

Densification (compaction)

- Densification is a unit operation that increases the density of waste materials so that can be stored and transported more efficiently.
- Several technologies are available for the densification of solid wastes and recovered materials including baling and pelleting.

Balers

- Balers reduces the volume of waste for storage, prepare the waste for marketing and increase the density of the waste thereby reducing the shipping costs.
- The materials most commonly baled include paper, cardboard, plastics, aluminum and tin cans and large metal component.

Source: Integrated Solid Waste Management: Engineering Principles and Management Issues
George Tchobanoglous, Hilary Theisen, Samuel Vigil, McGraw-Hill Companies, Incorporated, 1993

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16:57

Unit Operation Used for the Separation and Processing of Waste Materials

Baler



<https://www.imabeus.com/balers-to/paper-balers.html>

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17:28

Unit Operation Used for the Separation and Processing of Waste Materials

Can crushers

- Can Crushers are used to crush aluminum and tin cans, thus increasing their density and reducing handling and shipping costs.
- Typically, aluminum cans are crushed and blown into large transport trailers for shipping.

Source: Integrated Solid Waste Management: Engineering Principles and Management Issues
George Tchobanoglous, Hilary Theisen, Samuel Vigil, McGraw-Hill Companies, Incorporated, 1993

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17:54

Options for the Separation of Waste Materials

- Separation can be accomplished either at the **source** of the generation or at material recovery facility (**MRF**).
- Waste separations at the source is usually accomplished by manual means, the number & types of components separated will depend on the waste diversion program. Additional separation and processing will be usually required before these materials can be reused or recycled.
- MRFs are used for :
 - the further processing of source separated waste
 - the separation & recovery of reusable & recyclable materials from commingled MSW
 - improvement in quality (specification)

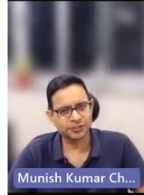
MRF can function as centralized facilities for the separations, cleaning & shipping of large volume of materials recovered from MSW.

The separation of waste materials from MSW can be accomplished **manually** or **mechanically**.

Source: Integrated Solid Waste Management: Engineering Principles and Management Issues
George Tchobanoglous, Hilary Theisen, Samuel Vigil, McGraw-Hill Companies, Incorporated, 1993

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19:51

Options for the Separation of Waste Materials

Types of MRFs

1. MRF for Source – Separated Waste
2. MRF for commingled MSW

The sophistication of the MRF will depend on

- Number and types of the components to be separated
- Waste diversion goals established for the waste recovery program
- Specifications to which the separated products must conform

Source: Integrated Solid Waste Management: Engineering Principles and Management Issues
George Tchobanoglous, Hilary Theisen, Samuel Vigil, McGraw-Hill Companies, Incorporated, 1993

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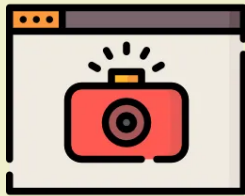
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