

UNIT-IV OFFSITE WASTE PROCESSING

LEARNING OBJECTIVES

After completing this Unit, you should be able to:

- identify the purpose of waste processing;
- explain the processing techniques for reducing the volume and size of wastes;
- carry out separation of various components;
- discuss the need for dewatering and drying of wastes;
- assess technical viability of various processing techniques.

PURPOSE OF PROCESSING

The processing of wastes helps in achieving the best possible benefit from every functional element of the solid waste management (SWM) system and, therefore, requires proper selection of techniques and equipment for every element. Accordingly, the wastes that are considered suitable for further use need to be paid special attention in terms of processing, in order that we could derive maximum economical value from them.

The purposes of processing, essentially, are (Tchobanoglous et al., 1993):

- (i) **Improving efficiency of SWM system:** Various processing techniques are available to improve the efficiency of SWM system. For example, before waste papers are reused, they are usually baled to reduce transporting and storage volume requirements. In some cases, wastes are baled to reduce the haul costs at disposal site, where solid wastes are compacted to use the available land effectively. If solid wastes are to be transported hydraulically and pneumatically, some form of shredding is also required. Shredding is also used to improve the efficiency of the disposal site.

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- (ii) **Recovering material for reuse:** Usually, materials having a market, when present in wastes in sufficient quantity to justify their separation, are most amenable to recovery and recycling. Materials that can be recovered from solid wastes include paper, cardboard, plastic, glass, ferrous metal, aluminium and other residual metals.

- (iii) **Recovering conversion products and energy:** Combustible organic materials can be converted to intermediate products and ultimately to usable energy. This can be done either through incineration, pyrolysis, composting or bio-digestion. Initially, the combustible organic matter is separated from the other solid waste components. Once separated, further processing like shredding and drying is necessary before the waste material can be used for power generation.

Having described the need for waste processing, we now discuss how waste processing is actually carried out.

MECHANICAL VOLUME AND SIZE REDUCTION

Mechanical volume and size reduction is an important factor in the development and operation of any SWM system. The main purpose is to reduce the volume (amount) and size of waste, as compared to its original form, and produce waste of uniform size. We will discuss the processes involved in volume and size reduction along with their selection criteria, equipment requirement, design consideration, etc.

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Volume reduction or compaction

Volume reduction or compaction refers to densifying wastes in order to reduce their volume. Some of the benefits of compaction include:

- reduction in the quantity of materials to be handled at the disposal site;
- improved efficiency of collection and disposal of wastes;
- increased life of landfills;
- Economically viable waste management system.

However, note the following disadvantages associated with compaction:

- poor quality of recyclable materials sorted out of compaction vehicle;
- difficulty in segregation or sorting (since the various recyclable materials are mixed and compressed in lumps);
- Bio-degradable materials (e.g., leftover food, fruits and vegetables) destroy the value of paper and plastic material.

Equipment used for compaction

Based on their mobility, we can categorise the compaction equipment used in volume reduction under either of the following:

- (i) **Stationary equipment:** This represents the equipment in which wastes are brought to, and loaded into, either manually or mechanically. In fact, the compaction mechanism used to compress waste in a collection vehicle, is a stationary compactor. According to their application, stationary compactors can be described as light duty (e.g., those used for residential areas), commercial or light industrial, heavy industrial and transfer station compactors. Usually, large stationary compactors are necessary, when wastes are to be compressed into:

- steel containers that can be subsequently moved manually or mechanically;

chambers where the compressed blocks are banded or tied by some means before being removed;

chambers where they are compressed into a block and then released and hauled away untied;

transport vehicles directly.

- (ii) **Movable equipment:** This represents the wheeled and tracked equipment used to place and compact solid wastes, as in a sanitary landfill.

Types of Compaction Equipment

Location or Operation	Type of Compactor	Remarks
Solid waste generation points	Stationary/residential	
	Vertical	Vertical compaction ram may be used; may be mechanically or hydraulically operated, usually hand-fed; wastes compacted into corrugated cardboard boxes, or paper or plastic bags; used in medium and high-rise apartments.
	Rotary	Ram mechanism used to compact waste into paper or plastic bags on rotating platform, platform rotates as containers are filled; used in medium and high-rise apartments.
		Compactor can be chute fed; either vertical or horizontal rams; single

	Bag or extruder	or continuous multi-bags; single bag must be replaced and continuous bags must be tied off and replaced; used in medium and high-rise apartments.
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Compactors

According to their compaction pressure, we can divide the compactors used at transfer stations as follows:

- (i) **Low-pressure (less than 7kg/cm²) compaction:** This includes those used at apartments and commercial establishments, bailing equipment used for waste papers and cardboards and stationary compactors used at transfer stations. In low-pressure compaction, wastes are compacted in large containers. Note that portable stationary compactors are being used increasingly by a number of industries in conjunction with material recovery options, especially for waste paper and cardboard.
- (ii) **High-pressure (more than 7kg/cm²) compaction:** Compact systems with a capacity up to 351.5 kg/cm² or 5000 lb/in² come under this category. In such systems, specialised compaction equipment are used to compress solid wastes into blocks or bales of various sizes. In some cases, pulverised wastes are extruded after compaction in the form of logs. The volume reduction achieved with these high-pressure compaction systems varies with the characteristics of the waste. Typically, the reduction ranges from about 3 to 1 through 8 to 1.

Size reduction or shredding

This is required to convert large sized wastes (as they are collected) into smaller pieces. Size reduction helps in obtaining the final product in a reasonably uniform and considerably reduced size in comparison to the original form. But note that size reduction does not necessarily imply volume reduction, and this must be factored into the design and operation of SWM systems as well as in the recovery of materials for reuse and conversion to energy.

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Table Size Reduction Equipment

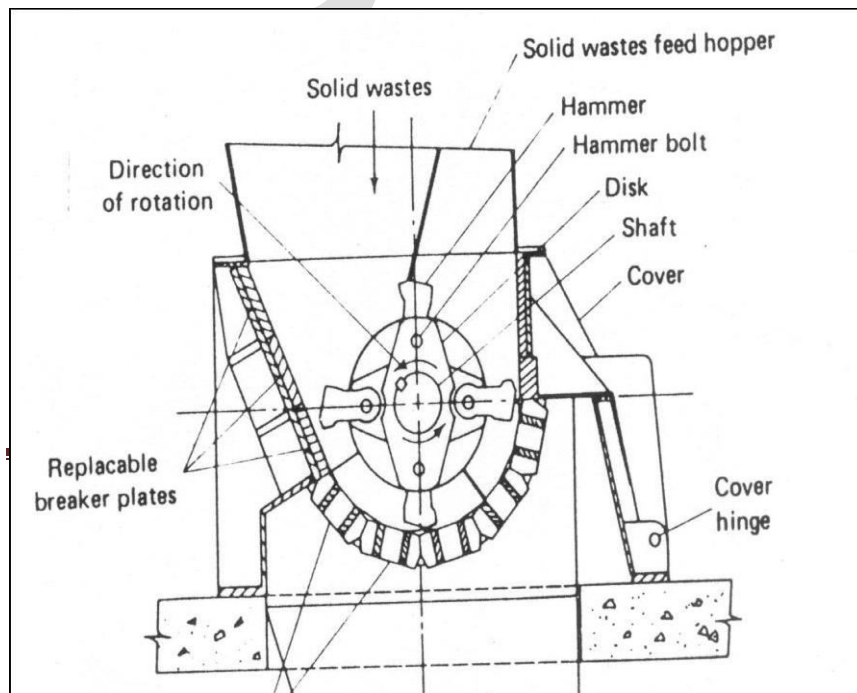
Type	Mode of action	Application
Small grinders	Grinding, mashing	Organic residential solid wastes
Chippers	Cutting, slicing	Paper, cardboard, tree trimmings, yard waste, wood, plastics
Large grinders	Grinding, mashing	Brittle and friable materials, used mostly in industrial operation
Jaw crushers	Crushing, breaking	Large solids
Rasp mills	Shredding, tearing	Moistened solid wastes
Shredders	Shearing, tearing	All types of municipal wastes
Cutters, Clippers	Shearing, tearing	All types of municipal wastes
Hammer mills	Breaking, tearing, cutting, crushing	All types of municipal wastes, most commonly used equipment for reducing size and homogenizing composition

		of wastes
Hydropulper	Shearing, tearing	Ideally suited for use with pulpable wastes, including paper, wood chips. Used primarily in the papermaking industry. Also used to destroy paper records

The most frequently used shredding equipment are the following:

- (i) **Hammer mill:** These are used most often in large commercial operations for reducing the size of wastes. Hammer mill is an impact device consisting of a number of hammers, fastened flexibly to an inner disk, which rotates at a very high speed:

Figure Hammer Mill: An Illustration



Solid wastes, as they enter the mill are hit by sufficient force, which crush or tear them with a velocity so that they do not adhere to the hammers. Wastes are further reduced in size by being struck between breaker plates and/or cutting bars fixed around the periphery of the inner chamber. This process of cutting and striking action continues, until the required size of material is achieved and after that it falls out of the bottom of the mill.

COMPONENT SEPARATION

Component separation is a necessary operation in which the waste components are identified and sorted either manually or mechanically to aid further processing. This is required for the:

- recovery of valuable materials for recycling;

- preparation of solid wastes by removing certain components prior to incineration, energy recovery, composting and biogas production.

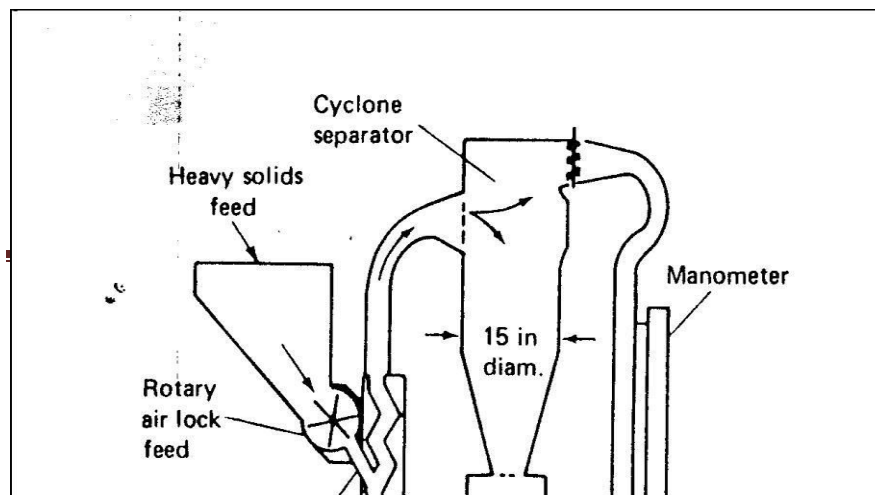
The most effective way of separation is manual sorting in households prior to

collection. In many cities (e.g., Bangalore, Chennai, etc., in India), such systems are now routinely used. The municipality generally provides separate, easily identifiable containers into which the householder deposits segregated recyclable materials such as paper, glass, metals, etc. Usually, separate collections are carried out for the recyclable material. At curbside, separate areas are set aside for each of the recyclable materials for householders to deliver material – when there is no municipal collection system. In case the separation is not done prior to collection, it could be sorted out through mechanical techniques such as air separation, magnetic separation, etc., to recover the wastes

Air separation

This technique has been in use for a number of years in industrial operations for segregating various components from dry mixture. Air separation is primarily used to separate lighter materials (usually organic) from heavier (usually inorganic) ones. The lighter material may include plastics, paper and paper products and other organic materials. Generally, there is also a need to separate the light fraction of organic material from the conveying air streams, which is usually done in a cyclone separator. In this technique, the heavy fraction is removed from the air classifier (i.e., equipment used for air separation) to the recycling stage or to land disposal, as appropriate. The light fraction may be used, with or without further size reduction, as fuel for incinerators or as compost material. There are various types of air classifiers commonly used.

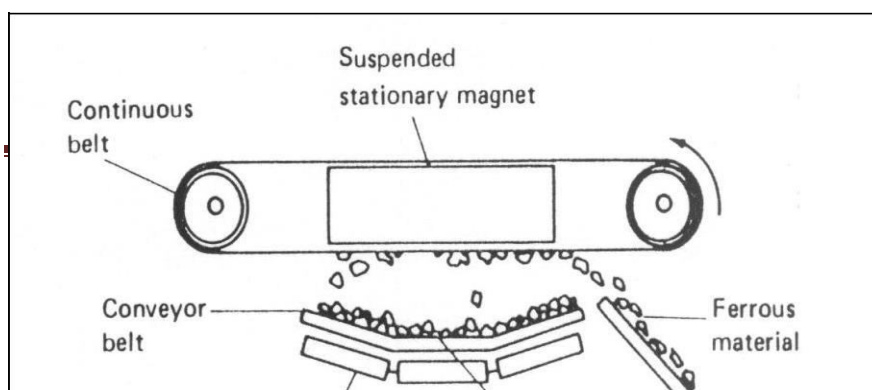
Zigzag Air Classifier



Magnetic separation

The most common method of recovering ferrous scrap from shredded solid wastes involves the use of magnetic recovery systems. Ferrous materials are usually recovered either after shredding or before air classification. When wastes are mass-fired in incinerators, the magnetic separator is used to remove the ferrous material from the incinerator residue. Magnetic recovery systems have also been used at landfill disposal sites. The specific locations, where ferrous materials are recovered will depend on the objectives to be achieved, such as reduction of wear and tear on processing and separation equipment, degree of product purity achieved and the required recovery efficiency.

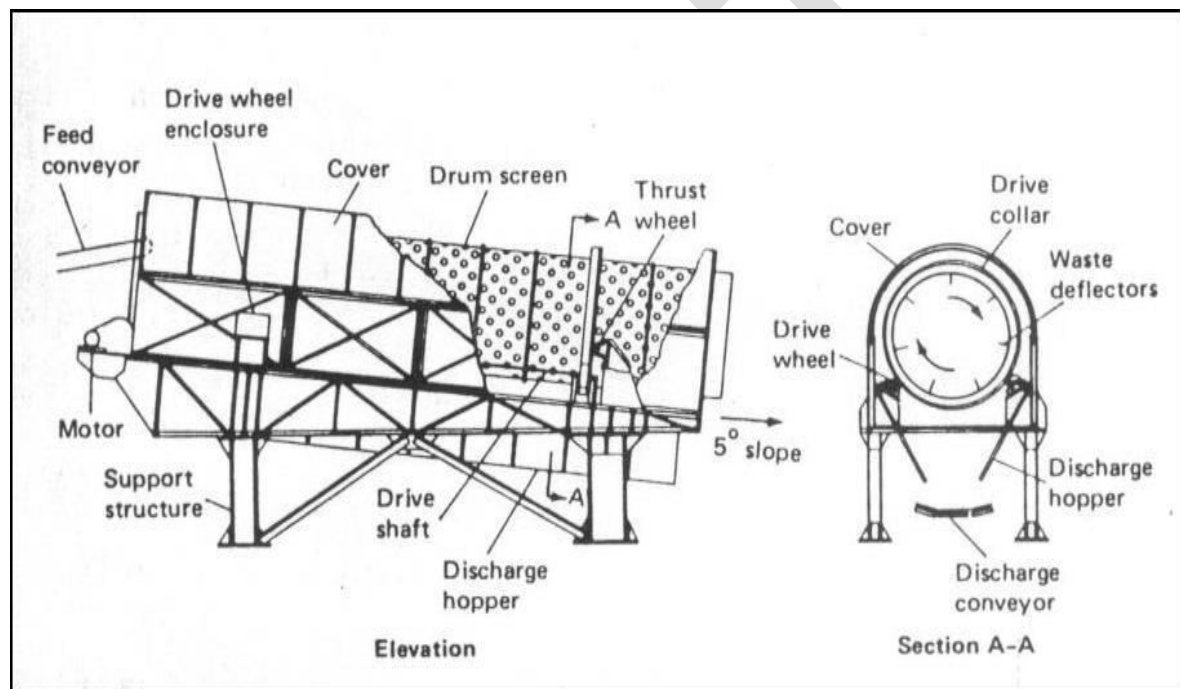
Suspended Type Permanent Magnetic Separator



Screening

Screening is the most common form of separating solid wastes, depending on their size by the use of one or more screening surfaces. Screening has a number of applications in solid waste resource and energy recovery systems. Screens can be used before or after shredding and after air separation of wastes in various applications dealing with both light and heavy fraction materials. The most commonly used screens are rotary drum screens and various forms of vibrating screens.

Rotary Drum Screen



DRYING AND DEWATERING

Drying and dewatering operations are used primarily for incineration systems, with or without energy recovery systems. These are also used for drying of sludges in wastewater treatment plants, prior to their incineration or transport to land disposal. The purpose of drying and dewatering operation is to remove moisture from wastes and thereby make it a better fuel. Sometimes, the light

fraction is *pelletised* after drying to make the fuel easier to transport and store, prior to use in an incinerator or energy recovery facility.

Moisture Content of Municipal Solid Waste Components

Component	Moisture (in percent)	
	Range	Typical
Food wastes	50 – 80	70
Paper	4 – 10	6
Cardboard	4 – 8	5
Plastics	1 – 4	2
Textiles	6 – 15	10
Rubber	1 – 4	2
Leather	8 – 12	10
Garden trimmings	30 – 80	60
Wood	15 – 40	20
Glass	1 – 4	2
Tin cans	2 – 4	3
Nonferrous metals	2 – 4	2
Ferrous metals	2 – 6	3
Dirt, ashes, brick, etc.	6 – 12	8
Municipal solid wastes	15 – 40	20



Drying

The following three methods are used to apply the heat required for drying the wastes:

- (i) **Convection drying:** In this method, hot air is in direct contact with the wet solid waste stream.
- (ii) **Conduction drying:** In this method, the wet solid waste stream is in contact with a heated surface.
- (iii) **Radiation drying:** In this method, heat is transmitted directly to the wet solid waste stream by radiation from the heated body.

Dewatering

Dewatering is more applicable to the problem of sludge disposal from wastewater treatment of plants, but may also be applicable in some cases to municipal/industrial waste problems. When drying beds, lagoons or spreading on land are not feasible, other mechanical means of dewatering are used. The emphasis in the dewatering operation is often on reducing the liquid volume. Once dewatered, the sludge can be mixed with other solid waste, and the resulting mixture can be:

- incinerated to reduce volume;
- used for the production of recoverable by-products;
- used for production of compost;
- buried in a landfill.