5. Processing Techniques and Equipment's

Various processing techniques are available to improve the efficiency of solid waste management systems. For example, to reduce storage requirements at medium- and high-rise apartment buildings, both incineration and baling are used. In some cases, wastes are baled to reduce haul costs to the disposal site. At the disposal site, solid wastes are compacted to use the available land effectively. Shredding is also used to improve the efficiency of disposal sites. The selection of processing techniques for these purposes depends on the components of the overall waste management system and, in most cases, is situation-specific.

5.1 Purposes of Processing

There are three main purposes of processing solid wastes:

- To improve the efficiency of solid waste management systems.
- To recover useful materials.
- To recover conversion products and energy.

5.2 Recovery of Materials for Reuse

Components that are most amenable to recovery are those for which markets exist and which are present in the wastes in sufficient quantity to justify their separation.

Materials that have been recovered from solid wastes include paper, cardboard, plastic, glass, ferrous metal, aluminum, and other residual nonferrous metal.

5.3 Recovery of Conversion Products and Energy

Combustible organic materials can be converted to intermediate product and ultimately to energy in a number of ways, including (1) incineration or direct combustion in power boilers to produce steam. (2) pyrolysis produce a synthetic gas or liquid fuel, and (3) biodegradation with and without sewage sludge to generate methane.

What is important as a first step is to separate combustible organic materials from the other solid waste components. Once they are separated, further processing is usually necessary before the materials can be used for the production of power. Typically, they must be shredded and dried before use.

5.4 Mechanical Volume Reduction

Volume reduction is an important factor in the development and operation of most of solid waste management systems. In most cities, vehicle equipped with compaction mechanisms are used for the collection of solid wastes. To increase the useful life of landfills, wastes usually are compacted before being covered. Recently, high-pressure compaction systems have been developed to reduce landfill requirements

Low-Pressure Compaction Typically, low-pressure compactors include those used at apartments and commercial establishments used for waste paper and cardboard, and stationary compactors used at transfer stations.

Fig. 1 compaction container

High-Pressure Compaction Recently, a number of high-pressure (up to 5,000 lb/in^2) compaction systems have been developed. In most of these systems, specialized compaction equipment is used to produce compressed solid wastes in blocks or bales of various sizes.

When wastes are compressed, their volume is reduced. The reduction in volume expressed in percent is given by the following:

Fig. 2 Landfill compacter

5.5 Chemical Volume Reduction

Chemical volume reduction is a method, wherein volume reduction occurs through chemical changes brought within the waste either through an addition of chemicals or changes in temperature. Incineration is the most common method used to reduce the volume of waste chemically, and is used both for volume reduction and power production. These other chemical methods used to reduce volume of waste chemically include *pyrolysis*, *hydrolysis*.

5.5.1 Incineration of Municipal Wastes

One of the most attractive features of the incineration process is that it can be used to reduce the original volume of combustible solid wastes by 80 to 90 percent. In some of the newer incinerators designed to operate at temperatures high enough to produce a molten material. Although the technology of incineration has advanced in the past two decades, air pollution control remains a major problem in implementation. In addition to the use of large municipal incinerators, onsite incineration is also used at individual residences, apartments, stores, industries, and hospitals.

5.5.1.1 Description of Incineration Process

The basic operations involved in the incineration of solid wastes are identified in Fig. 3. The operation begins with the unloading of solid wastes from collection trucks (1) into a storage bin (2). The length of the unloading platform and storage bin is a function of the number of trucks. The depth and width of the storage bin are determined by both the rate at which waste loads are received and the rate of burning. Storage capacity usually averages about the volume of 1day. The overhead crane (3) is used to batch load wastes into the charging hopper (4). The crane operator can select the mix of wastes to achieve fairly even moisture content in the charge. Large or incombustible items are also removed from the wastes. Solid wastes from the charging hopper fall onto the stokers (5) where they are mass-fired. Several different types of mechanical stokers are commonly used. Air may be introduced from the bottom of the grates (under-fire air) by means of a forced-draft fan (6) or above the grates (over-fire air) to control burning rates and furnace temperature. The heated air rises over the incoming high-moisture wastes at the top of the drying grate and thus drives off the moisture to permit burning as the wastes travel down the grate. Because most organic wastes are thermally unstable, various gases are driven off in the combustion process taking place in the furnace, where the temperature is about 1400^{o}F (760 ^{o}C). These gases and small organic particles pass into a secondary chamber, commonly called a "combustion chamber" (7), and burn at temperatures in excess of 1600°F (871 ^{o}C) . Odor-producing compounds usually are destroyed at temperatures above about 1400 to 1600°F (760- 871 ^{o}C).

Some fly ash and other particulates may be carried through the combustion chamber. To meet local air pollution control regulations, space must be provided for air-cleaning equipment (8). To secure adequate air flows to provide for head losses through air-cleaning equipment, as well as to supply air to the incinerator itself, an induced draft fan (9) may be needed. It may also be done with the forced-draft fan.

The end products of incineration are the cleaned gases that are discharged to the stack (10). Ashes and unburned materials from the grates fall into a residue hopper (11) located below the grates where they are quenched with water. Residue from the storage hopper may be taken to a sanitary landfill or to a resource recovery plant.

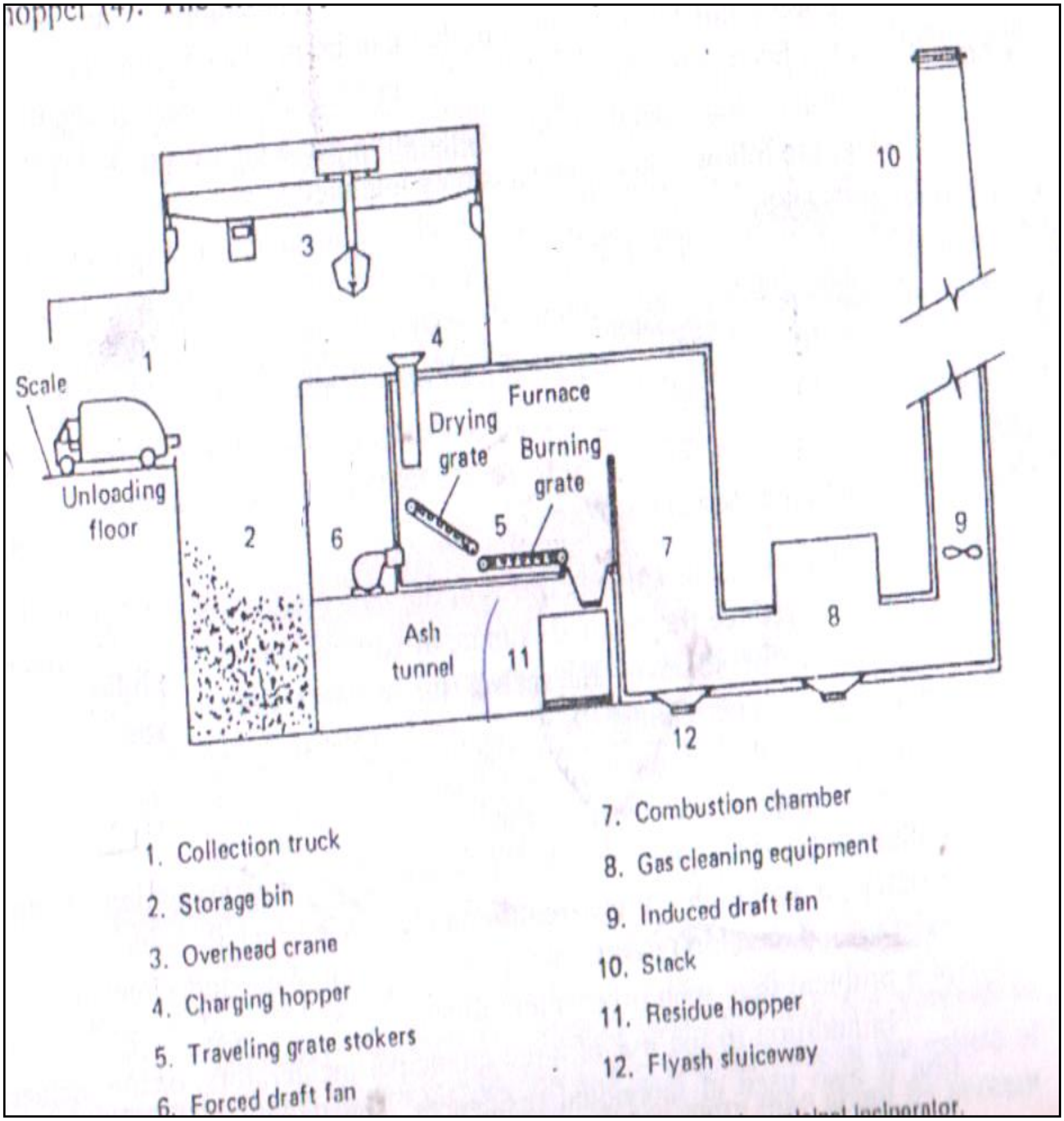

Fig.3 Steps of Incineration

Example : Determine the quantity and composition of the residue from an incinerator used for municipal solid wastes with the average composition given in Table 4-9. Estimate the reduction in volume if it is assumed that the density weight of the residue is 10001b/yd^3. Assume the average density of the solid waste in the incinerator storage pit is about 375 1b/yd^3.

TABLE 8-8 INCINERATION RESIDUE COMPUTATION FOR EXAMPLE 8-1

Component	Solid wastes*, lb	Inert residue†, percent	Residue lb	Residue percent
Food wastes	150	5	7.5	3.2
Paper	400	6	24	10.1
Cardboard	40	5	2	0.8
Plastics	30	10	3	1.3
Textiles	20	2.5	0.5	0.2
Rubber	5	10	0.5	0.2
Leather	5	10	0.5	0.2
Garden trimmings	120	4.5	5.4	2.3
Wood	20	1.5	0.3	0.1
Glass	80	98	78.4	32.9
Tin cans	60	98	58.8	24.7
Nonferrous metals	10	96	9.6	4.0
Ferrous metals	20	98	19.6	8.2
Dirt, ashes, brick, etc.	40	70	28.0	11.8
Total	1,000		238.1	100

* Based on 1,000 lb of solid wastes (See Table 4-4).
† From Table 4-9.
Note: lb × 0.4536 = kg

5.6 Mechanical Size Reduction

Size reduction is the term applied to the conversion of solid wastes as they are collected into smaller pieces. The objective of size reduction is to obtain final product that is reasonably uniform and considerably reduced in size in comparison to its original form. It is important to note that size reduction does not necessarily imply volume reduction. In some situations, the total volume of the material after size reduction may be greater than that of the original volume. In practice, the terms shredding, grinding, and milling are used interchangeably to describe mechanical size-reduction operations.

Wastes are shredded before they are baled. The disposal of shredded wastes in landfills without the use of daily cover is another important application of size reduction.

5.6.1 Size-Reduction Equipment

The types of equipment that have been used for reducing the size of and for homogenizing solid wastes include small grinders, chippers, large grinders, jaw crushers, rasp mills, shredders, and hammer mills.

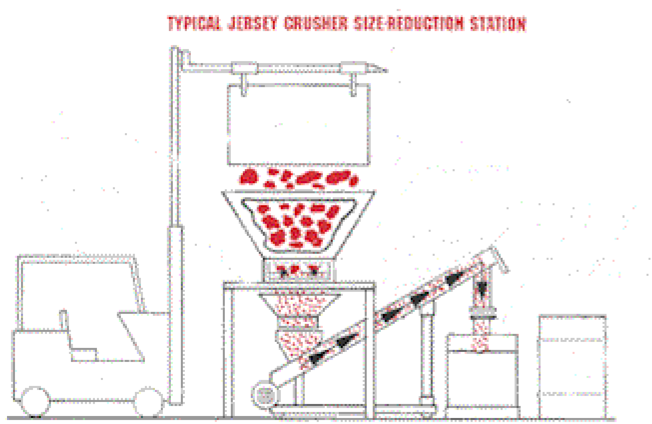

Fig. 4 Jaw Crusher

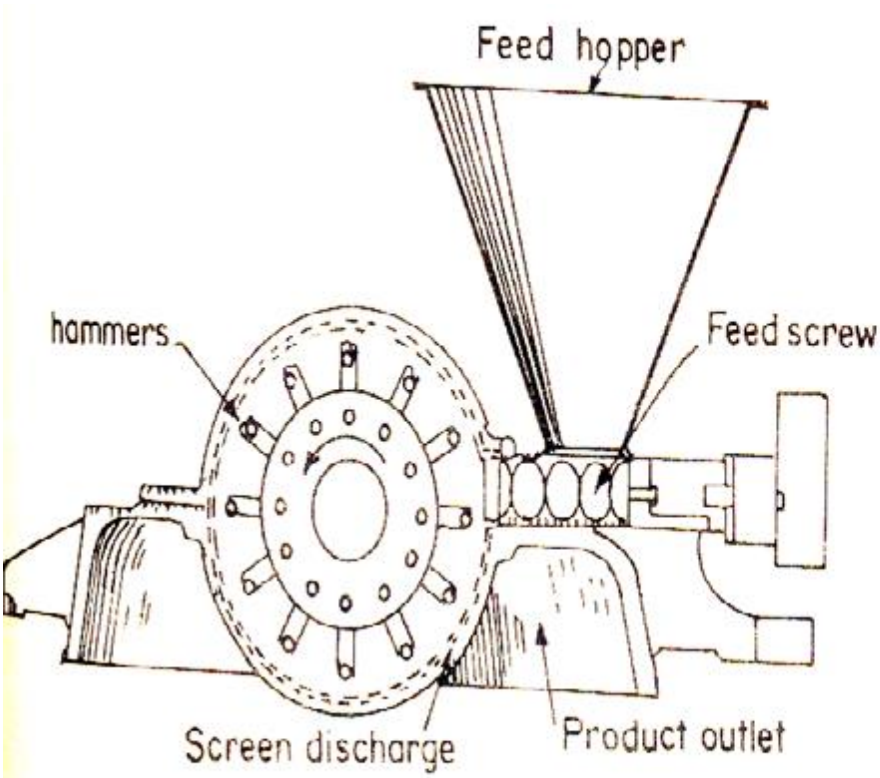

Fig.5 Hammer mill

Fig. 6 chippers

5.7 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.

- 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 Hand Sorting:

A. At the source where solid waste are generated

B. At a transfer station

C. At a centralized processing station

D. At the disposal site

The number and type of components salvaged or sorted depend on the location and the resale market.

5.7.1 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.

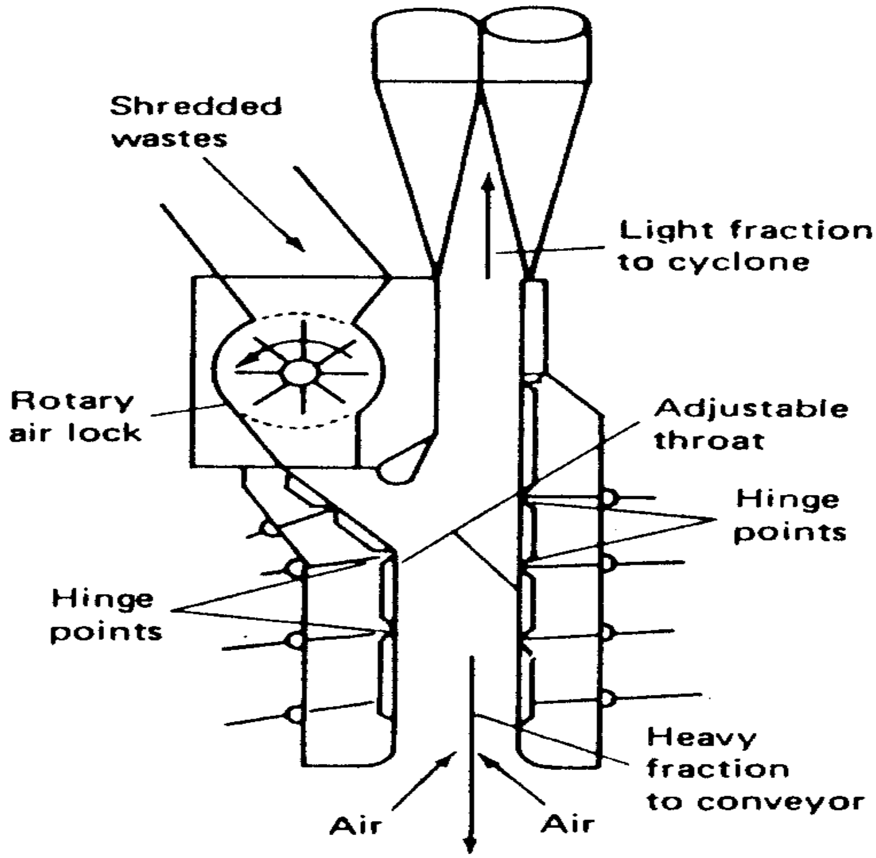

Fig.7 Conventional Chute Type

5.7.2 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.

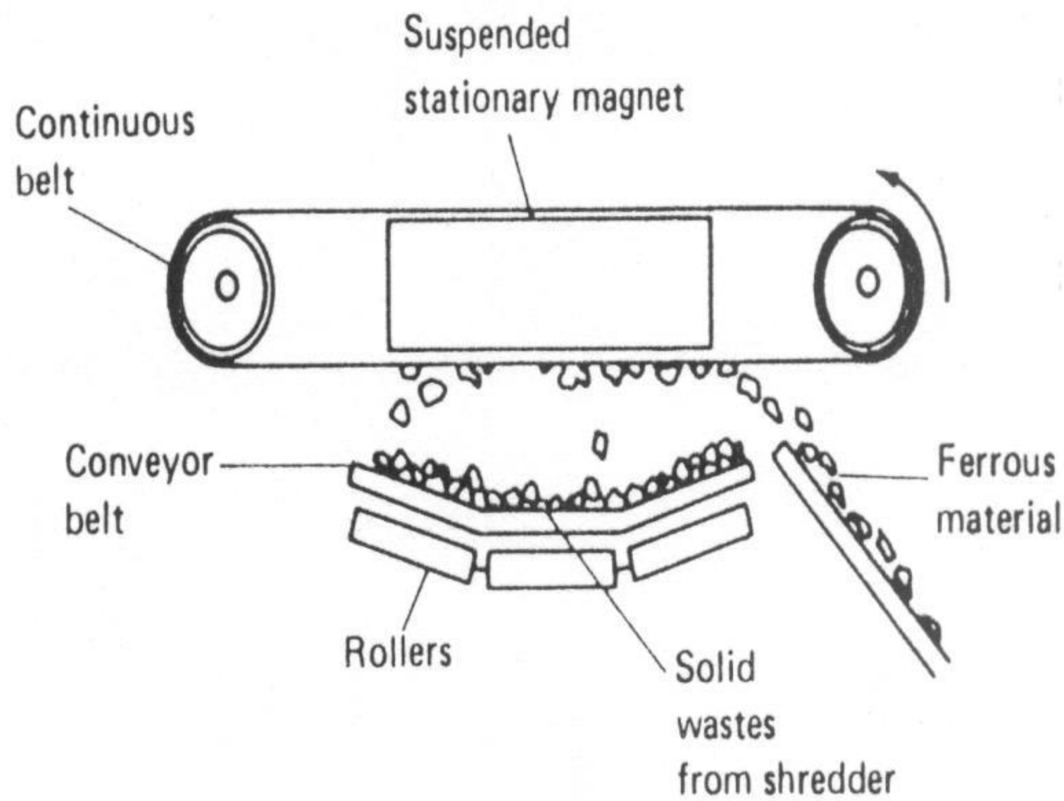

Fig.8 Suspended Type Permanent Magnetic Separator

5.7.3 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. Figures 6 shows a typical rotary drum screen. Note that rotating wire screens with relatively large openings are used for separation of cardboard and paper products, while vibrating screens and rotating drum screens are typically used for the removal of glass and related materials from the shredded solid wastes.

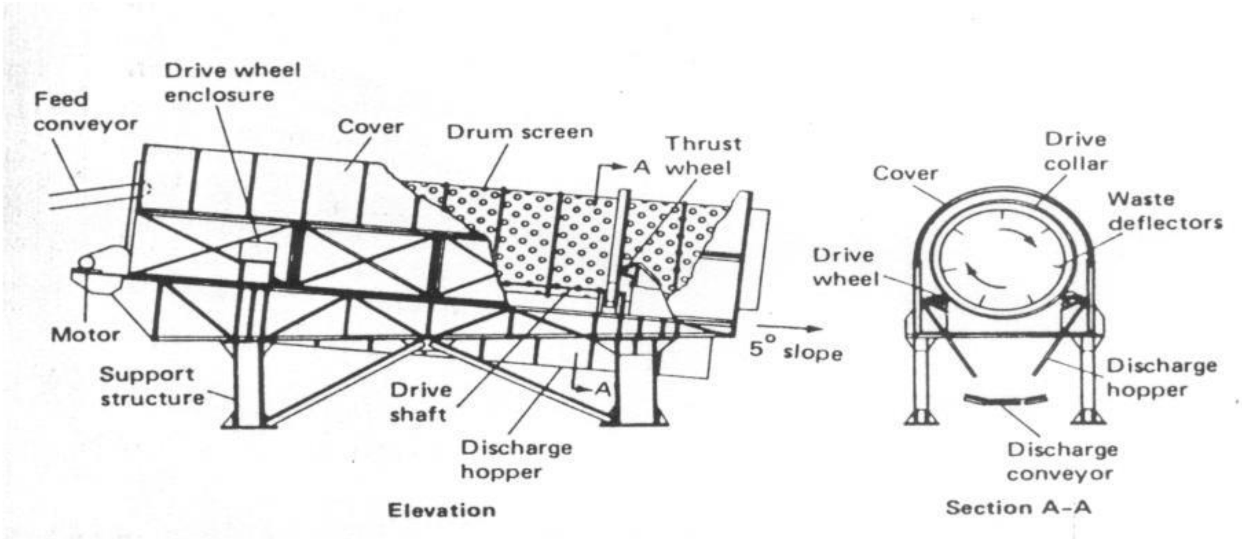

Fig. 9 Rotary Drum Screen

5.8 Drying and Dewatering

Drying and dewatering operations are used primarily prior 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.

5.8.1 Drying

Over the years a wide variety of dryer designs have evolved. Before considering any of these designs, however, it may be helpful to review how heat can be applied to the material to be dried. Typically, this is accomplished by one or more of the following methods:

1. Convection, in which the heating medium, usually air or the products of combustion, is in direct contact with the wet material
2. Conduction, in which the heat is transmitted indirectly by contact of the wet material with a heated surface
3. Radiation, in which heat is transmitted directly and solely from the heated

body to the wet material by the radiation of heat

5.8.2 Dewatering

The problem of sludge disposal from municipal waste-water treatment plants has become critical for many large communities in which the use of drying beds, lagoons, or land spreading is no longer practical or economically feasible. In most cases some form of sludge dewatering has been adopted to reduce the liquid volume. Once dewatered, the sludge can be mixed with other solid wastes. The resulting mixture can be (1) incinerated to reduce the volume, (2) used for the production of recoverable byproducts, (3) used for the production of compost, or (4) buried in a landfill.

Centrifugation and filtration are the two common methods for the dewatering of sludge. Sludges with solid content of a few percent can be thickened to about 10 – 15% in centrifugation and about 20 – 30% in pressure filtration or vacuum filtration.