

# **CHAPTER 8**

## **SORTING AND MATERIAL RECOVERY**

### **8.1 INTRODUCTION**

The term 'sorting' indicates separation and storage of individual constituents of waste material. In this chapter, the term 'sorting' is used synonymously with 'separation' and 'segregation'.

### **8.2 OBJECTIVES OF SORTING**

The following are the objectives of sorting in the Indian context:

- (a) To separately store recyclable material for reuse.
- (b) To ensure that waste which can be processed for recovery of material and energy (through composting, incineration or any other suitable technology) does not become co-mixed with undesirable elements.
- (c) To separately store hazardous material for disposal in hazardous waste landfills or appropriate processing.
- (d) To minimise the waste and ensure reduction in landfill space for final disposal

### **8.3 STAGES OF SORTING**

There are various stages at which sorting can take place in the waste stream. These can be identified as the following:

- (a) At the source / household level
- (b) At the community bin (municipal bin)
- (c) At a transfer station or centralised sorting facility
- (d) At waste processing site (pre-sorting and post-sorting)
- (e) At the landfill site

## **8.4 SORTED WASTE STREAMS**

Sorting is carried out to segregate the waste into different streams to fulfil one or more of the objectives listed above. Accordingly the waste should be divided into the following streams:

- (a) Dry Recyclables
- (b) Construction and demolition waste
- (c) Biodegradable waste
- (d) Bulky waste (white goods)
- (e) Hazardous waste
- (f) Mixed MSW (often referred to as comingled waste)

## **8.5 SORTING OPERATIONS**

Sorting can be carried out manually or through semi-mechanised and fully mechanised systems

Manual sorting operations comprise of

- (a) unloading the waste
- (b) manually (with protective measures) spreading the waste
- (c) hand picking (with protective measures) visually identifiable waste for reuse
- (d) collecting and stockpiling the remaining waste.

Semi-mechanised sorting operations comprise of

- (a) unloading of waste (mechanised)
- (b) loading of waste on conveyer belts (mechanised)
- (c) hand picking of visually identifiable waste off the belt for reuse (manual)
- (d) collecting, stocking and reloading the remaining waste (mechanised)

Fully mechanised sorting operations comprise of

- (a) unloading of waste

- (b) size reduction of waste through shredders and crushers
- (c) size separation of waste using screening devices
- (d) density separation (air classification) of waste
- (e) magnetic separation of waste
- (f) compaction of waste through balers/crushers
- (g) reloading of waste

Semi - mechanised and fully mechanised systems are used at central sorting facilities. In semi-mechanised systems, productivity of sorters can be of the order of 5 tonnes of sorted material per person per day (Table 8.1).

**Table 8.1: Productivity of Manual Sorters by Picking Off A Conveyor Belt in a Semi-Mechanised System**

<b>Material</b>	<b>Average tonnes/person/day</b>	<b>Range tonnes/person/day</b>
Paper	7.58	8.36 – 13.05
Metals	6.06	1.21 – 17.53
Glass	8.28	1.02 – 16.11
Plastics	1.60	0.60 – 3.21
Average	5.12	2.69 – 8.88

Source : “Integrated Solid Waste management” – A Life Cycle Inventory”.  
White et al (1995), Chapman & Hall, London

A typical example of a combination of manual and mechanical sorting flow chart (mass balance) adopted at a central sorting facility in a developed country is shown in Fig. 8.1 for 1000 tonnes per day waste generation.

## 8.6 CURRENT STATUS

Waste is currently sorted out, but not necessarily in the required waste streams. It is important to examine the current status of sorting before embarking on a series of guidelines to prescribe what needs to be done.

Household waste sorting in India is a complex activity which involves more than one sector and more than one location. For the sake of understanding it is convenient to divide it into primary level sorting and secondary/tertiary level sorting.



### **8.6.1 Primary and Secondary/Tertiary Sorting**

Currently sorting of household waste is carried out both at the household level by the inmates and at the common bin level by ragpickers. This seems to be the general picture around the country except in few instances where NGO (Non-Governmental Organisation) or municipality intervention has attempted to introduce household sorting on a more intensive level.

Primary sorting is carried out both within the household, and at the municipal bin or at the final disposal site such as the landfill, or waste dump.

Further or secondary /tertiary sorting is carried out in the recycling trade chain by kabaris and middlemen.

### **8.6.2 Primary Sorting at Source**

There is a tradition in households in Indian cities to keep aside items like newspapers, used bottles, jars, pesticide cans, old clothes, rags, broken and old white goods, strong plastic bags etc. and not mix them with other everyday household wastes. These are used as items of economic value, to be sold or just as give-aways. The waste here is normally dry and capable of being easily and safely stored.

Garden waste is also separate from household waste, in houses which have greenery. However since there is no separate mechanism for its collection or disposal, it ends up being mixed with the municipal waste.

### **8.6.3 Primary Sorting at The Community Bin (Municipal Bin)**

What then finds its way to the municipal bin is kitchen waste, thin plastic bags, used paper, some amount of other paper and plastic packaging, glass such as old bulbs and florescent tubes, used batteries, household medical waste, used diapers and sanitary napkins, used beverage cans and such like. The bulk of this is food waste.

At the municipal bin, the informal sector, spearheaded by the ragpicker as its front-line collector takes over. The items most often collected are some types of plastics, mostly mineral bottles and stronger plastic bags, paper, rags, metal cans, rubber items etc.

#### **8.6.4 Primary Sorting at the Landfill**

Ragpicking also continues at the landfill level. Here ragpickers who do not have access to city municipal bins, pick out even those wastes which are left behind or overlooked at the municipal bin. It is not unusual to see a trail of ragpickers collecting items raked up in the wake of the bulldozer which is compacting the landfill. Here the items found of value and hence collected, include small metal pieces like nails - collected by a stick topped with a magnet-soggy and thin plastic bags which are washed and dried, any other bits and pieces which would yield some financial returns.

At all levels the general categories of items not collected are construction debris, hazardous wastes like used batteries, infectious wastes such as bandages, cotton, napkins, or non-recyclable wastes such as some types of plastics or packaging.

It is then obvious that the degree of sorting as carried out by the informal sector and the householder at present is extremely intensive, and only those items are being left out for which there is almost no possibility of reuse or recycling. As such, this system is very different from that in more developed countries.

#### **8.6.5 Secondary and Tertiary Sorting**

After the waste which has been sorted into main categories at the primary level reaches the first informal recycling trade middleman - the kabari's warehouse, more detailed sorting is carried out. Hence all metals, types of plastics, types of paper such as newspaper, magazines etc. are segregated. This waste then is bought by the larger wholesaler, who does more than sorting, since he is the final link between the recycling factory and the kabari, and can extend business terms like credit, hedging for better pricing etc. It is not necessary that there always be a tertiary level in the materials chain, and both secondary and tertiary levels can simultaneously co-exist in a particular material stream.

#### **8.6.6 Occupational Health**

At the municipal bin level, injuries and infection can be caused to ragpickers. There have been a few studies done on the occupational health risk to ragpickers, and injury rates can go upto 6 per month. They have also been found to have infected wounds, sore feet, but no specific study has been done which isolates health effects such as an increased incidence of illness directly attributable to waste, and not other socio-economic factors. Some studies are also currently under progress. It is however not wrong to presume that their occupation risk

owing to injury and disease transmission through waste is higher, and one of the first reaction of any municipality in the event of an epidemic has been to deny ragpickers access to the waste bins - and their livelihoods.

## 8.7 TOXICITY RELATED HAZARDS

Table 8.2 lists typical hazardous products found in co-mingled municipal solid waste.

**Table 8.2: Hazardous Products in Municipal Solid Waste**

Product	Concern
<b>Household cleaners</b>	
Abrasive scouring powders	Corrosive
Aerosols	Flammable
Ammonia and Ammonia based cleaners	Corrosive
Chlorine bleach	Corrosive
Drain openers	Corrosive
Furniture polish	Flammable
Glass cleaners	Irritant
Outdated medicines	Hazardous to others in family
Oven cleaner	Corrosive
Shoe polish	Flammable
Silver polish	Flammable
Spot remover	Flammable
Toilet bowl cleaner	Corrosive
Upholstery and carpet cleaner	Flammable and/or Corrosive
<b>Personal care products</b>	
Hair-waving lotions	Poison
Medicated shampoos	Poison
Nail polish remover	Poison , flammable
Rubbing alcohol	Poison
<b>Automotive products</b>	
Antifreeze	Poison
Brake and Transmission fluid	Flammable
Car batteries	Corrosive
Diesel fuel	Flammable
Kerosene	Flammable
Gasoline	Flammable, poison
Waste oil	Flammable

<b>Paint products</b>	
Enamel, oil-based, latex or water-based paints	Flammable
Paint solvents and thinners	Flammable
<b>Miscellaneous products</b>	
Batteries	Corrosive
Photographic chemicals	Corrosive, poison
Pool acids and chlorine	Corrosive
Pesticides, Herbicides and Fertilizers including garden insecticides, ant and cockroach killers, weed killers, etc.	Poison, some are flammable
Chemical fertilizers	Poison
Houseplant insecticide	Poison

**Source :** “Integrated Solid Waste Management” Tchobanoglous et al (1993), Mc. Graw Hill, New York

### 8.7.1 Hazardous Substance Containers

Large to medium-sized old pesticide cans, used aerosol cans etc. are sold by households mostly directly to the kabari. These are either used to reclaim the metal or reused as water containers etc. Both practices are hazardous, but there is very little awareness of this.

### 8.7.2 Household Batteries and Other Toxic Wastes

There is currently no separate collection mechanism for any other household toxic waste. Items here would include household batteries, small-sized paint cans, broken thermometers, household chemicals etc. The collection system does not exist since there are no plants to recycle these, and also since there are no producer take-back mechanisms in place.

### 8.7.3 Infectious Wastes

Household infectious wastes consists of home care items such as bandages, cotton, needles used for insulin and other purposes, sanitary napkins etc. There is no segregation of these wastes nor any mechanism for disinfection before disposal.

## 8.8 NON-RECYCLABLE PACKAGING

Many items are left out from the collection system, since the informal sector either does not have the technology to process or recycle them or it is not paying enough for the ragpicker to collect them. Examples of the first would

include new types of multi-layered or multi-material packaging such as tetrapacks, medicine packaging, squeezable tubes, laminated packaging, plastics like Poly Ethylene Terethalate (PET) etc.

The second category, i.e. uneconomic to collect, would include soggy paper, crushed glass, fluorescent tubes, used batteries, thin plastic carry bags, which are of minimum or no economic value. Of these carry bags are worth a special mention since they have become a source of country wide citizen's protests. These bags, being very thin, require a large number to be collected before they make up a sellable weight. Since the ragpicker normally gets paid per kilo of plastic collected, it would take him/her all morning to collect 800 bags needed to make up one kilo to fetch a paltry 2 to 3 rupees. On the other hand, heavier plastics would be faster and easier to collect.

## **8.9 PROBLEMS AND DESIRABLE CHANGE**

The main problems of sorting of waste as it is carried out manually at various stages listed in section 8.3 are:

- (a) Waste gets scattered at the bins.
- (b) The sorting itself entails rummaging through waste by ragpickers exposing them injuries through cut glass, metals as well as diseases through household infected waste as well as medical waste in case it has been mixed.
- (c) Some types of waste does not get recycled, since it is not currently recyclable.
- (d) Toxic or hazardous waste does not get collected and ends up either in landfills or in composting operations. Both cause other contamination such as of groundwater or of the compost.
- (e) Recycling takes place in very poor health and environmentally unsafe conditions.

### **8.9.1 Long Term Desirable Change**

Sorting at the levels at which it is currently being carried out is quite efficient except for some types of wastes. It may be desirable to keep this intact. Shifting of sorting to more centralised locations would mean transferring more waste to them as well as ensuring that waste is not picked beforehand - which would be rather difficult to do.

The current system is very intensive and also provides employment to a large number of persons. It is estimated that in Delhi alone more than 100,000 persons are engaged in the collection and recycling activity. However it must be realised that this system is exploiting the labour conditions and flouts all laws of child labour, wage payment, worker benefit, occupational safety, and environmental norms for the recycling units. Hence though extremely efficient and desirable, it has to be approached with caution in terms of interventions.

It would naturally follow that if all the conditions for formal sector labour are met in the informal sector, the cost of the system would increase. Such a cost would need larger economies of scale of recycling units, and better product quality to be able to recover the cost. It would also extend to investment in recycling facilities of those items which are not currently recycled and the ability to handle hazardous waste streams.

The only manner in which to carry this out is to impact a structural readjustment of the recycling sector with a producer responsibility built in. Hence recycling of batteries may need investment into this sector by the battery producer. Such systems are prevalent in more developed economies including for bulky goods such as cars. Normally this would also entail the setting up of recycling laws and working out a system of subsidies and tariffs to ensure that this is economic to do for all concerned.

However, it must also be ensured that the persons already engaged into the trade are protected in terms of their livelihoods, which calls for a gradual and incremental approach.

The following long-term changes are desirable:

- (a) An organised colony-wise collection system involving ragpickers, with proper gear and protection.
- (b) Investments in the recycling sector to ensure that the units are safe and operate at economic scales.
- (c) Augmentation of the material recycling trade through implementation of laws.
- (d) Development of recycling laws for specific types of wastes.
- (e) Incorporation of producer responsibility for collection and disposal or recycling of specific types of wastes, especially hazardous wastes.
- (f) Promotion of simple disinfection techniques and devices such as needle cutter for infectious waste to be pre-treated before disposal.

- (g) Maintenance of the existing kabari system.
- (h) Pre-sorting of waste for composting operations, through mechanical means..

## **8.10 GUIDELINES FOR SORTING FOR MATERIAL RECOVERY**

### **8.10.1 General**

- (a) Sorting of the waste at the source must be accorded the highest priority by the urban local bodies.
- (b) The existing system of the kabari-wallah, which efficiently recovers the dry-recyclables and bulky waste (white goods) from the source, must be facilitated.
- (c) The role of ragpickers in collecting and recovering recyclables (not taken by the kabariwallah) must be recognised and strengthened at the community level by using their services at the household/source level with the help of NGOs/private sector participation.
- (d) Municipalities must have separate waste collection, transportation and disposal streams for:
  - (i) Biodegradable waste
  - (ii) Mixed waste (comingled waste)
  - (iii) Construction and demolition waste
  - (iv) Hazardous waste
- (e) Biodegradable waste should be used for biological processing at a central facility/ decentralised facility.
- (f) Construction and demolition waste should be processed for re-use or stored in landfill cells capable of being mined for reuse.
- (g) Hazardous waste should be transferred to hazardous waste landfill or processed appropriately.
- (h) Horticulture waste from parks and gardens should be composted at the site or at a decentralised facility to be operated by the municipality.
- (i) Mixed waste (comingled waste) should be sorted into the various streams listed in section 8.8 either at a transfer station or at a centralised sorting

facility. If this is not feasible, mixed waste can be sent to a processing facility which has a well designed pre-sorting/post-sorting facility where the mixed waste can be sorted into separate streams. Mixed waste not found suitable for processing should be landfilled.

Fig. 8.2 shows the role of sorting at various stages. Fig.8.3 shows the importance of pre-sorting in waste management, where mixed waste reaches a waste processing facility.

### **8.10.2 At the Source**

- (a) It should be mandatory that all hazardous waste as listed in Table 8.2 is stored separately at source and not mixed with the other wastes. This should be periodically collected by the municipality from the household level or collected by them at a local collection centre designated for this purpose. In the long-term perspective such a system must move towards laws where manufacturers are expected to collect the hazardous waste resulting from their product at the source or through a suitable collection system.
- (b) It is desirable that those dry recyclables which are not collected by a kabari-wallah are stored separately at the source and collected (once or twice a week) by a waste collector who may be the same person as the ragpicker at the community municipal bin. To initiate separate storage at source and subsequent collection of such waste by the existing network of rag pickers, help may be taken from NGOs in the short-term.
- (c) Construction and demolition waste must be stored separately at the source and deposited at sites identified by the municipal authority or collected periodically by the municipal authorities (or an agency designated by them) on payment basis.

### **8.10.3 At the Community Bin (Municipal Bin)/ Waste Storage Depot/ Transfer Station**

- (a) Sorting at the community bin (municipal bin)/ waste storage depot/ transfer station is not desirable. However, if source level sorting (as indicated in 8.10.2(a) and (b) above) is not developed, then such sorting may be allowed till a household-level sorting and collection system is established.





- (b) Sorting at community bin/ waste storage depot/ transfer station can only be allowed to be carried out by ragpickers, if help of NGOs is taken and if ragpickers are given personal protective gear and proper implements and also if it is ensured that there is no scattering of waste.

#### **8.10.4 Intermediate Sorting at Central Sorting Facility**

A central sorting facility can be established if the cost of setting up and operating such a facility is met through the returns accruing from supply of recyclables to various vendors. In the present scenario, a central sorting facility at an intermediate stage is not visualised to be a viable option in India since the kabariwallahs and the ragpickers recover most of the valuable recyclables at the source. However, if such a facility is adopted, a semi-mechanised system with handpicking-off-the-belt would appear to be appropriate and economical for Indian condition in comparison to a fully mechanised system. The existing set of ragpickers would have to be integrated into such a system.

#### **8.10.5 Sorting at Waste Processing Site**

Pre-sorting at waste processing facilities is desirable to ensure that the processed output (such as compost) meets the regulatory standards. At small or decentralised waste processing facilities, receiving less than 25 tonnes per day of waste, manual pre-sorting is recommended prior to processing. For waste processing facilities receiving more than 25 tonnes per day of waste, semi-mechanised and mechanised pre-sorting is recommended. If a waste processing facility is receiving predominantly mixed waste in large quantities (in excess of 100 tonnes per day), the pre-sorting facility at such a site should be akin to a central sorting facility having semi-mechanised systems capable of sorting the mixed waste into various waste streams. Such a pre-sorting facility should have the following components : (a) conveyer belts for picking-off-the-belt; (b) screening devices for size separation; (c) magnetic separators and (d) shredders/ crushers for size reduction and (e) ballistics separators. The pre-sorting facility should be designed with adequate storage space as well as standby equipment to take care of system breakdowns.

At sites where pre-sorting is found to be operationally difficult, post-sorting can be adopted provided it is ensured that the end product meets all regulatory standards with respect to contaminants.

### **8.10.6 Sorting Prior to Landfilling**

Sorting on landfill working face by ragpickers (i.e. behind the dozer) should be discouraged. It should only be permitted when the incoming waste rate is low (i.e. 2 to 3 trucks per hour at one working face). Protective gear for occupational injuries must be provided to all ragpickers. Since access to modern landfills is restricted, ragpickers must be allowed a prescribed entry and exit procedure. When the incoming waste volume is high, the chances of accidents are high and access to ragpickers is not recommended.