

UNIT 1 SOURCES AND TYPES OF SOLID WASTES

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1.1 INTRODUCTION

Economic development and rising living standards in the Asian and Pacific Region have led to a huge increase in the quantity and complexity of generated waste. So it is important for public agencies and private businesses that are assigned or desire to delve into treatment of waste to understand sources and types of wastes. Knowledge of the sources and types of solid wastes as well as the information on composition and the rate at which wastes are generated and disposed is, therefore, essential for the design and operation of the functional elements associated with the management of solid wastes. The same holds true for generators of such wastes. Such understanding is a crucial initial step in treating waste.

Objectives

After studying this unit, you should be able to

- define waste
- know different types of wastes
- discuss solid wastes
- describe the classification of solid wastes

1.2 WASTES

Everything that we discard after it loses its utility is known as waste. Waste is an unavoidable by-product of most human activity. The design of this world is such that there are always two aspects of everything: advantage and disadvantage, useful and waste, etc. It is any substance which is discarded after primary use or is worthless, defective and of no use. A by-product by contrast is a joint product of relatively minor economic value. A waste product may become a by-product, joint product or resource through an invention that raises the value of a waste product above zero.

1.3 TYPES OF WASTE

There are different types of waste on the basis of different criteria:

1.3.1 Based on Matter

Matter is any substance that has mass and takes up space by having volume. It may be solid, liquid or gas. So, on the basis of matter following are the types of waste:

1.3.1.1 Solid waste

Solid waste predominantly, is any refuse in solid state that we make in our homes and other places. These include old car tires, old newspapers, broken furniture and even food waste. They may include any waste that is non-liquid or non-gaseous.

1.3.1.2 Liquid waste

Liquid wastes are the liquid part of the waste material. Liquid waste includes effluents of industries, fertilizer and pesticide solutions from agricultural fields, leachate from landfills, urban runoff of untreated waste water and garbage, mining wastes etc. The liquid waste may contain nontoxic inorganic substances or toxic organic substances.

1.3.1.3 Gaseous waste

Gaseous waste are waste products in gas form resulting from various human activities like manufacturing, processing, material consumption, biological processes etc. The gaseous wastes include carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbon (CFC), oxides of nitrogen (NO_x), carbon monoxide (CO), oxides of sulphur (SO_x) etc. (Figure 1.1)



Figure 1.1: Solid, Liquid and Gaseous Waste

1.3.2 On the Basis of Degrading Feature

Degradation is the act of lowering something or someone to a less respected state. On the basis of degradation waste can be differentiated by:

1.3.2.1 Biodegradable wastes

Biodegradable materials are those substances made of organic matter, such as plant and animal matter that can be easily broken down by nature. For example, vegetable peels and other kitchen waste, vegetables, fruits, tea leaves, paper, wood, etc.

1.3.2.2 Non-biodegradable wastes

Non-biodegradable materials are those materials, which cannot be broken down easily, and retain their form for a long period of time. For example, metals, tin, glass, plastics etc. (Figure 1.2)

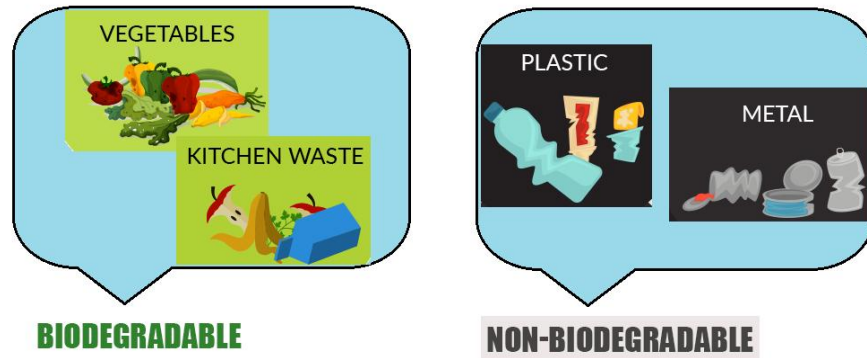


Figure 1.2: Biodegradable and Non-biodegradable Waste

1.3.3 On the Basis of Environmental Impact

An environmental impact is defined as any change to the environment, whether adverse or beneficial, resulting from a facility's activities, products, or services. In other words it is the effect that people's actions have on the environment. Types of waste which affect environment are:

1.3.3.1 Hazardous wastes

Dangerous substances emitted from the commercial, industrial and agriculture or economical use which are unsafe to use for further purpose.

1.3.3.2 Non-hazardous wastes

Safe wastes emitted from the commercial, industrial and agriculture or economical use, considered harmless to use for further purpose.

Below figure 1.3 gives the simple picture of types of wastes.

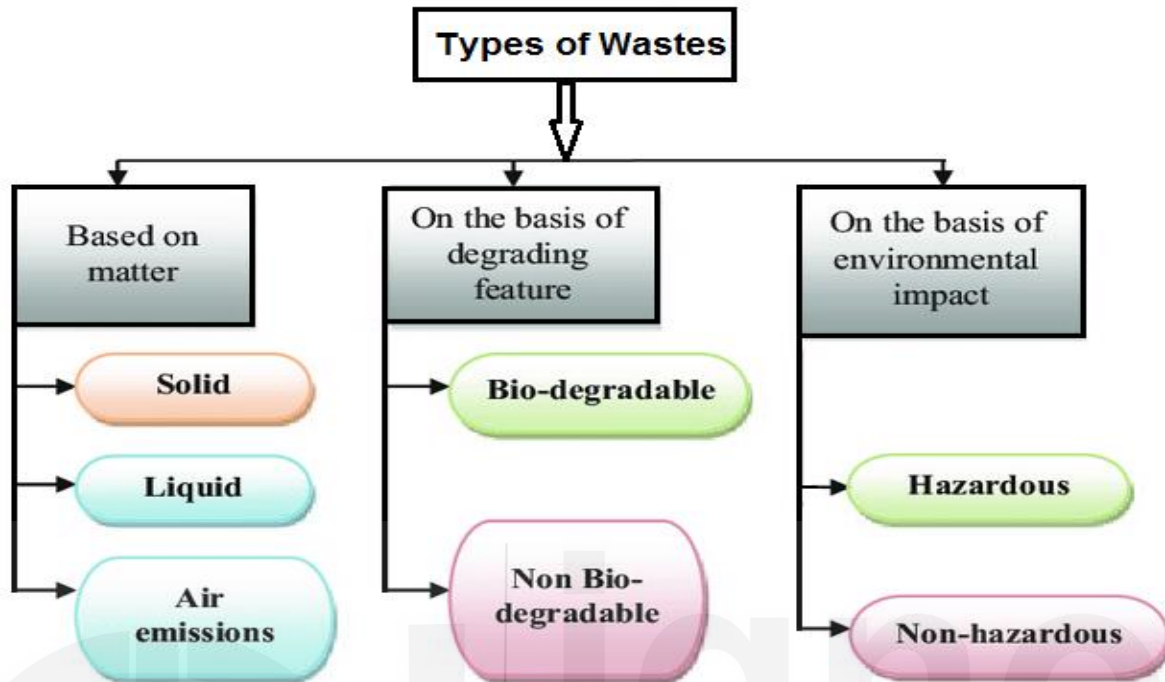


Figure 1.3: Types of Waste

SAQ 1

- a) What are organic and non-organic wastes?
- b) What is waste? Write down the types of waste.

1.4 SOLID WASTES

Solid wastes refer to the range of solid materials arising from animal and human activities and are discarded as unwanted and useless. Solid wastes are the organic and inorganic waste materials such as product packaging, grass clippings, furniture, clothing, bottles, kitchen refuse, paper, appliances, paint cans, batteries, etc., produced in a society, which do not generally carry any value to the first user(s). Solid wastes, thus, encompass both a heterogeneous mass of wastes from the urban community as well as a more homogeneous accumulation of agricultural, industrial and mineral wastes. While wastes have little or no value in one setting or to the one who wants to dispose them, the discharged wastes may gain significant value in another setting.

1.5 TYPES OF SOLID WASTES

Solid waste can be characterized either on the basis of:

- Waste origin
- Waste composition

1.5.1 Types of Solid Wastes Based on Origin

Here the solid waste is characterized on the basis of where it is coming from, the types of solid wastes based on origin includes:

1.5.1.1 Municipal solid waste

Municipal solid waste (MSW), commonly known as trash or garbage in the United States and rubbish in Britain is a waste type consisting of everyday items that are discarded by the public. Garbage can also refer specifically to food waste, as in a garbage disposal; the two are sometimes collected separately. Although the waste may originate from a number of sources that has nothing to do with a municipality, the traditional role of municipalities in collecting and managing these kinds of waste have produced the particular etymology “municipal”. It consists of household waste, construction and demolition debris, sanitation residue and waste from streets, generated mainly from residential and commercial complexes.

As per the Ministry of Environment and Forest (MoEF) it includes commercial and residential waste generated in municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes. Residential waste refers to wastes from dwellings, apartments, etc., and consists of leftover food, vegetable peels, plastic, glass, metals, paper, clothes, yard waste, ashes, etc. Commercial waste refers to wastes consisting of leftover food, glasses, metals, ashes, etc. These are generated from stores, restaurants, markets, hotels, motels, auto-repair shops, medical facilities, etc.

The total municipal solid waste (MSW) generated in urban India has been estimated at 68.8 MT/year (0.573 million metric tons per day (MMT/d) in the year 2008). The average collection efficiency of MSW ranges from 22% to 60%.MSW typically contains 51% organic waste, 17% recyclables, 11% hazardous and 21% inert waste.

1.5.1.2 Industrial waste

Industrial solid waste in the Asian and Pacific Region, as elsewhere, encompasses a wide range of materials of varying toxicity level. This range would include packaging materials, waste from food processing, oils, solvents, resins, paints, sludges, glass, ceramics, stones, metals, plastics, rubber, leather, abrasives, etc. As with municipal solid waste, the absence of a regularly updated and proper database on industrial solid waste ensures that the exact generation rates are largely unknown. Industrial solid waste generation varies, not only between countries at different stages of development but also between developing countries. In China, the generation ratio of municipal to industrial solid waste is one to three. In low income countries such as Bangladesh, Sri Lanka and Pakistan, however, this ratio is much less. In developed countries such as Australia and Japan, the ratio is one to eight. However, based on an average ratio for the region, the industrial solid waste generation in the region is equivalent to 1900 million tons per annum. This amount is expected to increase substantially and it is estimated that it will double in less than 20 years with the current growth rates.

1.5.1.3 Agricultural wastes

The agricultural sector is one of the main sectors generating the largest quantities of agricultural solid wastes, which may be allowed to accumulate indiscriminately and constitute nuisance to global health and threat to food security or used as raw materials for bio-economy. Expanding agricultural production has resulted in increased quantities of livestock waste, agricultural crop residues and agro-industrial byproducts. Agricultural solid wastes are produced mainly from farming activities. However, it is not limited to the production but other activities associated with farming and food chain. Every stage and phase of the agricultural-food chain can generate significant agricultural solid wastes. The broad classification of agricultural solid wastes includes the following:

- (1) Crop production solid wastes:** Crop solid wastes are typically produced from agricultural activities involving crop production. Examples of such agricultural solid wastes are crop residues, husks etc.
- (2) Food and meat processing solid wastes:** This type of agricultural solid wastes is produced from the processing of crop or animal products for human consumption, such as slaughterhouses. Examples of food and meat processing agricultural solid wastes include bones, feathers, banana

peels etc.

(3) Animal production solid wastes: Animal production solid wastes are generated from the production of livestock for different purposes. This includes litter, animal carcasses, damaged feeders, water-trough, etc.

(4) On-farm medical solid wastes: On-farm medical solid are generated from the use of drugs, insecticides or vaccines. Examples of such wastes include vaccine wrappers, containers, disposable needles etc.

(5) Industrial agricultural solid wastes: Agricultural produce and livestock are not only cultivated and produced for dietary consumption. They are used for other uses. For example paper production using agricultural products as raw materials also generate some quantities of agricultural solid wastes.

(6) Chemical wastes: Chemical wastes are generated from the use of pesticides, insecticides and herbicides on the farm or store, such as pesticide containers or bottles. It has been reported that about 2% of pesticides remain in the containers after use. In ignorance one may throw in the ponds or on the open field resulting in food poisoning, pollution, resulting in the loss of many lives.

Among the countries in the Asian and Pacific Region, China produces the largest quantities of agriculture waste and crop residues followed by India. In China, 587 million tons of residues are generated annually from the production of rice, corn and wheat alone. In Myanmar, crop waste and residues amount to some 4 MT/year (of which more than half constitutes rice husk), whilst annual animal waste production is about 28 million tons with more than 80% of this coming from cattle husbandry (Figure 1.4).



Figure 1.4: Agriculture wastes

1.5.1.4 Institutional wastes

Institutional waste mainly consists of paper, plastic, glasses, etc., generated from educational, administrative and public buildings such as schools, colleges, offices, prisons etc. In a study it is found that the institutional waste generation rate by a person in the study area was 0.14 kg/day and it is found minimum in the case of educational institution. A study reveals that the waste generation rate is maximum in the case of educational institution followed by government institution and minimum in private institution.

1.5.1.5 Biomedical Wastes

Medical care is vital for our life, health and well being. But the waste generated from medical activities can be hazardous, toxic and even lethal because of their high potential for diseases

transmission. Biomedical waste or hospital waste is any kind of waste containing infectious or potentially infectious materials. Biomedical waste may be solid or liquid. Biomedical waste is a type of bio-waste. Common generators (or producers) of biomedical waste include hospitals, health clinics, nursing homes, emergency medical services, medical research laboratories, offices of physicians, dentists, veterinarians, home health care and morgues or funeral homes. Biomedical waste is distinct from normal trash or general waste, and differs from other types of hazardous waste. Biomedical waste is hazardous due to its infectious, injurious and chemical nature. Biomedical wastes are classified in following categories (Figure 1.5):

- (1) **Human anatomical waste:** Human tissues, organs, body parts and fetus below the viability period (as per the Medical Termination of Pregnancy Act).
- (2) **Animal anatomical waste:** Experimental animal carcasses, body parts, organs, tissues, including the waste generated from animals used in experiments or testing in veterinary hospitals.
- (3) **Soiled waste:** Items contaminated with blood, body fluids like linen, mattresses, beddings, dressings, plaster casts, cotton swabs and bags containing residual or discarded blood and blood components.
- (4) **Expired or Discarded medicines:** Pharmaceutical waste like antibiotics, cytotoxic drugs including all items contaminated with cytotoxic drugs along with glass or plastic ampoules, vials etc.
- (5) **Chemical waste:** Chemicals used in production of biological and used or discarded disinfectants.
- (6) **Microbiology, biotechnology and other clinical laboratory waste:** Blood bags, laboratory cultures, stocks or specimens of microorganisms, live or attenuated vaccines, human and animal cell cultures used in research, industrial laboratories, production of biological, residual toxins, dishes and devices used for cultures.
- (7) **Contaminated waste (Recyclable):**Wastes generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles and fixed needle syringes) and vacutainers with their needles cut) and gloves.
- (8) **Waste sharps including metals:** Needles, syringes with fixed needles, needles from needle tip cutter or burner, scalpels, blades, or any other contaminated sharp object that may cause puncture and cuts. This includes used discarded and contaminated metal sharps

(9) **Glassware:** Broken or discarded and contaminated glass including medicine vials and except those contaminated with cytotoxic wastes.



Figure 1.5: Biomedical wastes

1.5.1.6 Open areas

Open-areas waste includes wastes from areas such as streets, alleys, parks, vacant lots, playgrounds, beaches, highways, recreational areas, etc.

1.5.2 Types of Solid Wastes Based on Composition

These are the types of solid wastes which are characterized on the basis of what it contains, these include:

1.5.2.1 Garbage

This refers to animal and vegetable wastes resulting from the sale, handling, preparation, storage, cooking and serving of food. Garbage comprises putrescible (rotting) organic matter, which produces an obnoxious odor, attracts rats and other vermin.

1.5.2.2 Rubbish

Rubbish is a general term applied to solid wastes originating in households, commercial establishments and institutions, excluding garbage and ashes.

1.5.2.3 Ashes and residues

These are substances remaining from the burning of wood, coal, charcoal, coke and other combustible materials for cooking and heating in houses, institutions and small industrial establishments. Ashes consist of fine powdery residue, cinders and clinker often mixed with small pieces of metal and glass. When ashes produced in large quantities, as in power-generation plants and factories, these are classified as industrial wastes. Ashes and residues are almost entirely inorganic, so they are valuable in landfills.

1.5.2.4 Combustible and non-combustible wastes

These consist of wastes generated from households, institutions, commercial activities, etc., excluding food wastes and other highly putrescible material. Typically combustible material consists of paper, cardboard, textile, rubber, garden trimmings, etc. Non-combustible material consists of such items as glass, crockery, tin & aluminum cans, ferrous & non-ferrous material and dirt.

1.5.2.5 Bulky wastes

These include large household appliances such as refrigerators, washing machines, furniture, vehicle parts, tires and wood. These household wastes require a special collection mechanism because these can't be accommodated in normal storage containers.

1.5.2.6 Street wastes

These wastes are collected from streets, walkways, parks and vacant plots. These include paper, cardboard, plastics, dirt, leaves and other vegetable matter. Littering in public places is widespread and acute problem in many countries.

1.5.2.7 Construction & demolition wastes

These wastes are generated as a result of construction, refurbishment, repair and demolition of houses, commercial buildings and other structures. It consists mostly of inert and non-biodegradable material. They consist mainly of earth, stones, concrete, bricks, lumber, roofing, plumbing materials, heating systems and electrical wires. It constitutes about 10-20 % of the municipal solid waste (excluding large construction projects). It is estimated that the construction industry in India generates about 10-12 million tons of waste annually. Projections for building material requirement of the housing sector indicate a shortage of aggregates to the extent of about 55,000 million cum. An additional 750 million cum. aggregates would be required for achieving the targets of the road sector. Recycling of aggregate material from construction and demolition waste may reduce the demand-supply gap in both these sectors (Figure1.6).



Figure1.6: Construction & demolition waste

1.5.2.8 Hazardous wastes

Hazardous wastes may be defined as wastes of industrial, institutional or consumer origin which, because of their physical, chemical or biological characteristics are potentially dangerous to human and the environment (Figure 1.7). In some cases although the active agents may be liquid or gaseous, they are classified as solid wastes because they are confined in solid containers (Table 1.1). Wastes might be classified as hazardous if they show particular characteristics:

Reactivity: This kind of waste results in chemical reactions in particular conditions. This can trigger explosions or give off different gases, fumes, or vapors. The activity happens when the substance is mixed with H₂O or compressed. Some examples include unused explosives and

lithium/sulfur batteries. It is important to note that no test methods exist to test a waste for reactivity.



Figure 1.7: Hazardous wastes

Corrosivity: Corrosive wastes are various materials like solids that are either acids/bases or make acidic/alkaline solutions. A corrosive waste is one which has pH level at/under 2.0 or at/above 12.5. Liquid wastes can also be corrosive in the case it's able to corrode various metal containers like drums, storage tanks, and barrels. Examples include used battery acid.

Ignitability: In certain situations this type of waste can spark fires. These wastes have a flash point less than 60°C (140°F), or blow up (spontaneous combustion). Some examples include used solvents and waste oil.

Toxicity: Toxic waste is dangerous or deadly when it is absorbed or indigested. This involves substances, including lead, mercury, Dichlorodiphenyltrichloroethane (DDT) etc.

Table 1.1: Types of household hazardous products

Common Household Hazardous Products		
Acids	Fabric dyes	Pesticides
Adhesives & glues	Fertilizer	Pet spray
Aerosol cans	Nail polish	Pharmaceuticals
Antifreeze	Fluorescent lights	Photographic chemicals
Art & hobby paints	Furniture polish & wax	Rat poison
Asphalt & roofing tar	Insecticides	Septic tank cleaners
Batteries	Fuel oils	Shoe polish
Bleach	Lubricating oils	Spot removers
Brake fluid	Mercury	Toilet bowl cleaner
Car wax & cleaners	Varnish	Transmission fluid
Cartridges	Motor oil	Windshield wiper fluid
CFCs	Oven cleaner	Wood preservatives
Disinfectants	Paint	Lead

1.5.2.9 Sewage wastes

The solid by-products of sewage treatment are classified as sewage wastes. They are mostly organic and derive from the treatment of organic sludge from both the raw and treated sewage. The inorganic fraction of raw sewage such as grit is separated at the preliminary stage of treatment, but because it entrains putrescible organic matter which may contain pathogens, must be buried/ disposed off without delay. Treated and dewatered sludge can be used as a soil conditioner but invariably its use for this purpose is uneconomical (Figure 1.8).



Figure 1.8: Sewage wastes

1.5.2.10 Dead animals

Dead animals are those that die naturally or are accidentally killed on the road. This category does not include carcasses and animal parts from slaughter houses, which are regarded as industrial wastes or agricultural waste. Dead animals are divided into two groups large and small. Among the large animals are horses, cows, goats, sheep, pigs etc. and among the small ones are

dogs, cats, rabbits, rats, etc. The reason for this differentiation is that large animals require special equipment for lifting and handling when they are removed. If not collected promptly, dead animals pose a threat to public health since they attract flies and other vermin as they decay.

SAQ2

- a) Differentiate between garbage and rubbish.
- b) What do you understand by hazardous waste? What are the characteristics of hazardous wastes?
- c) What do you understand by construction and demolition (C&D) waste? Explain in brief.

1.6 SUMMARY

Wastes are unwanted or unusable materials. Waste is any substance which is discarded after primary use, or is worthless, defective and of no use. A by-product by contrast is a joint product of relatively minor economic value. A waste product may become a by-product, joint product or resource through an invention that raises the value of a waste product above zero. Examples include municipal solid waste (household trash/refuse), hazardous waste, wastewater (such as sewage, which contains bodily wastes (feces and urine) and surface runoff), radioactive waste, and others.

1.7 KEY WORDS

Corrosivity : Corrosivity describes how aggressive water is at corroding pipes and fixtures. Corrosive water can cause lead and copper in pipes to leach into drinking water and can eventually cause leaks in plumbing.

Ignitability : Ignitability is the characteristic used to define as hazardous those wastes that could cause a fire during transport, storage, or disposal. Examples of ignitable wastes include waste oils and used solvents.

Putrescible : Something that is liable to decay

Toxicity : Dangerous or deadly when it is absorbed or indigested

1.8 ANSWERS TO SAQs

SAQ 1

- a) Refer section 1.3.2
- b) Refer section 1.2 & 1.3

SAQ 2

- a) Refer section 1.5.2.1 & 1.5.2.2
- b) Refer section 1.5.2.9
- c) Refer section 1.5.2.7

FURTHER READING

- (1) Government of Montana (2012), “Resource Recovery”.
- (2) International Waste Activities (2003), “U.S. Environmental Protection Agency”.
- (3) Journal of Cleaner Production (2005), “Improving Recycling Markets”.
- (4) United Nations Environment Programme (2005), “Solid Waste Management”