1. Types of collection services/system.
   i) Curb-side collection system.
   ii) Alley collection system.
   iii) Set-out and set back collection system.
   iv) set-out collection system.
   v) Neighbourhood collection system.
   vi) Block collection system
   vii) Door to Door collection system.

i) Curb side
→ In this system house owner/maintainance staff brings the waste containes & leaves on roadside curb on the designated day of a week during the designated hour of the day.
→ Municipality provides routine of collection time & days. ones the waste is emptied by the municipal collector, the house owner returns the containes.

ii) Alley collection system.
→ instead of collection of waste from house to house all house owners of the neighbourhood bring their waste at definite place in the alley. These place may be a designated space on road corner or a shaded or barred area for the purpose.
Municipal Collectors empty all containess & leave the containers which will be brought back by individual house owner later.

iii) Set out and setback collection system:-
Full containes are set out by the municipal worker emptied into the container truck & returned the emptied container into the house. No responsibility is given to the house owner for bringing it out or returning it back.

iv) Setout containes system.

Trying to reduce the collection time of municipal collector in this system set-out is done by the municipal collector. After emptying the containes, it is left at the curbside for the house owner to collect.

v) Neighborhood collection system:

→ Simplified version of alley collection system.

→ municipality provides containes on the roadside of neighborhood

→ ~~Neighborhood~~ Neighboring house throw their waste in the containes, either brought in small containes like plastic bucket or in plastic bags. The wask is emptied in the containes. Municipality collects the containes in skip trucks when it is filled.

vi) Block collection system

→ effective collection system without occupying road space for long.

→ In this system bells or whistles or siren are used to make people aware of their time of waste disposal. All neighbor hood bring their waste at designated time with the blowing of whistle, bell or siren. Waste is poured into the collection truck.

vii) Door to door collection system:

Normally practiced in richer / wealthy community of cities, this system is similar to curbside collection system.

→ Municipal collector use whistle to inform the house owner. Either the house owner or municipal collector takes out the waste from the house & empties into collection truck / collection rickshaw.

One the collection truck is full they bring the wask in communal collection point to load in the larger vehicle to bring it to transfer system.

2) Transfer ~~sep~~ station (TS):-
→ a place where solid waste from collection vehicles is transferred to larger transport vehicles to carry to MRF/landfill or other ultimate disposal sites.

→ TS are considered when:-
→ haullage distance is long (>7km)
→ Small capacity vehicles are used for collection system. (<10m3)
→ Small capacity containers are used in Haul container system.
→ Resource recovery facilities are installed.

## Design consideration of TS:-
1) Types of transfer operation to be used.
2) Capacity requirements.
3) Equipments & accessories requirements.
4) Environmental requirements.
5) Locational requirements.

1) Types of transfer operation to be used:-
→ Types of vehicles.
→ Types of loading.
→ Storage or non-storage.

Three types of TS based on vehicle loading.
a) Direct-load TS.
→ waste from collection vehicles are directly discharged into the transfer tion vehicles.
→ may be with or without compacting facilities.

b) Storage load TS:-
→ waste is first discharged into the storage pit from which they are load in transport vehicles

- Storage for a day or two is allowed.

c) Combined Direct load & storage load T.S:-
→ Normally provided when MRF is installed.
→ Some wastes are stored other are directly discharged.

2) Capacity requirements:-
→ Collection vehicles donot have to wait very long.
→ Large Ts and use of fewer transport vehicles.
→ Small Ts and use of more transport vehicles.

3) Equipments & accessories requirements:-
→ Depends on the function of TS.
→ If designed for MRF it needs equipments accordingly.
→ for loading front-end loaders, compactors.
→ Weighing bridge.
→ Recovery & storage facilities.

4) Environmental requirements:
→ EIA should be conducted.
→ construction of wind screen
→ Leachate collection & treatment facilities
→ Bird hazard control

5) Locational requirement-
→ As near as possible to the solid waste production areas.
→ within easy access to road capable of running large trucks
→ Min. of public & environmental objectives.

1. Adverse effect of environmental pollution.

1) Acid Rain.
→ water mixing with $H_2SO_4$ & $HNO_3$ to form rain
→ caused by industrial wastes of $SO_2$, $SO_3$ & $NO_2$.

$SO_3 + H_2O \rightarrow H_2SO_4$

$NO_2 + H_2O \longrightarrow HNO_3$

Acid rain $pH < 5.6$.

→ Effects,
→ Destruction of aquatic organisms
→ Destruction of forests & crops.
→ Dissolving of lime stones
→ Destruction of metallic building, statues etc.

2) Global warming.
→ Increase in temp$^x$ of atmosphere due to greenhouse effect.

Greenhouse gases—
$CO_2$, Methane ($CH_4$), Oxides of Nitrogen (NOx), chloroflurs carbon.

→ Green effect is the process by which absorption of ~~emmenission~~ emission of infared radiation by gases in atmosphere warm a planet's lower atmosphere & surface.

→ Effects
• Melting of polar ice caps. (glaciers.
→ Raising of sea level & submerging of small islands.
→ Change of global climatic pattern.

3) Ozone layer. Depletion
→ Ozone is trimetric molecule of oxygen ($O_3$)
→ Ozone layer is a thin layer found at 25km away from earth's surface.
→ acts as protective shield to prevent the entry of harmful UV to earth.
→ Effects,
→ Cause cataract.
→ Cause mutations & skin cancers.
→ Reduce body immunity
→ Affect Photosynthesis & reduce crop yield.

4) Photo chemical smog.
→ Yellow coloured mist formed by combination of smoke & fog which cause eye irritation & vision impairment.

Effects
→ Respiratory tract disorders.
→ toxic to plants & lowes production of food
→ Vision affected due to turbidity.
→ quality of rubbes & clothes decreses due to bleaching

5) Biomagnification.
→ collection of toxic chemical pollutants along with food chains from 1 trophic level to other.

6) Eutrophication.
→ formation of green color foamy layer by growing algae excessively due to increase of $PO_4^{-3}$ & $NO_3^-$ concentration in reservlors by adding waste materials from industries, agrochemicals, faecal matter & detergents.

Date:
Page:

7) Increase of Radiation.

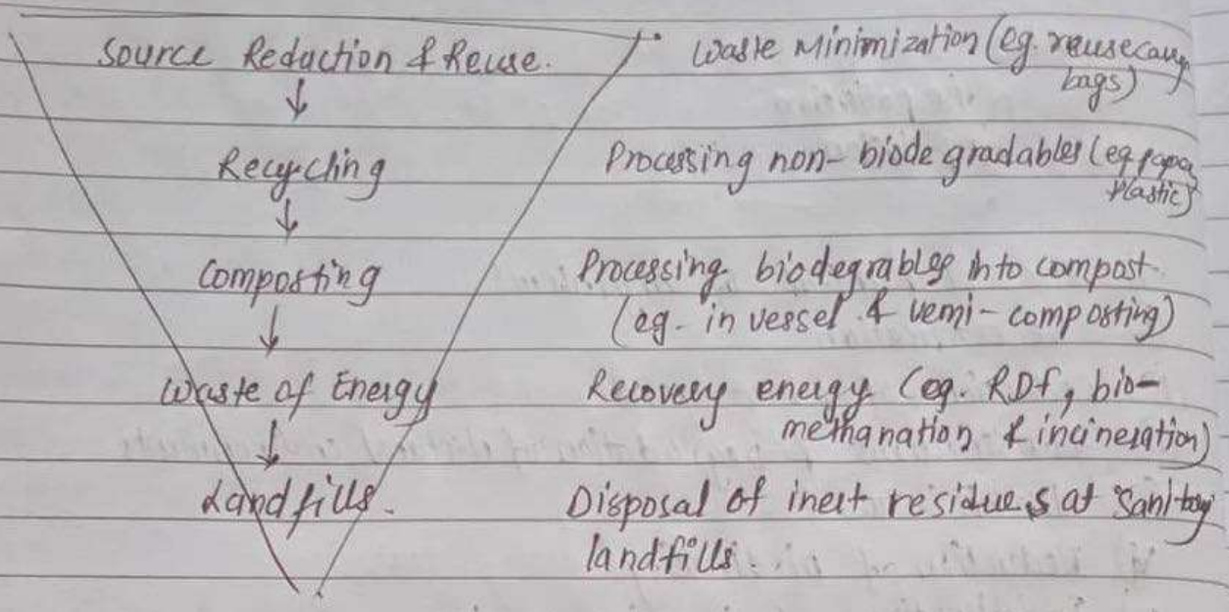
Also.
Noise pollution
Air pollution.

i) Loss of habitat of organisms.
ii) Desertification.
iii) Reduction of plant yeid.
iv) Constructions & degradation of Natural environments.
v) Health issues
vi) Reduction of biodiversity
vii) Introduction of invasive species
viii) Economical losses.

2) E-waste.
→ describes discarded electronic equipment, entertainment device electronics, mobile phones, television sets & refrigerators.
→ this definition includes used electronics which are destined for reuse, resale, salvage, recycling or disposal.

Date:
Page:

2. ISWM Hierarchy.




ISWM.

It is a ~~comphret~~ comprehensive waste prevention, recycling, composting and disposal program. An effective ISWM system considers how to prevent, recycle, and manage solid waste in ways that most effectively protect human ~~hem~~ health and the environment.

Functional elements of ISWM. / Development phases.

~~Four~~ Functional elements of ISWM are:-

(1) Waste generation

(2). Waste handling & separation, storage & processing at the sources.

(3). Collection.

(4). separation, processing and ~~transpor~~ transformation of Solid waste

(5). ~~Traf~~ Transfer & transport.

(6). Disposal.

4) Hazardous waste.

→ Hazardous waste is the waste with properties that makes it dangerous or capable of having a harmful effect on human health or the environment.
It harms human health because they are lethal, non-degradable can be biologically magnified or otherwise cause to detrimental cumulative effect is a hazardous waste.

~~Types of hazardous waste;~~

→ typically produced by manufacturers and other industrial organizations.

Types:-

By EPA ⇒ four main categories in which hazardous waste is classified are:-

1) Listed wasted
   - → f-list - from Non-specific sources.
   - → K-list - from spe. sources.
   - → P-list - acute hazardous wastes
   - → U-list - miscellaneous.

2) Characteristic waste
   - → ignitability → flammable & can creak fires.
   - → corrosivity → waste that can rust & decompose & ability to
   - → Reactivity → explosive, unstable under normal condtn
   - → toxicity → fataly poisonous when ingested & absorbed.

3) Universal wasted
   Wastes such as bulbs, mercury-containing equipment, pesticides & batteries, → these waste are more commonly produced & identified as "dangerous waste".

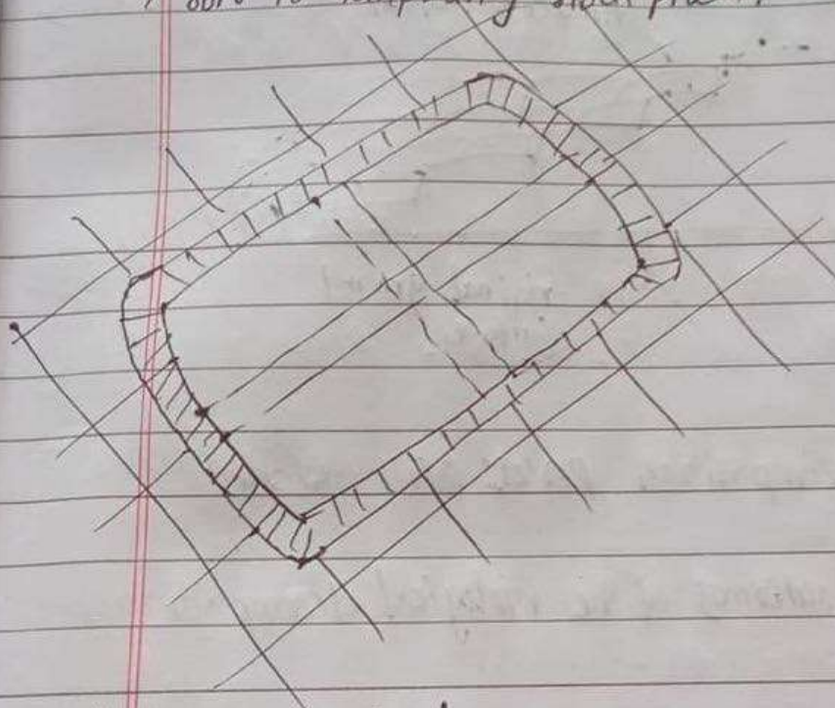
4) Mixed.
   wastes that contain both hazardous as well as radioactive components. Because mixed wastes involve hazardous & radioactive materials, their treatment & disposals vary.

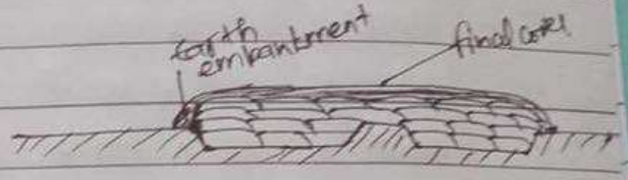
5) Landfilling methods :-

1) Excavated cell or trench method.
2) Area method.
3) Depression method.

1) Excavated cell or trench method :-

→ Cell or trench is excavated on ground to be filled by MSW.
→ this method is suitable in flat terrain with deep water table.
→ The soil excavated can be used for daily cover.
→ Soil is temporarily stock piled.

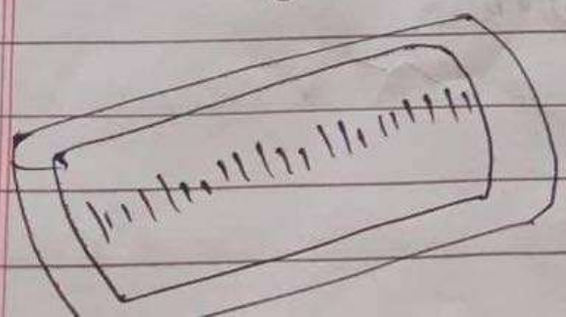


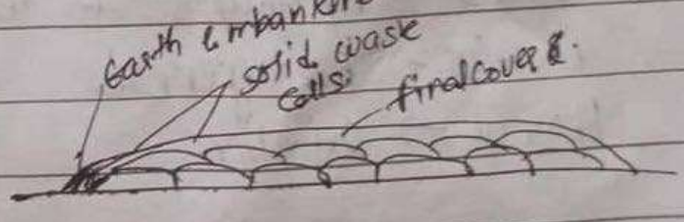



2) Area method.

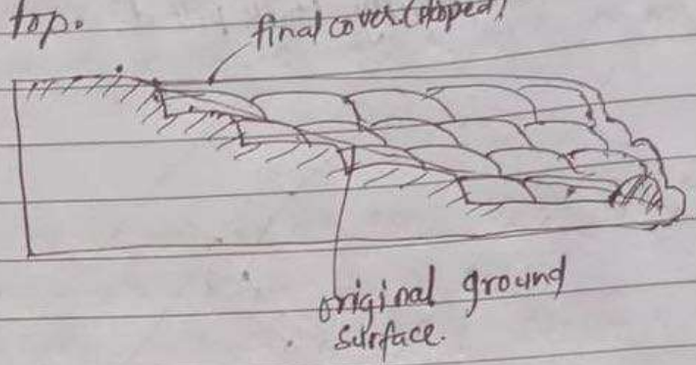
→ Adopted where excavation is not suitable because of high GWT. (ground water table)

→ Site preparation includes proper lining & leachate collection system.
→ Surface ~~damage~~ drainage must be considered.
→ large amount of cover material will be needed as local material may not be available.





3) Depression method.
→ In this method canyons, ravines, dug borrow pits and quarries are used for land filling.
→ In case of mountainous countries like Nepal, most of landfill are of this type.
→ Control of surface drainage is relatively important.
→ subsurface flow from sides should be properly managed.
→ normally adequate cover material is available of site.
→ filling from bottom to top.




→ Stage of biological decomposition process with relevant eqⁿs in landfill.
→ Gas & leachate are the outcomes of the biological decomposition of MSW in landfills
→ Major gases produced are;

$CH_4$ ⟶ 45 ~ 60%.
$CO_2$ ⟶ 40 ~ 60%

→ Minor gas produced are:-
$H_2S$, $NH_3$, $O_2$, $H_2$, $N_2$, $CO_x$ et..

# Phases I → Aerobic phase.
Phase II → Hydrolysis & fermentation.
Phase III → Acetogenesis
Phase IV → Oxidation.

Date:
Page:

1) Phase I (Aerobic phase.
→ initial phase of wask decomposition in landfills.
→ $O_2$ is available from air trapped while handling & compacting during placement.
→ In presence of $O_2$ aerobic hydrolysis takes place.
→ DO (dissolved oxygen) comes from precipitation.
→ Normally no leachate is produced in this stage, if produced acidic in nature
→ Heat is generated in this process even upto 70 to 90°C
→ Gas produced are $CO_2$ (90%) & some water vapour.
→ Process is carried out until $O_2$ is exhausted.

2) Phase-II Hydrolysis & fermentation (Acidegenesis).-

→ Carbohydrates, Protien, Lipids } hydrolysis → Sugar → acidogenis → { $CO_2$ Carbon di oxide; $H_2$ Hydrogen; $NH_3$ Ammonia; organic acid.

→ Initial anearobic phase nitrate & sulphate sewing as electron acceptors are reduced to nitrogen gas and hydrogen sulphide.
→ Leachate at this stage contains high concentration of ammonical nitrogen.
→ Organic acid produced as mainly acetic acid but propionic acid, butyric, lactic and formic acid.
→ pH starts dropping as the formation of acidic components.
→ Temperature drops to 30°C - 50°C
→ Gas production is 80% $CO_2$ and 20% $H_2$.

Date:
Page:

3) Phase III Acetogenesis:-
→ Because of acidic condtⁿ increased and $CO_2$ concentration of PH goes further down to its minimum (5.0 or over).
→ As the process takes place $CO_2$ production increase and $H_2$ production decrease. As the process continues $CO_2$ production starts decreasing & $H_2$ starts increasing.
→ $CO_2$ is consumed on forming organic acids.
→ Utilizing $H_2$ metal sulphides are formed at later stage giving black colour to the leachate.
→ $N_2$ is observed in early phase but starts dissappearing.
→ The BODs, COD & conductivity of the leachate will increase.

4) Phase IV Methanogenesis:-
→ Methane forming micro-organisms, methanogens becomes active by converting acetic acid and hydrogen gas.
→ Some methanogens directly convert $CO_2$ & $H_2$ producing $CH_4$.
→ 60% $CH_4$ & 40% $CO_2$.
→ Slow reaction taking numbers of years to complete decomposition (is 30 years over 100 years).
→ Mesophilic bacteria works in 30-35°C where as thermophilic bacteria works in the range 45-65°C.
→ PH will rise to 6.8-8 due to conversion of acids & $H_2$ to $CH_4$ & $CO_2$.
→ BODs, COD, conductivity values will be reduced in leachate formed.
→ The leachate is more stable with lesser metal concentration.

5) Phase V Maturation phase.
→ The formulation of $CH_4$ & $CO_2$ starts deminishing as the substrate is consumed for the purpose.
→ The leachate may contain humic acids which are difficult to to process further biologically.
→ New aerobic micro-organism slowly replace the anaerobic micro-organisms.

2. 1. 4)

4) Factors considered in selection of land fill-
1) Haul distance (normally within 20km - cost implication.
2) Location restrictions:-
* near airport (4-5km, min. 2km).
* In flood plains, wetlands.
* Areas with known fault & unstable areas.
* Military restricted area.
* with in 500m from residential / commercial area.
* 50m from Property lines.

3) Available land area:-
* land area for filling
* land area for optional activities., buffer zone.
* preferably longer duration, 10 year is matter, min. 5 year.
* Public land.

4) site access.
→ 200m from all weather road head.
→ Proximate to urban area.

5) Soil condtn & topography
→ availability of soil for cover, final cover & lining ~~method~~ material.
→ topo — slope, method of landfilling.

6) Climatic condtn..
local weather condtn for access of vehicle, operational activities.

7) Surface water hydrology:-
* Local surface water flow channels, natural drainage.
→ flood analysis - 5 to 100 year return period.
→ flood risk.

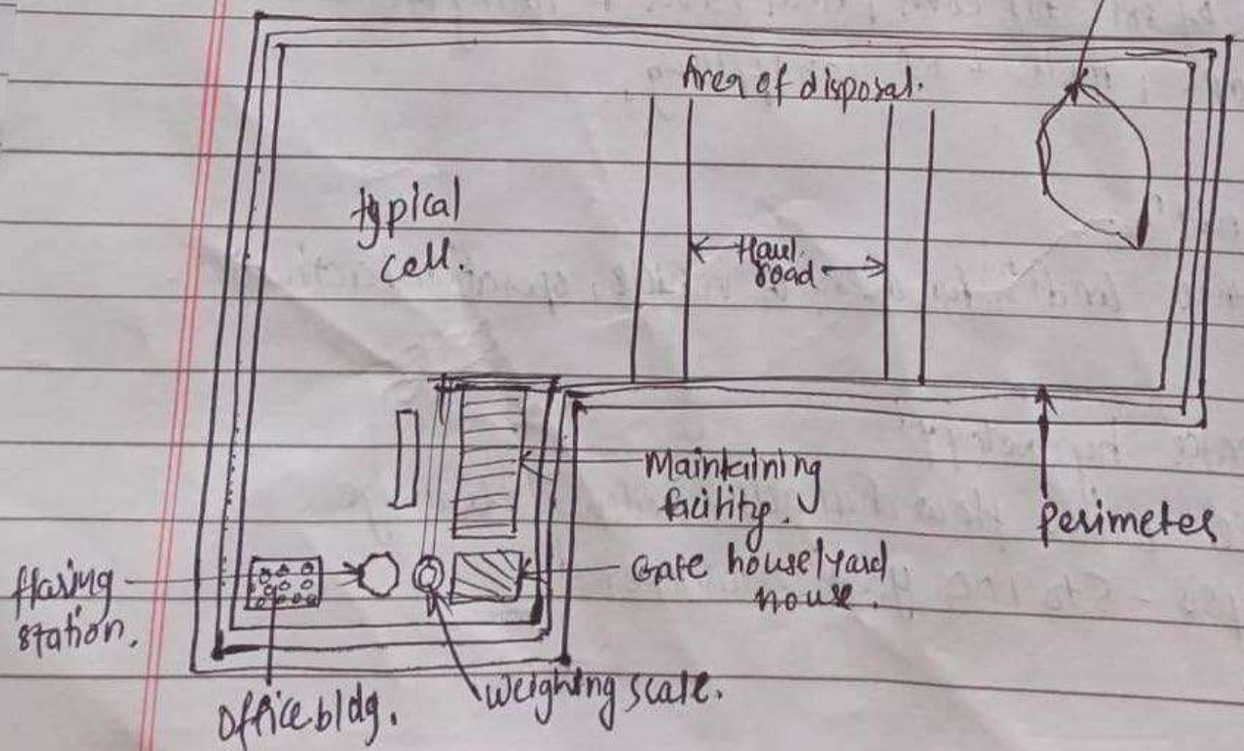
8) Local envt control → Conduct EIA.
- social, biological, economical, envtal envt. consideration.
→ mitigation measures.

9) Ultimate use of completed landfills.
→ Design & operation is influenced by post closure.

5 Diff. components involved in planning designing & operation of landfill.

→ Elements considered in planning
1) Landfill layout & design.
(II) " operation & Mgmt.
(III) Chemical reactions occuring in landfill.
(IV) Mgmt. of landfill gases.
(V) Mgmt. of leachate.
(VI) Envt. monitoring
(VII) Landfill closure & post closure care.

→ Designing operation of landfill.



1) Establish gross area of landfill site:-
→ This includes:
* Fill area.
* Area of land for operation and maintainance facilities.
* Buffer zone.

2) facilities.

| Required | Optional |
|---|---|
| → Boundary wall, gate, guard house. | → Gas extraction facility |
| * Leachate collection and treatment facilities. | → pumping house |
| * Vehicle cleaning, maintainance facilities, fuel storage & garage. | → Infectious waste incineration or seperate landfill facility |
| * Gas flaring facilities. | → composting plant |
| | → SW recycling facilities. |

3) Initial development stage:-
→ Excavation & preparation of leachate drainage.
* cut off drain to divert surface water/drainage entering into landfill.
* landfill gas collection & extraction system.
* Leachate pound
* Bottom liner laying
* Inspection wall to control leachate & gas migration.

4) placement of waste.
→ waste placed in cell & compacted.
→ Exposed faces of cells are covered with covering materials.
→ laying gas recovery trench after one or two cells.
→ vertical gas extraction arrangements.

operation.
Biological decomposition / Biological method of waste treatment.

20 Sources of solid waste.
→ Residance
→ Industry
→ Institution
→ commercial places
→ Recreation centres.
→ Hospital
→ Pharmacy, pharmaceutical industry
→ construction sites.
→ Agricultural activities
→ Animal husbandary activities & other.

Types of solid waste.
→ Residential
→ Commercial
→ Industrial
→ Institution & service centre.
→ construction & demolition
→ Special.
→ Agricultural & animal husbandry.

→ Properties of SW.
(i). Physical
(ii) Chemical
(iii) Biological.

1) Physical..
(i) Individual :- organic waste, plastics, paper & paper products, metal, glass, rubber, leather, textiles, wood etc.

(ii). Partial size :- size of waste can be determined by;

$S_c = L$ ; $S_c = \left(\frac{L+W}{2}\right)$ ; $S_c = \frac{L+W+h}{3}$

Date:
Page:

$S_i$ = size of component, mm.
$l$ = length.
$w$ = width.
$h$ = height

(iii) Moisture content. (Percentage of wet wet of MSW material

→ $Mc = \frac{w-d}{w} * 100\%$

$w$ = initial wt.

$d$ = wt. of sample after drying out for 24 hrs and 105° for 1 hr.

(iv) Density (spc. wt.)

(the wt. of material per unit volume

$= \frac{\Sigma M}{\Sigma V}$ → Kg/m³

$\Sigma M$ — total wt. kg

$\Sigma V$ = total vol $m^3$.

(v). Permeability (hydraulic conductivity).

→ Permeability of compacted solid waste is an important physical property because it governs the movement of liquids & gases in landfills.

perm. depends on - pore size distribution
- surface area
- porosity

$K = C.d^2 \left(\frac{\gamma w}{\mu}\right)$

2.) Chemical Properties of MSW:-
→ useful to determine waste processing techniques like waste incineration, composting, heat recovery etc.

i) Proximate analysis:-
→ Proximate analysis for combustible components of MSW includes following tests:-
- Moisture (drying 105°c for 1hr)
→ volatile combustible matter (ignition of 950°c in the absence of oxygen)
→ fixed carbon (the carbon not blunt after volatile matter is removed)
→ Ash (weight of residue after combustion in an open crucible)

ii) Fusing Flushing Point of ash:-
- When MSW is heated at very high temp the ash formed will convert into solid form as clinker by fusion and agglomeration.
→ This characteristic is important while designing incinerator and its by products.
→ Normally, ash as fusing point as 1100-1200°c.

iii) Energy content.
→ Determination of heat of combustion when SW is burnt.
→ there are three methods of determing.

① Unit energy content = $\frac{\Sigma EC}{\Sigma M}$.

ii) Determining energy content at dry basis.
Moisture content of MSW = Mc.
Energy content = $\frac{\Sigma ES * 100}{(100 - Mc)}$ KJ/kg.

(iii) Determining energy content on ash free dry basis.
$= \frac{\Sigma EC * 100}{(100 - M_c - \%.ash)}$ KJ/kg.

see note. 1g (A)

Date:
Page:

Dulong's formula.

~~S = sulphur~~ $KJ/kg = 337C + 1428\left(H - \frac{O}{8}\right) + 95S$

→ Ultimate analysis:-
to determine basic elements that compose the solid waste.
→ Helps to determin harmful affects to atmosphere when released as fumes.
- Ch lorinated & Sulphur compounds etc

3. Biological Properties

a) Most of the organic fraction of MSW lies within following seven groups:-

a) Water soluble constituents.
b) Hemi cellulose.
c) Cellulose.
d) fats, oils & waxes.
e) Protein.
f) Lignin.
g) Ligno-Cellulose.

b) Biodegradability of organic waste components
- → food waste
- → paper.
- → cardboard
- → yard waste
- → rubber, wood etc

c) Breeding of flies.

0 to 12 days - eggs development
20 hrs - 1st stage larva Period
24 hrs - 2nd stage larva period
3 days - 3rd stage larva period.
4-5 days - Pupal stage
Total - 9 to 11 days

d) Production of Odour.
→ Odour is produced due to anaerobic decomposition of readily decomposable organic compounds.

21 factors affecting waste generation rates are:
- (i) public attitude.
- (ii) Legislation
- (iii) 3R Principle.
- (iv) climatic condition & season
- (v) Waste collection services
- (vi) Extent of salvage & recycling of wastes.
- (vii) frequency of collection of waste.

22. Sampling of Municipal waste.

The procedure for sampling of solid waste depends on the pupose waste investigation and testing. It is essential to obtain a sample that is representative for the population or type of enterprise that is to be investigated.

Some impotant aspects have to be determined while sampling solid waste:-

(i) Sampling area of enterprise.
- → no. & size of house holders
- → no of employees for industry
- → no. of bed for hospital.

(ii) Sampling dates.
- seasonal variation.

(iii) Sampling period.
- waste ~~called~~ collected over a day, a week etc

(iv) Sampling
- directly from wask production
- at the collecting or transport vehicle.
- → at the treatment plant.

(v) Sampling size :- size of vessel for sampling

23. Composting / Types of composting / factors affecting

Composting is nature's process of recycling decomposed organic materials into a rich soil known as composting m. By composting nutrients of organic waste back into the soil. finished compost look like soil - dark brown, crumbly & smells like a forest floor.

→ factors affecting.
- → Physical size & particle size distribution.
- → Seeding and mixing requirements.
- → Mixing and turning of compost.
- → total oxygen requirement.
- → Moisture content.
- → Temperature and temperature control.
- → control of pathogens.

Types of composting :-

a) Backyard composting.

b) Vermi-composting.

vermi composting is a product of composting process using various species of worms, usually red wigglers, white worms and other earthworms to create heterogenous mixture of decomposing organic matter, bedding material & vermicast.

The red red worms feed most rapidly at temp$^{r}$ of 15-25°C. They can survive of 10°C temp$^{r}$ above 30°C may harm them.

Large-scale vermicomposting is practiced in Canada, Italy, Japan, Malaysia, US. It is the rapid way of composting & worms increased very rapidly. red worm eats organic matter equal to its wt. at once. It is used in Nepal for commercial use as well as home use.

c) Grass cycling

c) ~~Nitrous cycle~~ cycling

24 Methods of Resource recovery / recycling of organic waste in stm

a) Biogas.
→ typically refers to a measure of different gases produced by the breakdown of organic matter in absence of oxygen.
→ It can be produced by ~~anaerobic~~ anaerobic digestion of biodegradable materials inside a closed system.
→ Biogas contains primarily methane ($CH_4$) & carbon dioxide ($CO_2$) and in small amount hydrogen sulphide ($H_2S$), $H_2O$. The energy released by bio gas can be used for ~~cooling~~ cooking, heating purposes.

b) Incineration:-
→ waste treatment process that involves combustion of organic substances contains in waste materials.
→ Incineration of waste materials converts the waste into ash, gas and heat.
→ Incineration to energy recovery is one of several waste to energy technologies such as gasification, pyrolysis.
→ Reduce solid mass of the waste 80-85% by volume.
→ Incineration has particularly strong benefits for the treatment of certain waste types ie: clinical wastes, hazardous wastes, pathogens & toxins waste.

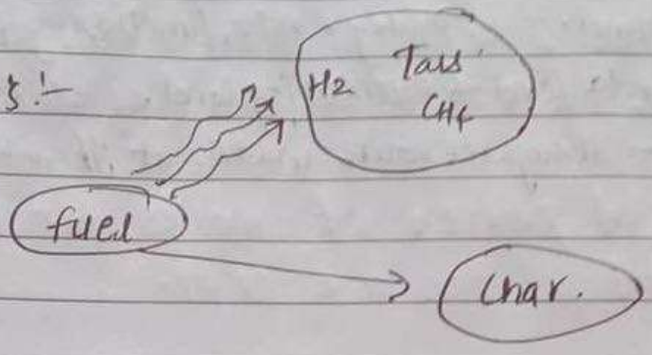
c) Recycling.
process of converting waste materials into new materials and objects. Recycling can prevent the waste of potentially useful materials and reduce the consumption of fresh raw materials, these by reusing energy usage, air pollution and water pollution.

(Incineration & Landfilling)

Recycling is a key components of modern waste reduction. Recyclable materials includes many kinds of glass, paper, cardboard, metal, plastic, textiles & electronics.

→ Recycling a material would produce a fresh supply of the same material.

d) Pyrolysis :-




→ thermochemical decomposition of organic material elevated temp$^{t}$ in absence of oxygen.

→ involves the simultaneous change of chemical composition & physical phase & is irreversible.

Pyrolysis is a type of thermolysis and is most commonly observed in organic materials exposed to high temperature. It is one of the process involved in charring wood, starting at 200-300°C process is used ~~in daily~~ heavily in the chemical industry.

e) Composting.

25 Recovery Process in Nepal.

a) Use as a animal feed.
→ fed directly eg. food waste from hotels & resturants.
- Processed feed eg. bone meal for chicken.

b) Composting.
→ Bhaktapur compost plant - 3tons/day - not functioning properly
→ Composting at household level & community level.
→ anaerobic digestion - slaughter house waste. at Thankot slaughter house.

c) Use of energy source
- directly burning the waste for energy - agricultural by products.

- conversion to briquette - compressing the combustible organic waste in dense solid fuel.
- converted to biogas through anaerobic digestion, specially animal waste.

d) Paper recycling - 22000 tons per year consumption 20% available for recycling. In the Netherlands is it is 80%

e) Bone carving for buttons, combs etc.
f) Brush making from hair.
g) Roofing straw mats & footwear from straw.

26) Where is TS of solid waste used.

→ place where local waste collection vehicles will deposit their waste & cargo prior to loading into larger vehicles.

Date:
Page:

## Operation of landfill.

→ biological method of waste treatment.

**Landfill gases Mg wt :**

→ principle gas produced in landfill are $CH_4$, $CO_2$, $H_2$, $O_2$.

→ Reasons to control → Reduce atm. emission.
→ Minimize the release of odorous emission.
→ Min. sub surface gas migration
→ Recovery of energy from $CH_4$

Control system

| Passive. | Active |
|---|---|
| → Pressure created in landfill drives the gases | → Applied where mor rigourous regulations need to be followed |
| → effective when gases are produced at higher rate. | → perimeter gas extraction well within the landfill. including b/o well |
| → Gravel packed trench, porous pipes etc. are produced to channel the gas :- | → series of vertical gas extraction wells inside landfill. |
| → perimeter interceptor trench | → the blower will create negative |
| → " slurry wall | pressure in the system to attract |
| → Interpermeable barries. | gases to wells. |

Date:
Page:

Q8. Role of Envt. Engineer.

→ they use principles of biology & chemistry to develop solutions regarding envt. problems.

→ They are involved in matters such as recycling, waste disposal, water & air pollution control & public health issues.

→ They try to minimize effects of acid rain, global warming automobile emissions & ozone layer depletion.

→ creative, detail-oriented person who works for making envt. healthy and pollution-free envt.

*Leachate management:*

1. Leachate recycling
    a. Collection and recirculation of leachate through the landfill
    b. The strong leachate contains high concentration of organic compounds which when re-circulated the constituents are attenuated by further biological activities
    c. The Acetogenic leachate when re-circulated will increase to high pH during methanogenic phase releasing heavy metals in the landfill itself.
    d. Also helps to recover landfill gas from the leachate as well as accelerate the decomposition process by seeding the micro-organisms
    e. The ultimate leachate with smaller quantity need to be managed at the end
2. Leachate evaporation
    a. Providing lined leachate evaporation ponds
    b. May need cover for rainy season.
    c. In covered ponds, odorous gases may accumulate under the roof/cover which may be collected and passed through compost heap or soil to extract odorous substances.
    d. Alternative to ponding, leachate may be evaporated by spreading over the finished landfill before covering. It may be spread over the land if land is available and there is no danger of ground water pollution.
3. Leachate treatment
    a. Standard treatments of waste water may be applied based on the quality of leachate
    b. The treatment facility may be provided at landfill or brought to municipal waste water treatment plant