

Waste to Energy: An Overview

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The Waste Materials You See Around

Organic

(C,H,O,N)

- Animal and human excreta
 - Agricultural residue
 - Trees, Shrubs, grass
 - Urban sewage
 - Municipal solid waste
 - Industrial organic waste
 - Industrial liquid waste
- (Can be Burnt or Digested to produce energy)**

Inorganic

(Fe,Pb,Si,Al,Cu)

- Building materials
 - Waste glass materials
 - Metal scrap materials
 - Electronic waste
 - Inorganic industrial solid waste
 - Inorganic industrial liquid waste
 - Road construction items
- (Can't be Burnt/Digested to produce energy)**

Animal and Human Excreta

- **4 cows or buffaloes ⇒ 50 kg dung/day ⇒ Biogas plant ⇒ 2 cu.m. biogas/day ⇒ Sufficient for a family of 5 persons**
- **Community toilet ⇒ 70 persons per day ⇒ 40 kg excreta/day ⇒ Biogas plant ⇒ 2 cu.m. biogas/day ⇒ Sufficient for a family of 5 persons**

Agro-Industrial Organic Solid Waste

- **Types of Waste:**
 - Sugar mill bagasse
 - Large saw mill waste wood materials
 - Paper and pulp mill dried solid waste
 - Food industry seed, peels, filter press
 - Agricultural residues – surplus only
- **Technology: Combustion/Cogeneration**
 - Fuel processing – Sizing, drying, transporting
 - Burn in boiler – High pressure steam 60, 100 bar
 - Steam Passed through turbine –Electricity generation
 - Electricity control/supply – Step up transformer
 - Bagasse Cogen – Process steam + Electricity
 - Biomass requirement – 30-35 tons per MW per day

Urban Sewage Waste

- **Sewage Treatment Plant (STP):** The Municipal Liquid Waste generated largely due to bathing, washing and sanitary activities collected through open or underground drainage systems to a central place.
- **Only few cities have STP.** Most of them release the waste without treatment to open fields or river, hence pollution and health hazard.
- **In typical Indian city, 110 liters per person per day on an average.** Thus a city of population 1 lakh will produce 11 million liters per day (MLD) of liquid waste.
- **The average COD is just 750 ppm (mg/liter).** A 30 MLD STP can produce power only up to 0.75 MW.
- **Hence STP based power projects are not commercially viable.** However, power generation helps recovering some of cost of pollution control process.

Industrial Liquid Waste

Distillery waste water (spent wash) 1 MLD \Rightarrow
Contains COD 1 lakh ppm (mg/liter) \Rightarrow 100 g COD
per liter of waste water \Rightarrow Total COD 1 lakh kg in
1 MLD of waste water \Rightarrow UASB industrial biogas
plant \Rightarrow 80% COD removal efficiency \Rightarrow Total COD
removed 80,000 kg \Rightarrow 0.5 cu.m. biogas per kg of
COD removed \Rightarrow Total biogas 40,000 cu.m. \Rightarrow
Biogas engine produces 2 kWh (units) electricity
per cu.m. Total units generated 80,000 units per
day \Rightarrow Equivalent to 3 MW power project

NOTE: 30 MLD Sewage \Rightarrow 0.75 MW While 1 MLD distillery waste \Rightarrow 3 MW

General Perception:

Waste means MSW

Let us delve into this in detail

Suggested Reading

Search on google

- [Brain teasers and easers on waste, Sudhir Kumar](#)
4 pages
- [Technology options for MSW, Sudhir Kumar](#)
11 pages

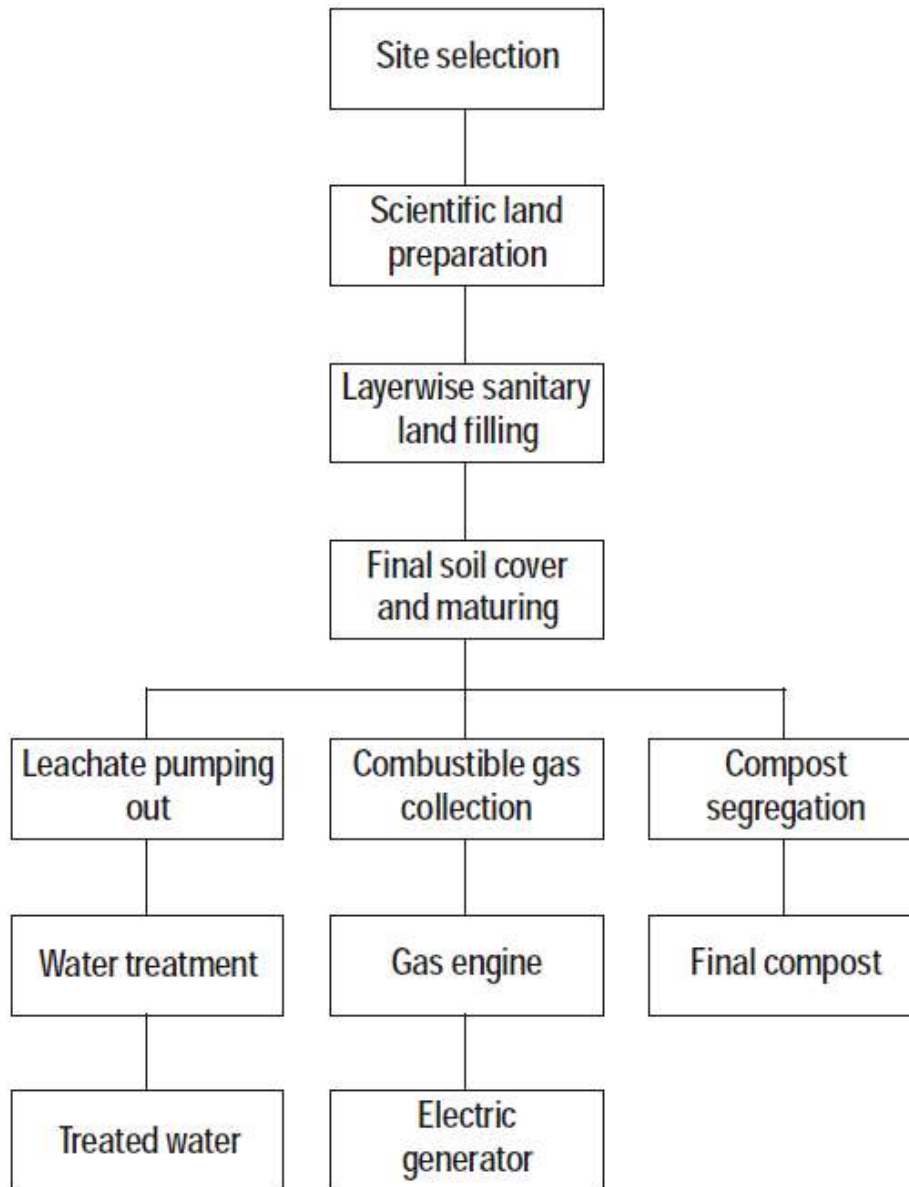
Salient Features of MSW

- Only organic matters (OM) useful to generate energy
- Indian Cities: OM 40% to 60%
- Developed Countries: OM 70% to 80%
- Maharashtra: Solapur highest OM - “Bidi” industries, “Tendu” leaves reject
- In India:
 - Collection efficiency only 60% to 70%,
 - Mostly unscientific dumping
 - Average MSW - 0.5 kg per person per day
 - City with population 1 lakh produces 50 tons per day (TPD)
 - Estimate: Mumbai (6000 TPD), Pune (3000 TPD), Kalyan (800 TPD), Solapur (400 TPD) and Aurangabad (300 TPD)
- MSW 100 TPD can produce minimum 1 MW
- Some technologies claim more power per ton

Technology Options: WTE

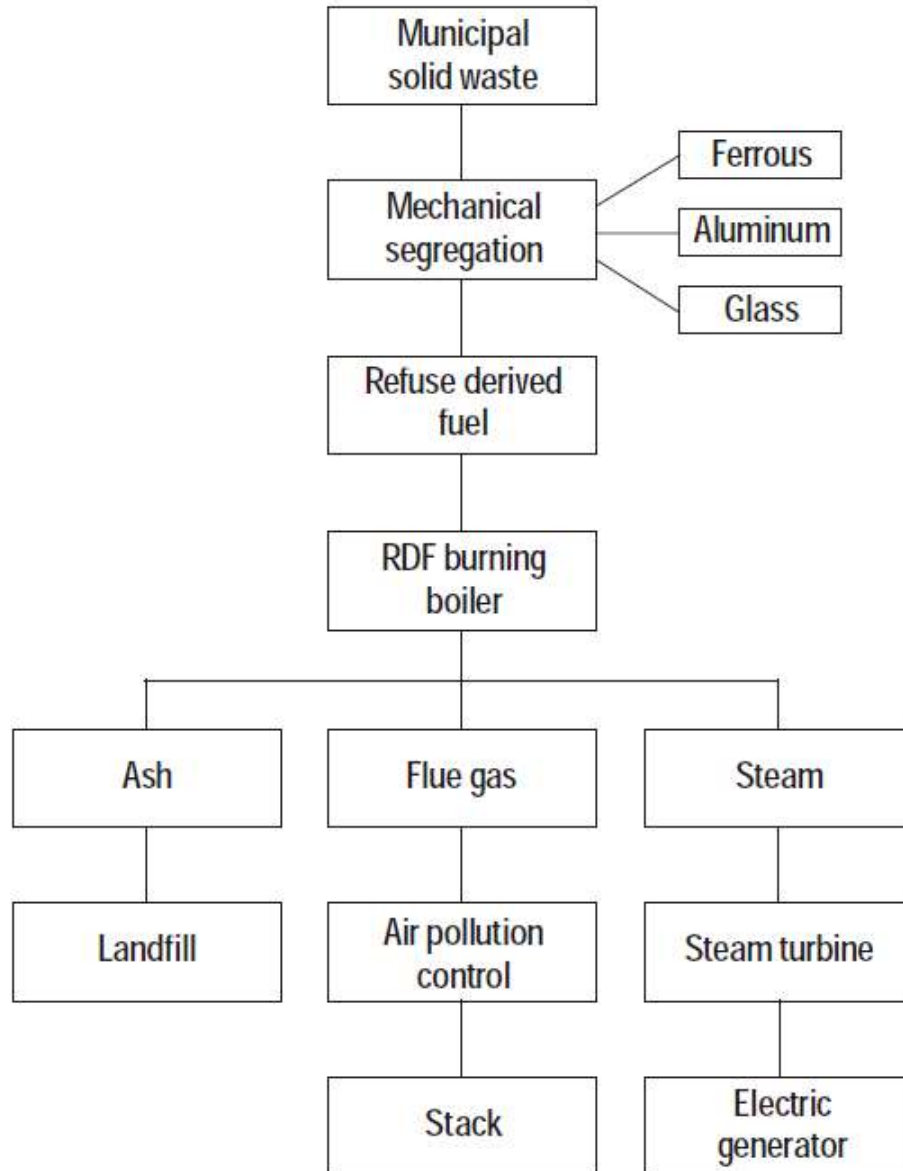
- **Sanitary landfill**
- **Incineration**
- **Gasification**
- **Anaerobic digestion**
- **Other types**

Sanitary landfill



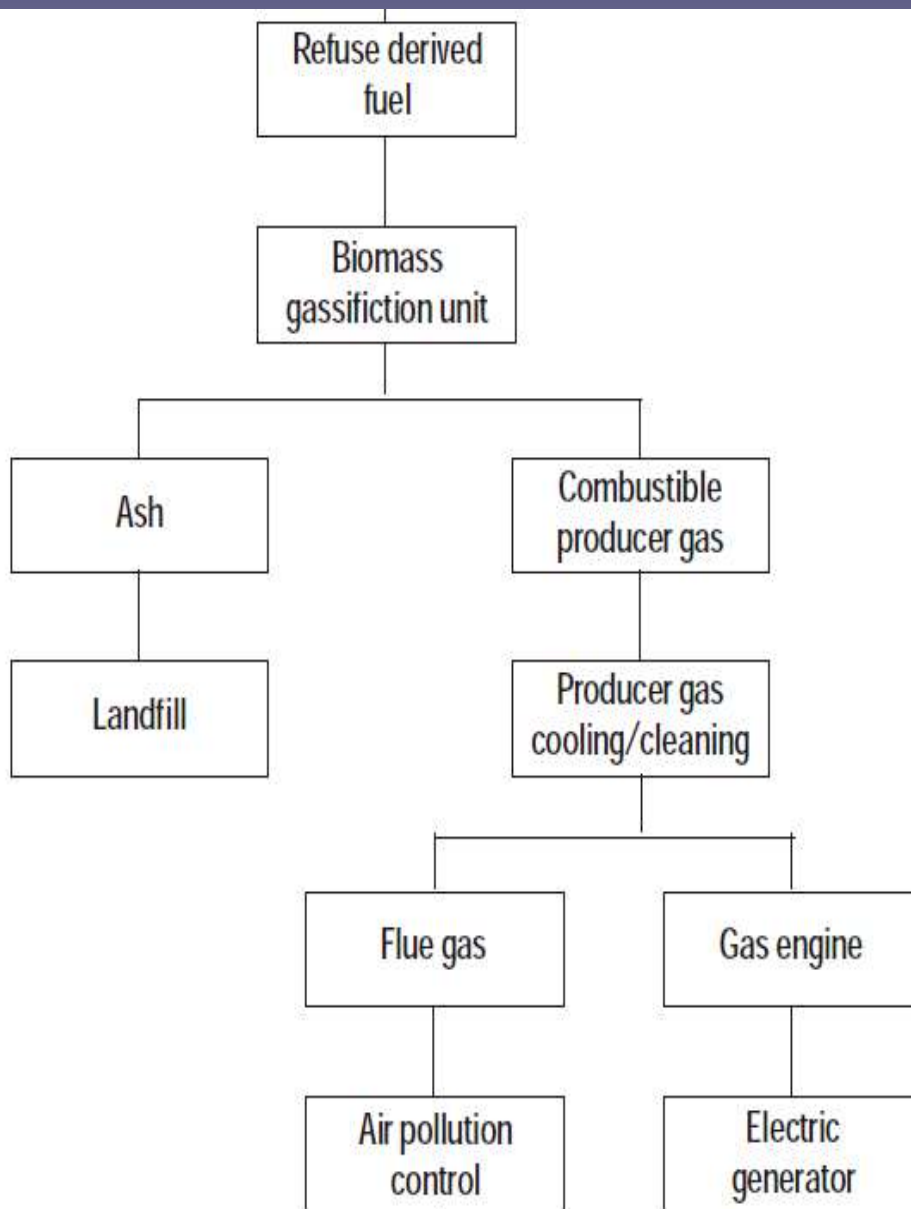
- **MSW Scientific dumping**
 - 60 cm compacted solid liner
 - flexible HDPE
 - geo-membrane liner
 - geo-textile liner,
 - 30 cm drainage material layer
 - 60 cm protective layer
- **Landfill gas 50% CH₄**
- **Utilized for:**
 - Heating
 - Power in IC engines
 - Gas and steam turbines
- **Better than normal dumping**
- **High cost**

Incineration



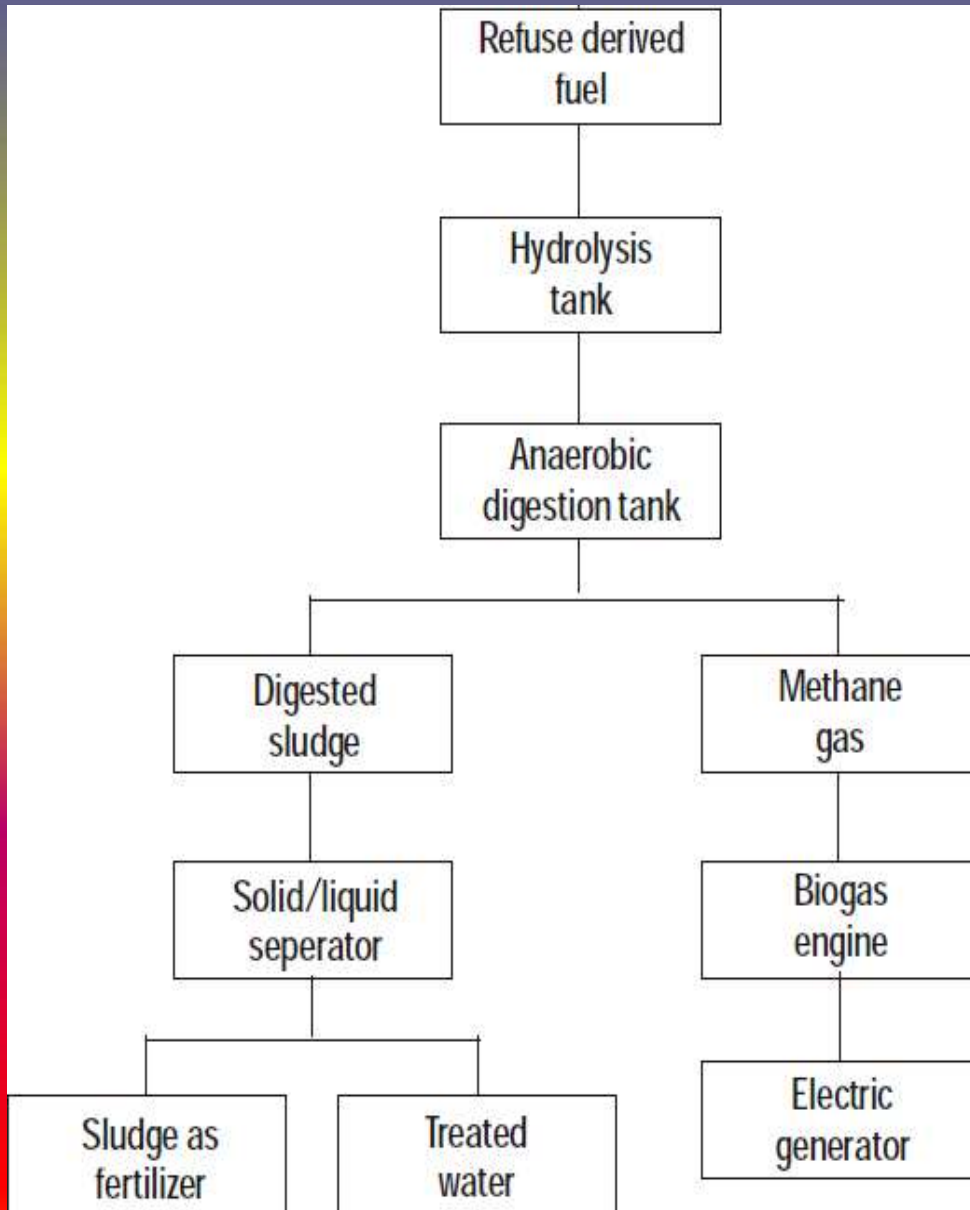
- **Controlled combustion - steam - steam turbines - Power**
- **Higher efficiency i.e. 550–600 kWh/ton**
- **About 75% of weight reduction and 90% of volume reduction**
- **Complete burning - even biologically hazardous waste**
- **Air pollution - Dust, CO₂, SO₂, NO_x, Dioxin and furan (Carcinogenic)**
- **If pollution control system - 30% additional cost – financially unattractive**

Gasification



- **Pyrolysis under limited air at high temperature**
- **Generate CO, CH₄, hydrogen, nitrogen**
- **Combustible gas - calorific value 1000–1200 kcal/m³**
- **Used in IC engines or boilers – steam - power**
- **Advantages:**
 - **Gasification to thermal efficiency is higher**
 - **Weight reduction of 75% and volume reduction of 90%**
 - **Better pollution control**
 - **Less area required**

Anaerobic Digestion



- **Mechanical segregation to obtain putrescible fraction,**
- **Hydrolysis tanks – break into smaller molecules**
- **Fed into anaerobic digestion tanks**
- **Produces combustible gas CH₄ (60%), and inert gas, CO₂**
- **CH₄ gas used to produce power through a biogas electric generator**
- **Remaining digestate (slurry) is a soil conditioner free from pathogens**
- **Advantages:**
 - **Less land required**
 - **No release of greenhouse gases**
 - **No problem of odor**
 - **Cost effective**

Other Types

- **Pelletization**
 - Producing fuel pellets from solid waste
 - Raw garbage (1000 kcal/kg), Pellets 4000 Kcal/kg
 - 15–20 tons pellets from 100 tons
 - Pellets – Burn in boilers – Steam – Turbine – Power
- **Flash pyrolysis**
 - Low temperature pyrolysis - fuel oil
 - Hammer mill - reduce particle size 3 mm
 - Reactor – 500 deg. C - atm. pressure – thick oil
- **Pyro-plasma process**
 - Two electrodes close distance - ionized gas passed
 - High voltage discharge between the electrodes
 - High temperature 5600–30000 °F created
 - Biomass turns into ionized gas
 - Ionized gas quenched and cooled
 - Most efficient
 - Very high cost

Cost and Incentives

- **Cost Estimated (Per 100 TPD):**
 - Incineration: Rs. 12-15 Cr
 - Biomethanation: Rs. 10-12 Cr
 - Gasification: Rs. 8-10 Cr
 - Pyro plama: Rs. 25-30 Cr
- **Financial incentives:**
 - Rs.20 - 60 lakhs per MW depending upon technology and user category (Govt., Cooperative, Private)
- **Fiscal incentives**
 - 80% accelerated depreciation
 - Ten years tax holiday
 - Concessional customs duty
 - Excise duty exemption
 - General Sales tax (GST) exemption(only in certain states)

Achievement (As on 30 June 2015)

- **Source : MNRE Website**
- **Grid Connected**
 - **Bio-Power (Biomass incineration, Gasification and Bagasse Cogeneration): 4418 MW**
 - **Waste to Power: 127 MW**
- **Off grid:**
 - **Waste to Energy: 146 MWeq**
 - **Biomass(non-bagasse) Cogen: 602 MWeq**
 - **Biomass Gasifiers: 18 MWeq**

THANK YOU

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