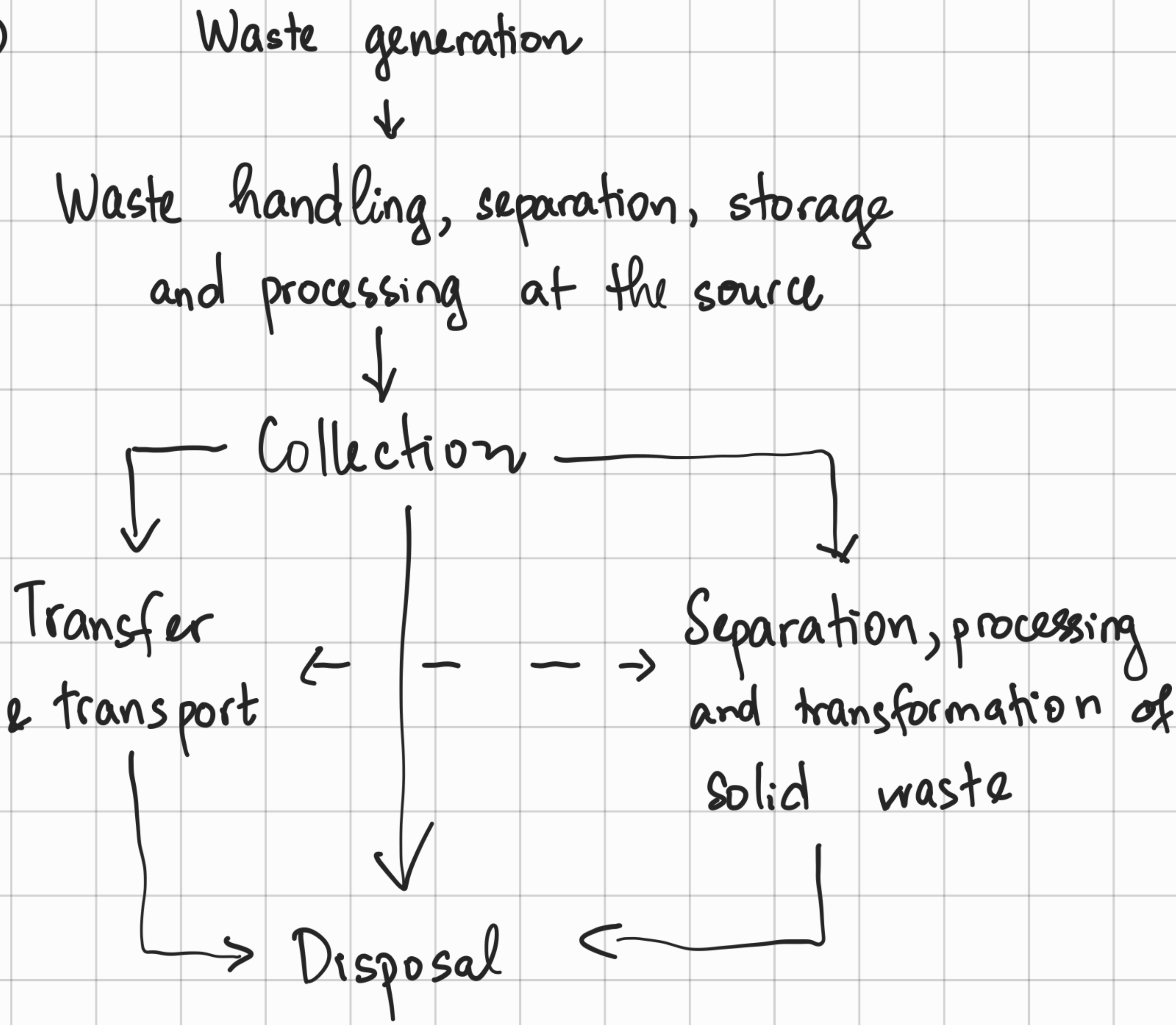
Hoang Thu Minh

1.

(a)



(b) Purpose of transfer station:

- Save transportation cost
- Secondary incentives:
  - some pretreatment : shredding, baling
  - reduction in traffic
  - improved public access, maybe combined with recycling

- improved organization of collection

- There is a need for transfer station when:
  - there are excessive haul distances
  - processing facilities or disposal sites locate in remote areas
  - integrated materials recovery/transfer facilities
  - Convenience transfer station at landfill

(c)
- Mesophilic phase (10 - 40°C)
  + Lasts only a few days
  + Explosive growth of bacteria & fungi
  + Rapid breakdown of soluble sugar and starches
- Thermophilic phase (> 40°C)
  + Can last from several days to months
  + High heat helps breakdown of proteins, fats, and "tough" plant material
- Maturation (Cooling phase) (10- 40°C)
  + remaining organic matter is slowly broken down
  + can last for several months

(d). Hauled collection service

- Advantages:
  - +, Can collect wastes from large sources
- Disadvantages
  - +, more travelling distances

• Stationary Collection system

- Advantages
  - +, less travelling
- Disadvantages
  - +, can only handle small sources

(e) Incineration

• Primary objectives:

- Reduce waste volume
- Inertisation of hazardous waste residues
- Destruction of contaminants
- Recovery of energy
- Transformation of residues into usable secondary products

- Secondary objectives:
  - Save landfill space
  - Minimize / Control emissions
  - Conserve energy resources
  - Conserve raw materials and resources

(f). Gathering / picking up of solid waste
- Hauling to the location where the contents of collection vehicles are emptied
- Unloading of wastes

2.

(a) - Hazard identification : sources and emissions
- Exposure assessment : Fate & transport, exposure event
- Toxicity assessment : Dose / Response & Biokinetics
- Risk Characterization

(b). Thermal processes : Using combustion to destroy hazardous wastes
  - e.g. Incineration, vitrification, Plasma Centrifugal Reactor

- Solidification / Stabilization / Fixation / Encapsulation

Incineration is the most widely used in Singapore

(c) Basel convention provides regulations to monitor the generation, transportation, treatment and disposal of hazardous wastes and control transboundary movement of these wastes.

(d) Major hazardous compounds in haze: NO_x, SO_x, PM2.5, PM10

Index used to quantify pollution level: PSI

(e). Rationales:

- Extend the lifespan of Semakau Landfill beyond 2035

- Measures: Adopt a circular economy approach
  - Sustainable production
  - Sustainable consumption
  - Sustainable waste & resource management
- Wastes of specific attention:

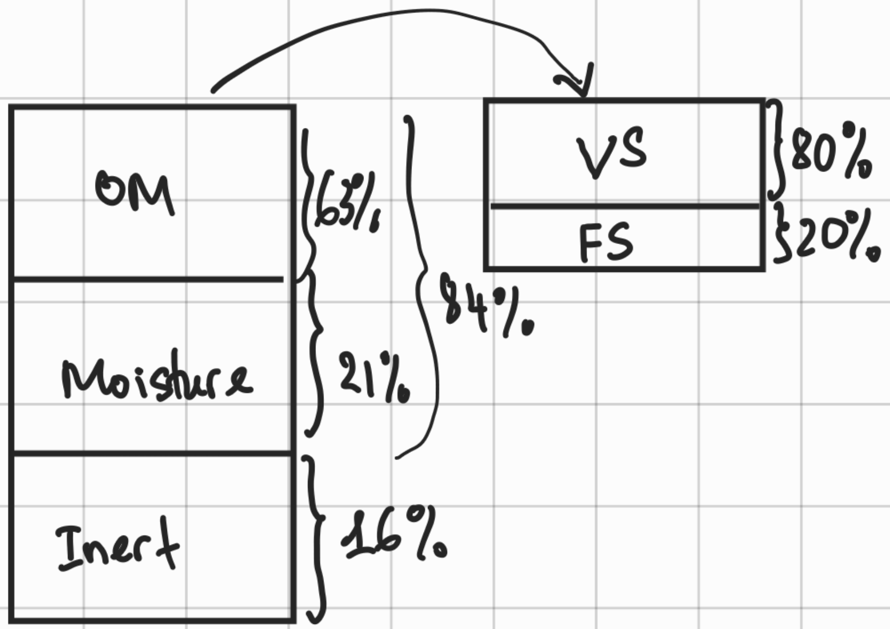
- Food waste
- E-waste
- Packing waste, including plastics

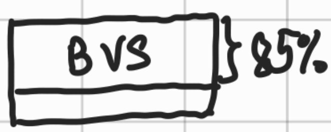
(f) NFPA symbol consists of 4 diamonds:

1. Blue (left size) : Health hazard
2. Red (top) : Flammability hazard
3. Yellow (right size) : Reactivity
4. White (bottom) : Special hazard

For the first 3 diamonds, numbers from 0-5 are used to rank the extent of that characteristic. (0 - lowest, 5 - highest)

3.





95% of BVS → biogas

BVS: $C_{48}H_{90}O_{35}N$

M = 100 kg

Amount of BVS = 100kg × 0.63 × 0.80 × 0.85
= 42.84 kg

Amount of BVS converted to biogass = 42.84 kg × 0.95
= 40.698 kg

$$C_{48}H_{90}O_{35}N + \frac{35}{4} H_2O \rightarrow \frac{175}{8} CO_2 + \frac{209}{8} CH_4 + NH_3$$

1240g   962.5g   418g
40.698 kg   →   31.59 kg   13.72 kg

Total volume of biogas ($CO_2 + CH_4$)

$$= \frac{31.59}{1.977} + \frac{13.72}{0.717}$$

$= 35.1 \ m^3$

(b) Assume the mass of MSW is 100 kg
Initial volume = 100 / 220 = 0.455 m^3

Component	Mass (kg)	Inert residue (kg)
Food waste	9	0.45
Paper	34	2.04
Cardboard	6	0.3

Plastics	7	0.7
Textiles	2	0.13
Rubber	0.5	0.0495
Leather	0.5	0.045
Yard waste	18.5	0.8325
Wood	2	0.03
Glass	8	7.84
Tin cans	6	5.88
Aluminium	0.5	0.48
Other metal	3	2.94
Dirt, Ash, etc	3	2.04

Total mass of residue = 23.677 kg

Volume of residue $= \frac{23.677}{590} = 0.0401\ m^3$

Volume reduction $= \frac{0.455 - 0.0401}{0.455} \times 100\%$

$= 91.2\%$

(c)

(i)

Component	Weight (kg)	Moisture Content (%)	Calorific Value (kJ/kg)	Calorific content (kJ)
Organic				
Food Wastes	20	70	4650	93000
Paper	34	6	16750	569500
Cardboard	4	5	16280	65120
Plastics	4	2	32560	130240
Textiles	2	10	17450	34900
Rubber	0.5	2	23260	11630
Leather	1	10	17450	17450
Yard Wastes	20	60	6510	130200
Wood	2	20	18610	37220
Misc. Organics	-	-	-	
Inorganic				
Glass	3	2	140	420
Tin Cans	3	3	700	2100
Aluminium	0.5	2		0
Other Metal	3	3	700	2100
Dirt, Ash, etc.	3	8	6980	20940
	$\Sigma = 100$ kg			$\Sigma = 1114820$

$$\text{Calorific value of MSW} = \frac{1114820 \text{ kJ}}{100 \text{ kg}}$$

$$= 11148.2 \text{ kJ/kg}$$

(ii)

Component	Weight (kg)	Moisture Content (%)	Calorific Value (kJ/kg)	Calorific content (kJ)
Organic				
Food Wastes	0.8×20 = 16	70	4650	74400
Paper	0.6×34 = 20.4	6	16750	341700
Cardboard	4	5	16280	65120
Plastics	4	2	32560	130240
Textiles	2	10	17450	34900
Rubber	0.5	2	23260	11630
Leather	1	10	17450	17450
Yard Wastes	20	60	6510	130200
Wood	2	20	18610	37220
Misc. Organics	-	-	-	
Inorganic				
Glass	3	2	140	420
Tin Cans	3	3	700	2100
Aluminium	0.5	2		0
Other Metal	3	3	700	2100
Dirt, Ash, etc.	3	8	6980	20940
	$\Sigma = 82.4$			$\Sigma = 868420$

$$\text{Calorific value of MSW} = \frac{868420 \text{ kJ}}{82.4 \text{ kg}}$$

$$= 10539 \text{ kJ/kg}$$

4.

(a)

hour	leaking volume (L)	c6h12o (g/L)	c6h6 (g/L)	M c6h12o (g)	M c6h6 (g)
1	1	5	10	5	10
2	1	5	10	5	10
3	2	10	20	20	40
4	2	10	20	20	40
5	5	25	50	125	250
6	5	25	50	125	250
7	1	5	10	5	10
8	1	5	10	5	10
			Total (g)	310	620
			Volume (m3)	100	100
			Concentration (mg/L)	3.1	6.2