Reduction of Unintentionally Produced Persistent Organic Pollutants (UPOPs) emissions by improving waste management practices at landfills

Hazardous Waste Management Options

GEF Project ID: 5558 – Component 2 - Development and Implementation of a Sustainable Management Mechanism for POPs in the Caribbean

February, 2020

BCRC CARIBBEAN
Basel Convention Regional Centre for Training and Technology Transfer for the Caribbean

UN environment
United Nations Environment Programme

Resources & Waste Advisory Group

gef

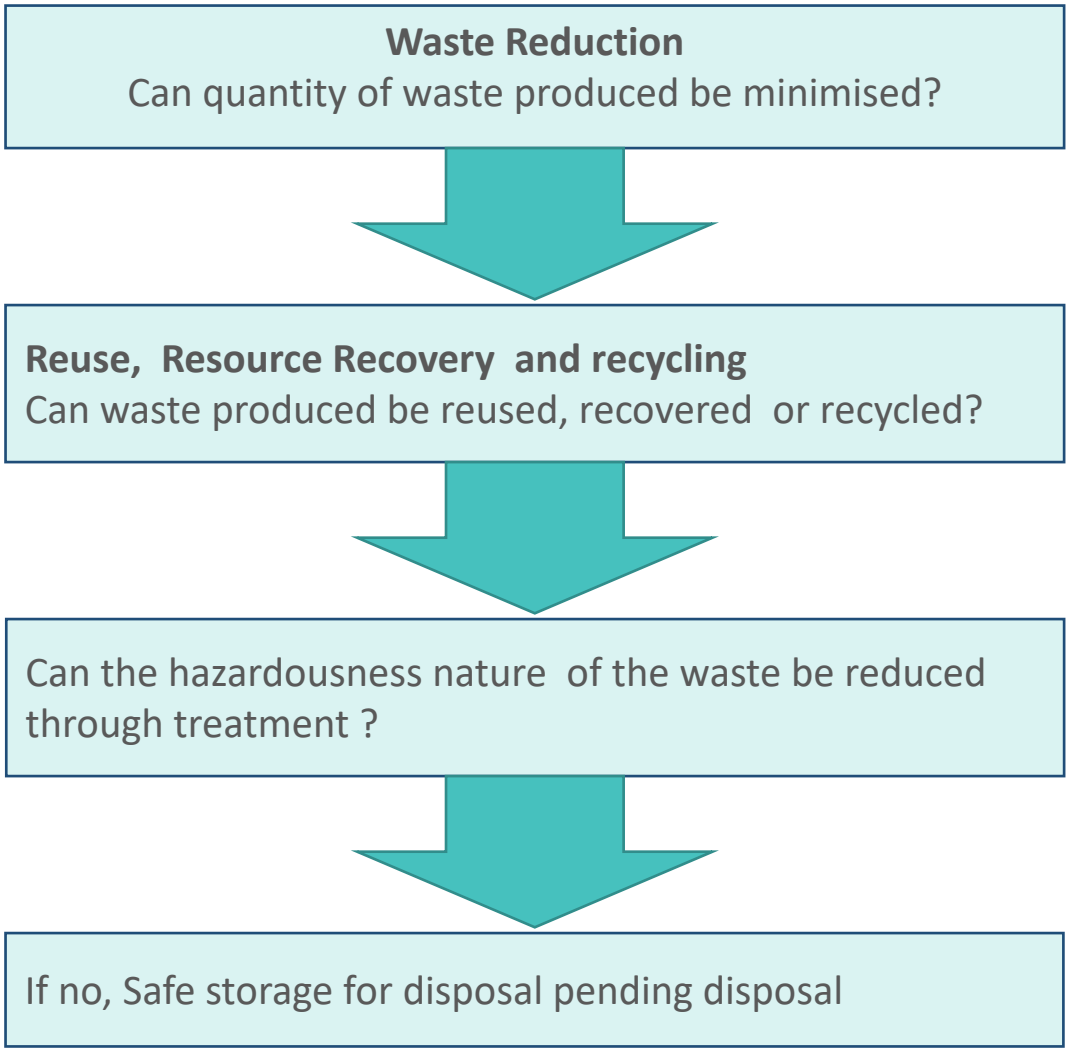
STOCKHOLM CONVENTION

UNIDO

Presentation Outline

- Definitions
- Introduction
- Resource recovery and treatment technologies
- Oil recovery
- Types of Waste Suitable for Oil Recovery options
- Considerations in the choice of options for oil recovery
- Uses of recovered oil
- Solvent recovery
- Treatment Processes
- Physico-Chemical Treatment
    - Neutralisation
    - Solidification
- Decision Matrix

Hazardous waste Management Hierarchy in SIDS Context



Definitions

Reuse - Use of a waste for the original or another purpose without pre-treatment or processing

Recycling Reuse of a waste after processing

Resource Recovery- Extraction of useful material or energy which may be reused

Treatment- Processing to reduce the hazardous properties of a waste

INTRODUCTION

- Particular problems develop if hazardous wastes are:
  - Jointly disposed in traditional waste landfill
  - Dumped illegally
  - Stored on-site without necessary precautions

- Every recycling or treatment process will produce a residue which will require storage and ultimately disposal

- Hazardous waste treatment has the potential to reduce hazardousness of the wastes and also reduce storage and disposal costs

Resource recovery and treatment Technologies

Technology	Process	Methodologies
Resource Recovery	Oil recovery	• Gravity separation • Coalescence separation • Filtration / Ultra-filtration • Emulsion splitting • Air floatation
	Solvent recovery	• Distillation
	Metal recovery	• Precipitation of metals • Ion exchange • Electrolytic cell
Treatment	Physico-chemical	• Neutralisation, coagulation, precipitation, oxidation and reduction, disinfection, ion exchange, wet air oxidation, reverse osmosis, sedimentation, clarification, flotation, filtration, evaporation, solidification
	Biological	• Aerobic and anaerobic
	Solidification	• Immobilisation
	Thermal processes	• High temperature destruction
	Land treatment	• Biological degradation

Resource recovery – oil recovery

Step	Activity	Objective	Typical Processes
1	**Pre-treatment**	• Waste volume reduction • Removal of impurities • Emulsion splitting	- settling - filtration A) addition of de-emulsification chemicals B) application of heat
2	**Treatment**	• Oil water separation	A) gravity separation B) coalescence separation C) ultra-filtration D) air floatation
3	**Refining** (Optional)	• Purification	Distillation Acid/clay process

Types of Waste Suitable for Oil Recovery options

Oily Waste Types	Pre-treatment Separation	Distillation Separation	Reuse*
Mineral oil	✓	✓	✓
Grease	✓	✓	✓
Oily sludge	✓	Not usable	Not usable
Oily water mixture / emulsions	✓	✓	✓
Oil-contaminated waste	✓	Not usable	Not usable

Considerations in the choice of options for oil recovery

The options depend on the actual composition of the wastes.

For example:

- recovery of a mix of many hydrocarbon fractions will not be cost effective by distillation
- a high content of water in a oily water mixture will require separation of the water before the oil fraction can be burned effectively as supplementary fuel

Uses of recovered oil

- As fuel in combustion plants or cement kilns
- Can lead to unacceptable emissions if not controlled
- Fuel blending with non-halogenated solvents and other high calorific value wastes may improve emissions

- In certain circumstances waste oils may also be used as
  - ➢ timber preservative
  - ➢ Low grade grease or lubricant

Solvent Recovery

Main technology: Distillation

Solid residue – frequently inert and may be landfilled, but may be hazardous waste

Feasibility and extent of recovery are governed by

- **Economies of scale**
- **Complexity of solvent mixtures to be separated**

Solvent Recovery

Some types of waste solvent suitable for recovery:

- Methanol
- Iso-propyl alcohol (IPA)
- Acetone
- Methyl ethyl ketone (MEK)
- Trichlorethylene (TCE)

Solvent recovery

Potential problems:

- **Residues may be hazardous**
- **Emission of VOCs**
- **Product may be contaminated**
- **Health & safety issues**

Treatment Processes

Physico-chemical Treatment (PCT)

Solidification

Wet air oxidation

Reverse osmosis

Biological Treatment

Incineration

Land treatment

Physico-Chemical Treatment

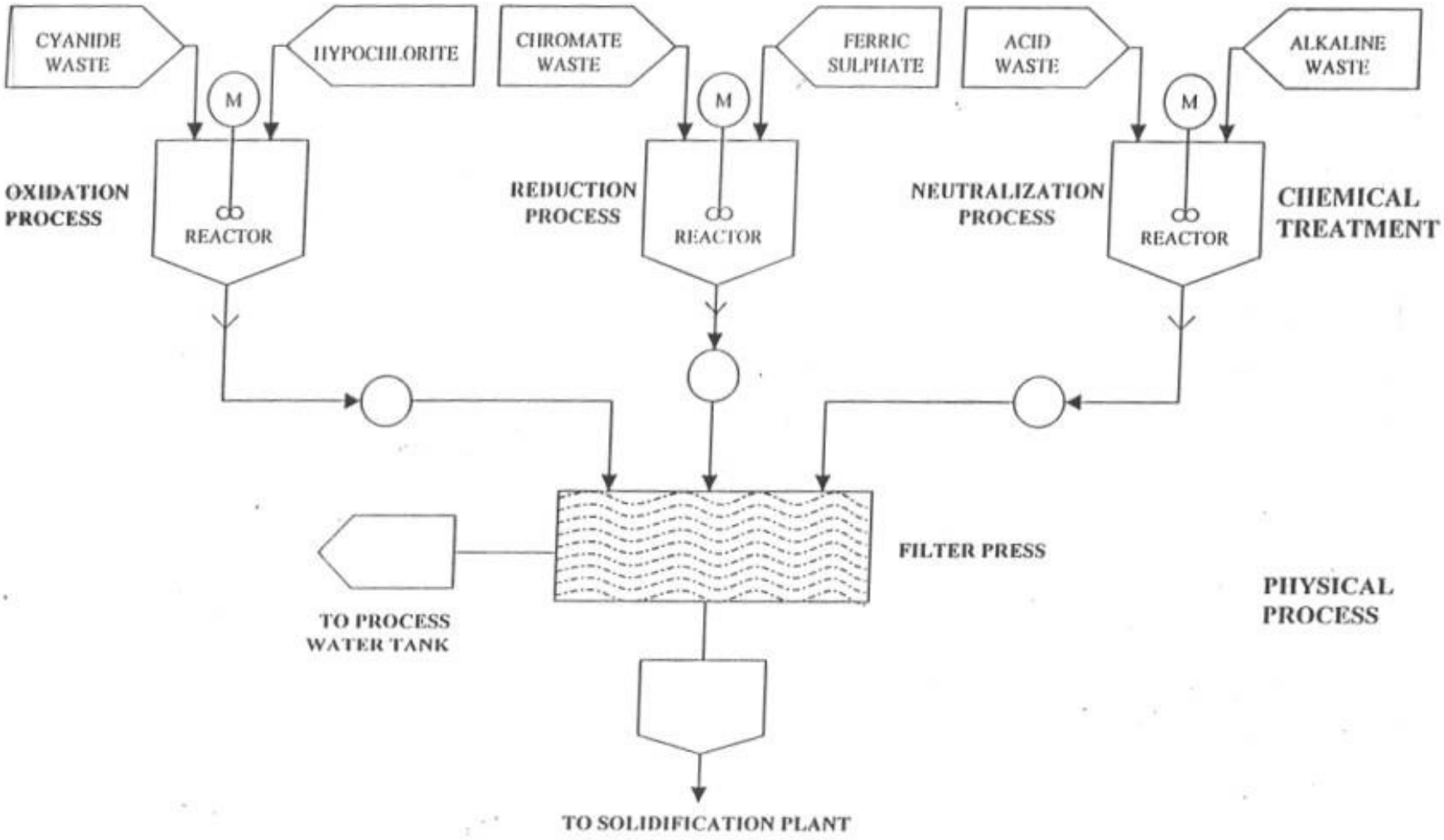
- To reduce the hazardous properties of the waste before its final disposal
  - Normally for inorganic wastes
  - Acidic/alkaline wastes
  - Wastes containing cyanide, Cr(VI), heavy metals
  - Other wastes containing ammonium complexes, fluoride, and mercury, etc
  - Combinations of above wastes

- TOC (Total organic Carbon) must be lower than 100 ppm

Physico-Chemical Treatment (PCT)

- Neutralisation of acidic and alkaline wastes
  - Lime or caustic soda for acids
  - Waste acid for alkalis
- Oxidation of cyanide
  - Hypochlorite (HTH) or alkaline chlorine
- Reduction of Cr(VI) to Cr(III)
  - Acid ferrous sulphate (NB: pH control)
  - Metabisulphite
- Precipitation of heavy metals
  - As hydroxide or sulphide
- All solids to landfill

Illustration of PCT



Neutralisation

Acidic solutions need to be neutralised with an alkali. They often contain heavy metals as well, which will be precipitated at the same time. They can be neutralised with waste alkaline solutions.

In practice, however, the acidic solution is usually neutralised with sodium hydroxide, lime or slaked lime (lime slurry) as shown by the following reactions:

Hydrochloric acid : $2\ HCl + CaCO_3 \rightarrow CaCl_2$ (solid) $+ H_2CO_3$

Sulphuric acid : $H_2SO_4 + CaCO_3 \rightarrow CaSO_4$ (solid) $+ H_2CO_3$

The precipitated calcium chloride ($CaCl_2$) and calcium sulphate ($CaSO_4$) will often be contaminated with precipitated heavy metals and need to be disposed of at a secure landfill.

Neutralisation

Alkaline solution: can also be neutralised with waste acidic solutions.

Sodium hydroxide neutralised with sulphuric acid

$2\ NaOH + H_2SO_4 \ \ ® \ Na_2SO_4$ (solid) $+ 2\ H_2O$

The choice of neutralisation method depends on the raw material available and the cost of the available agents.

Solidification

- Solidification reduces
  - the level of toxicity
  - solubility of pollutants
  - rate of leaching into the environment

- Normally used for residues from treatment processes (e.g. PCT, incineration) which are too toxic to be landfilled in their existing state

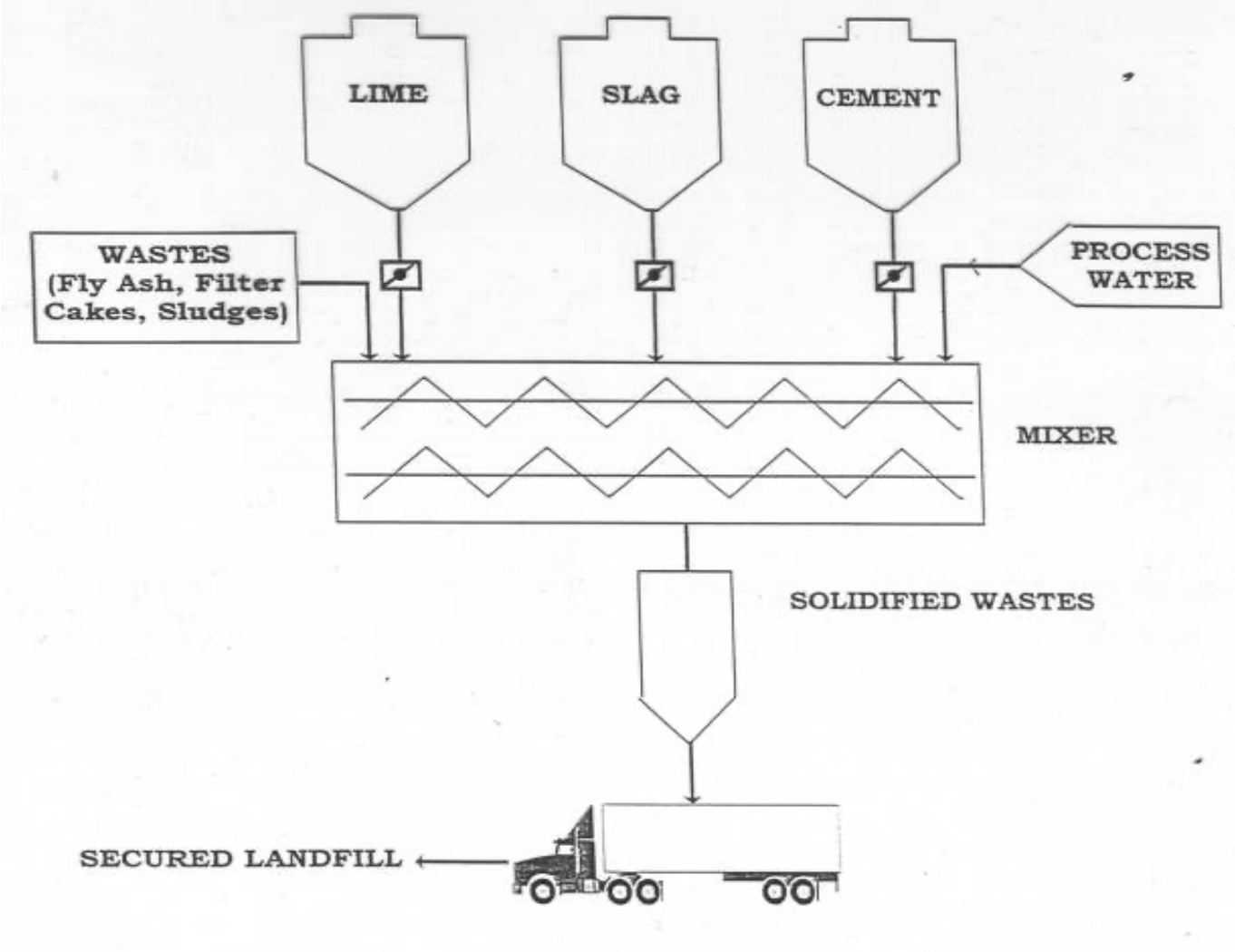
- Only suitable for inorganic wastes

Solidification

Types of waste suitable for solidification

- Inorganic sludges from electroplating plants
- Slurry from physical/chemical plant
- Fly ash from incinerator plants
- Soils contaminated with inorganics

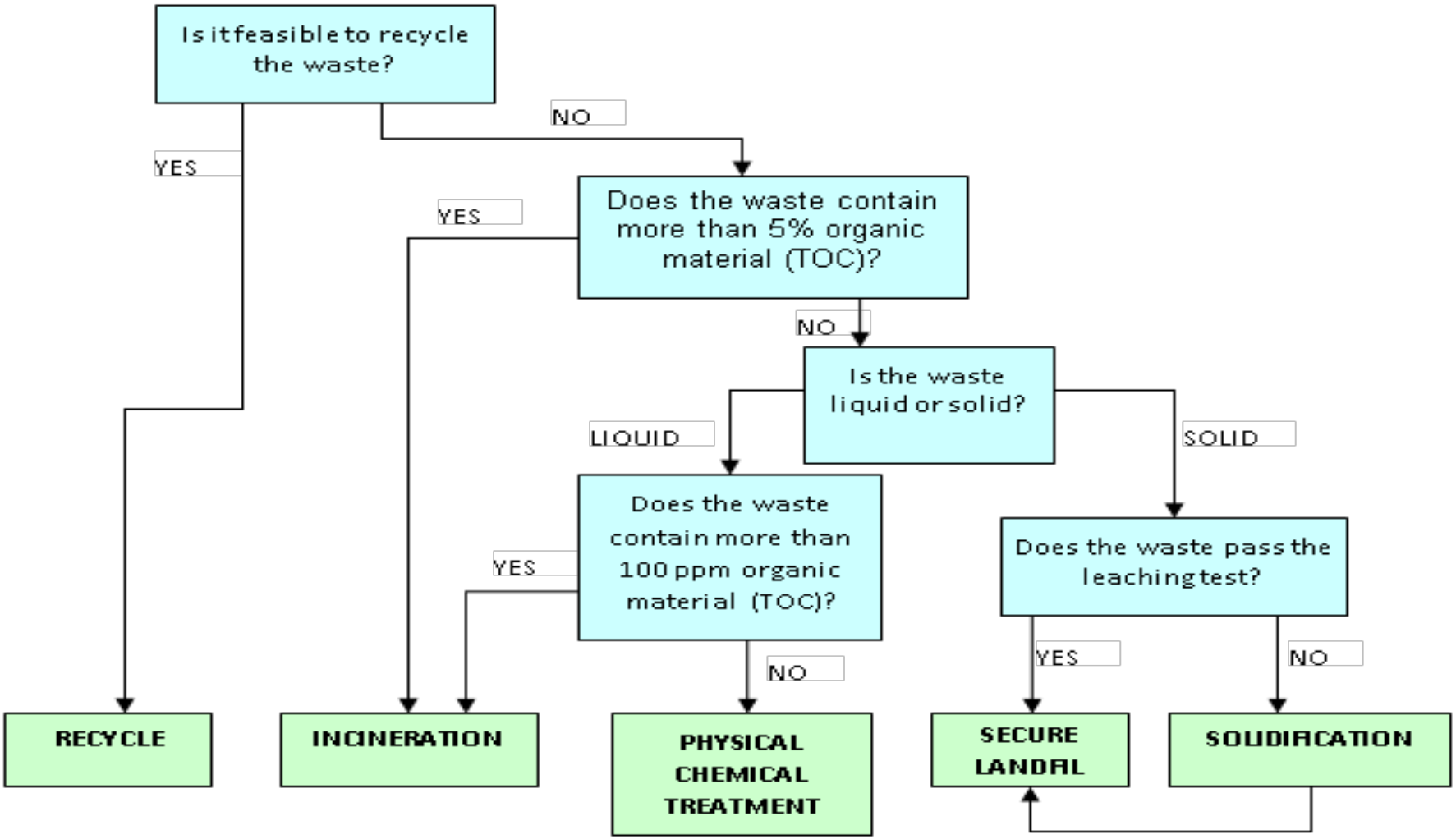
Solidification



Solidification

- The solidification unit can consist of a silo for cement and a silo for fly-ash/ lime, a hopper for waste and as the central unit a batch type mixer, which shall be placed on a scale.
- Based on the recipe fed to the control unit and the signals from the scale, conveyers will feed adequate amounts of waste, fly-ash, water and cement to the mixer.
- After mixing- material transferred to a truck, which shall transport the solidified waste to the landfill where it shall be allowed to harden.
- Solidified material can be tested accordingly to the leaching test CEN/TC292/WG2 adopted in the European Union (EU).

Decision matrix



Physico-Chemical Treatment

Some Potential Problems

- Insufficient/excessive use of reagents
- Wastes may contain organics
- Health and safety issues
- Sludges may be landfilled without meeting appropriate leaching tests
- Storage of wastes awaiting treatment may be unsatisfactory
- Containment system around plant may be ineffective