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Treatments & Landfill

Regional Training in Hazardous Waste
September 30 – October 2, 2014
San José, Costa Rica

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Pretreatment / Conditioning

PHYSICAL treatments

Name	Description
Filtration	Separation of solid or liquid phase due to the retention of solid particles by a filtration system. Plate and frame filter press, belt filter, vacuum filter
Centrifugation (sedimentation, flocculation and flotation)	Separation of solid or liquid phases by using centrifugal force
Evaporation – Drying	Generally with drying beds, drainage blankets and evaporation
Other physical treatments such as air or steam stripping, carbon adsorption or ion exchange	

Systems generally used for treating sludge.

Filtration

Plate and frame filter press

Belt filter

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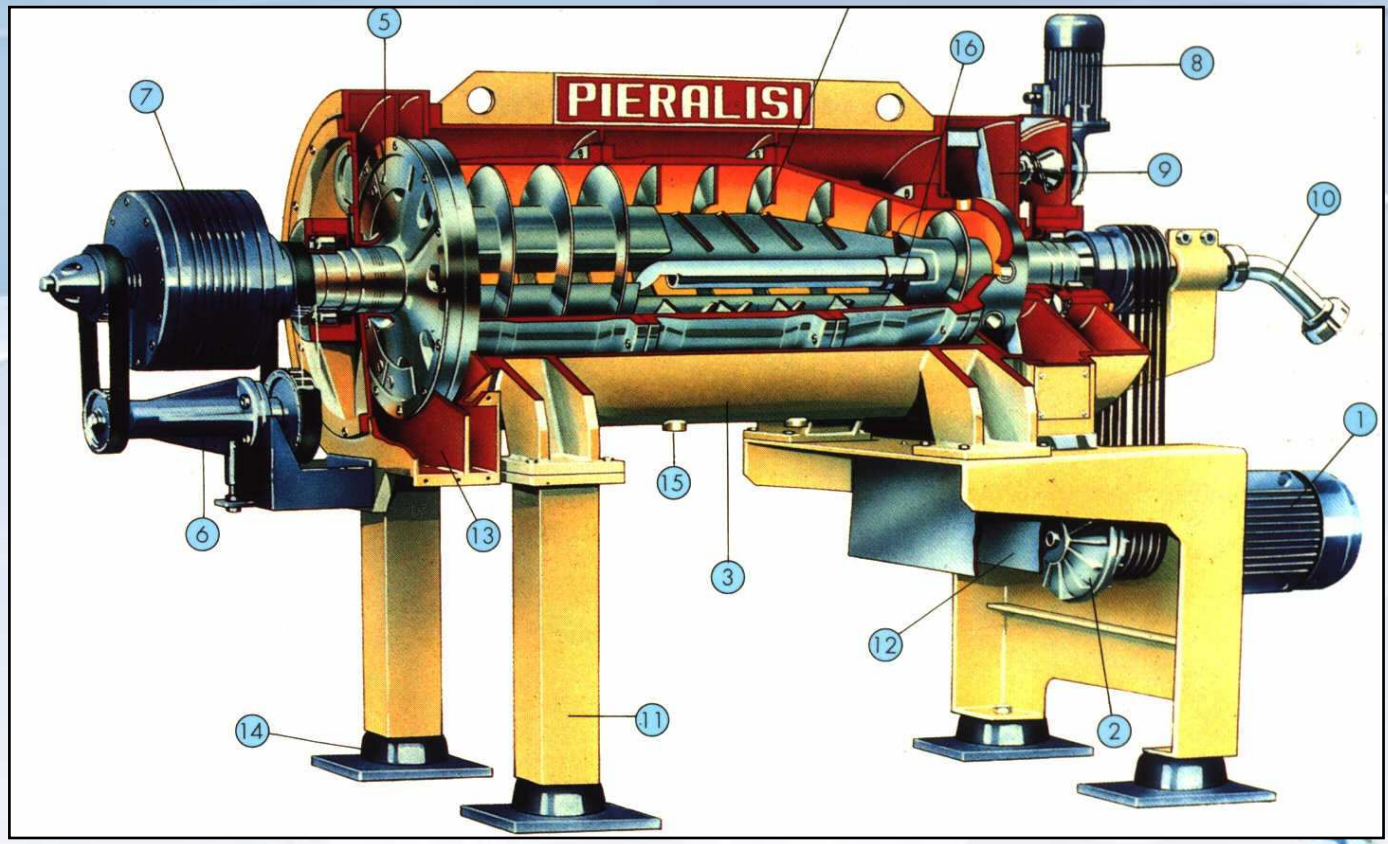
Centrifugation



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Advantages / Disadvantages

+ Used for the treatment of sludge, flexible characteristics
+ Simple operation
+ Short treatment time
- It does not change any hazardous characteristics
- Initial investment
- Energy consumption

Drying

Drying bed

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Advantages / Disadvantages

+ Used for the treatment of sludge, flexible characteristics

+ Simple operation

- It does not change any hazardous characteristics

- Initial investment (smaller than the previous one)

- Long treatment time

Pretreatment / Conditioning

Chemical treatments

Name	Description
Precipitation	Formation of insoluble compounds by adjusting pH or adding certain anions or cations E.g.: precipitation of heavy metals with sodium or calcium hydroxide
Neutralization	pH adjustment by using acids or alkalis
Oxidation – Reduction	To change the oxidation state of the contaminant, changing its toxicity or other property E.g.: Chromium VI to Chromium III

Treatment with recovery
Biological

Name	Description
Composting	Controlled process of transformation of organic solid waste into a bio-stabilized compound, through decomposition, oxygenation and oxidation. It is an aerobic degradation of organic waste, under controlled conditions, by microorganisms.
Landfarming	Form of soil bioremediation by tilling the soil, where a waste biodegradation process is developed by the microorganisms in the soil.
Anaerobic Digestion	Controlled process of anaerobic decomposition transforming organic waste into methane and biofertilizer. Methane can be used to generate electric power.

Treatment with recovery

Thermal

Name
Co-processing / Alternative fuel
Incineration with energy recovery
Gasification

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Co-processing – Alternative Fuel

A technique used for industrial waste, by using it as partial replacement for raw materials (co-processing) or fuels (alternative fuels), in clinker kilns in cement factories. Hazardous materials are retained in the clinker.

Types of waste to be used:

- Raw material substitutes: similar characteristics to raw materials. Co-processing.
- Fuel substitutes: waste with a high calorific value that replace traditional fuels. Alternative fuel.

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Alternative fuel

Waste used as alternative fuel from the following waste:

- Waste from hydrocarbons, fats and oils
- Plant waste from agriculture or forestry
- Tires or materials with similar characteristics
- Packaging waste, except for PVC containers

The temperature kilns reach to process clinker varies between 1600-2000ºC.

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Incineration with energy recovery

A process that turns waste into combustion gases, slags and ashes, reducing waste by an average of 90% in volume and 75% in weight.

Burning of materials at high temperatures (generally over 900ºC), in combination with an adequate amount of air and time.

It is necessary to have sophisticated gas treatment systems and a strict emissions control.

Incineration with energy recovery

Energy recovery has a dual function:

1. Recover heat contained in combustion gases to heat water, produce saturated steam for heating or process, or superheated steam to generate electric energy.
2. Cool down combustion gases to proper temperatures for their subsequent treatment, before being released to the environment.

Energy is recovered by means of steam boilers.

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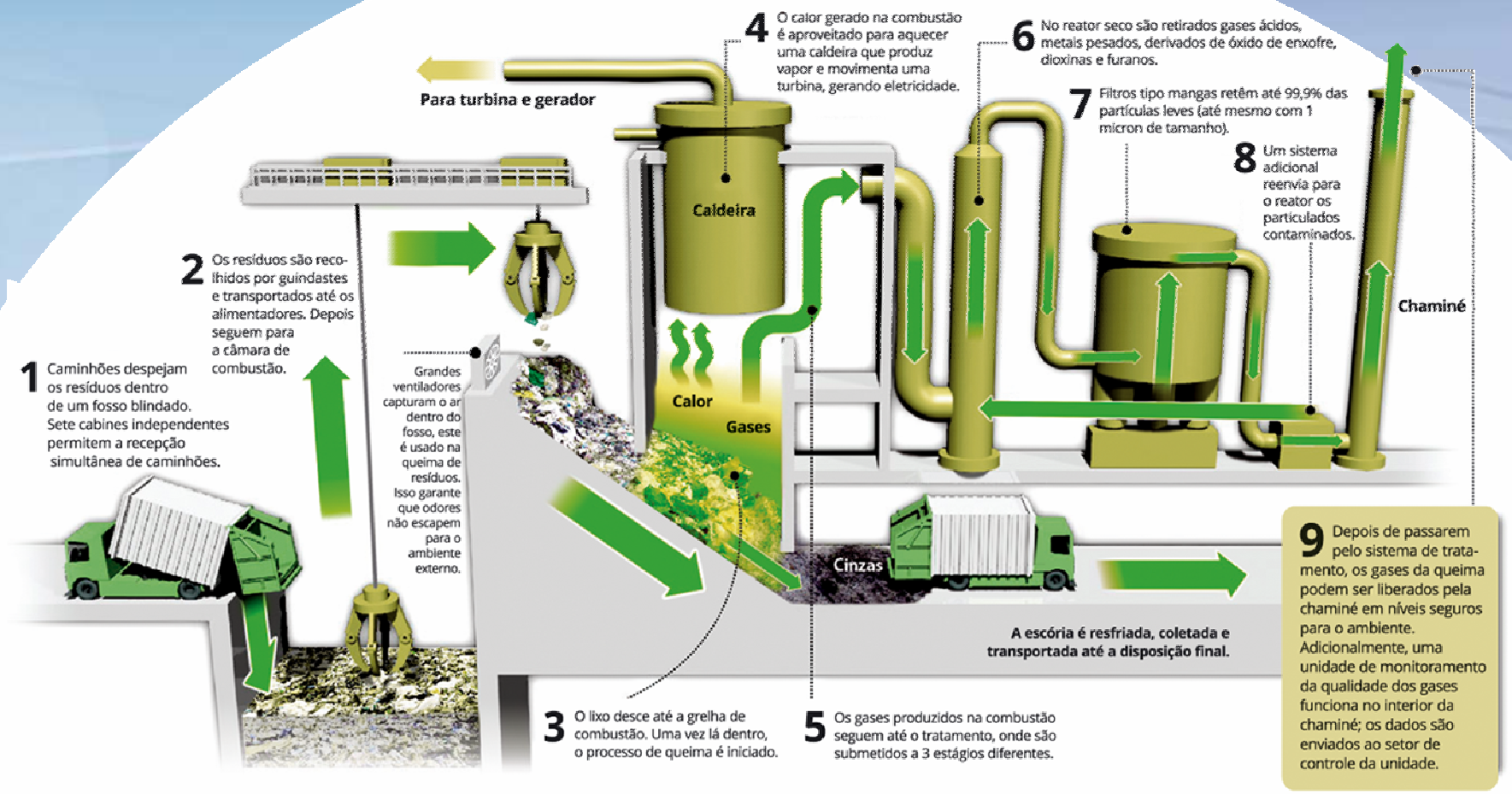
Incineration with energy recovery



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Incineration: Advantages/Disadvantages

+ Drastic reduction in volume

+ Reduction of environmental impacts

+ Destruction of contaminants

- High investment and operating costs

- Need for skilled labor

- Limits on emissions of *dioxins and furans*

- NIMBY effect

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Incinerator:

Nowadays, the main incinerator technologies are:

- Rotary kilns.
- Static kilns.
- Grate furnaces.
- Fluidized-bed furnaces.

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Good combustion practices:

Incinerators should be specially designed and the equipment should be operated and maintained by specialized staff.

There are 4 extremely important factors that should be monitored in the combustion of solid waste in order to ensure a full conversion of the organic compounds present in waste, carbon dioxide and water:

- Temperature,
- Oxygen content,
- Turbulence and
- Residence time.

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Incineration – Examples

Likeng
Location: Guangdong, China
Start of operations: 2006
Supplier: Keppel Seghers

Ivry Paris XIII
Location: Paris, France
Start of operations: 1969
Supplier: CNIM, Martin

Baku WTE
Location: Baku, Azerbaijan
Start of operations: 2012
Supplier: CNIM, Martin

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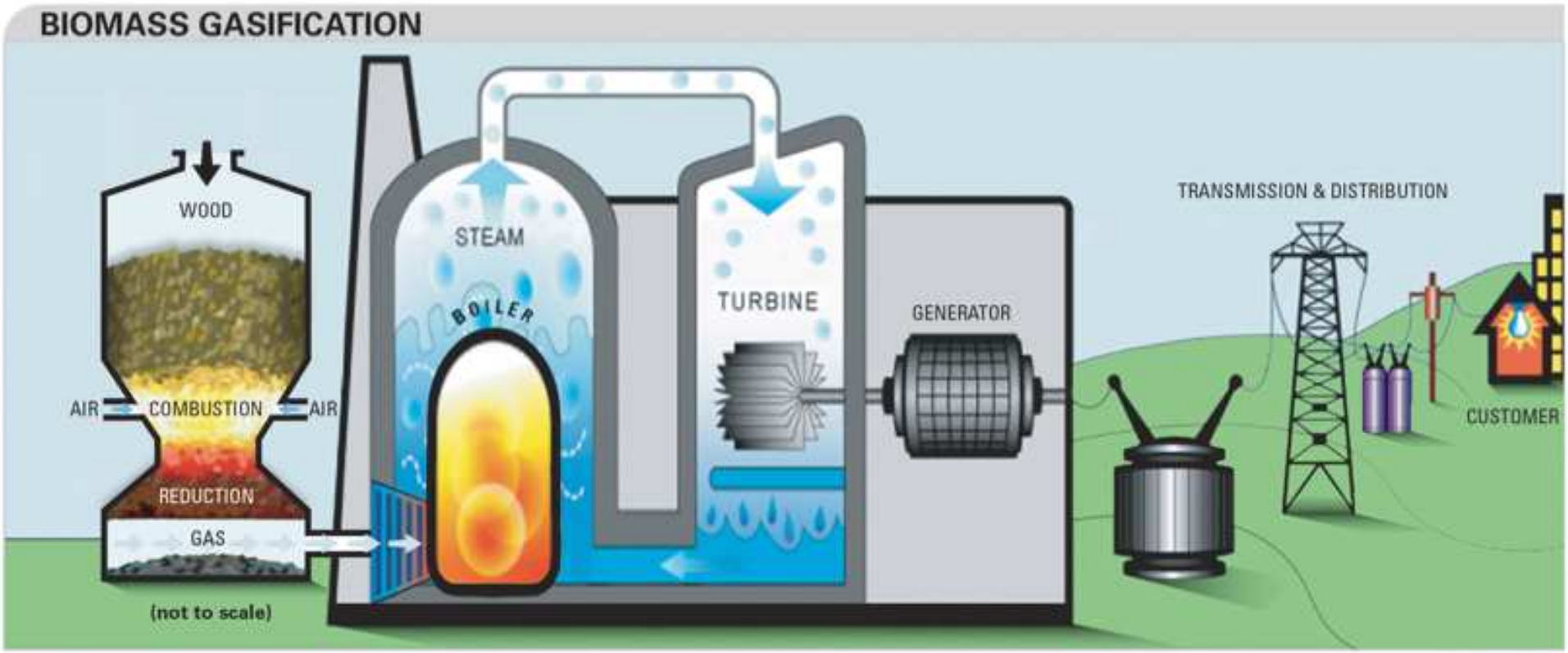
Gasification



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Plasma gasification and vitrification

Plasma is considered the 4th state of matter.

It involves bringing waste into contact with a gas energized to its plasma state using electric energy.

Temperatures between 3000ºC and 15,000ºC are reached.

Due to these high temperatures, the release of gases such as dioxins and furans is prevented.

Wastes with high chlorine contents, pesticides and PCBs can be treated, although several other types of waste can also be treated.

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Treatment without recovery

Name
Incineration of hazardous wastes
Pyrolysis
Autoclave
Microwave
Solidification – Stabilization

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INCINERATION OF HAZARDOUS WASTES

Similar characteristics to those mentioned for incineration with energy recovery.

It is generally carried out in rotary kilns.

The required temperature varies between 850ºC and 1600ºC, with a residence time of 2 seconds.

Rotary or static kilns are generally used.

Solidification – Encapsulation

It involves generating a solid homogeneous mass of treated waste.

It is generally used for inorganic waste with low percentages of organic matter.

Objectives:

- Improve handling and physical characteristics of waste.
- Reduce surface area of transfer or loss of substances to the environment.
- Limit the solubility of any waste constituent.
- Immobilize hazardous constituents.

Advantages / Disadvantages

+ Flexibility of waste characteristics

+ Simple operation

+ Short treatment time

- Increase in volume

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AUTOCLAVE: also known as wet thermal disinfection or steam sterilization.

Waste is exposed to high temperatures, using steam injection and high pressure, which enables the destruction of pathogens.

Temperatures of 121ºC are usually accepted, with a residence time of 30 minutes or more, depending on the amount of waste.

Conditioning factors:

- Type of waste.
- Packaging characteristics.
- Waste volume and its distribution in the chamber.
- Biological indicator: Bacillus stearothermophilus.

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MICROWAVE

It involves subjecting biological and infectious waste, previously ground and sprayed with steam, to high-frequency electromagnetic vibrations, until reaching and maintaining a temperature of 95-100ºC for the required time.

These electromagnetic vibrations set water molecules present in waste into high-speed motion. The friction between these molecules generates intense heat.

This process is not suitable for large amounts of medical solid waste (more than 800-1000 kg per day).

Microwave disinfection systems are frequently used for the local treatment of laboratory waste and involve small ovens, the operating principle of which is the same as domestic microwave ovens.

Never put metal objects inside these ovens, since microwaves bounce off metal and generate electric discharges between the metal and the oven walls. Therefore, sharp or cutting waste must never be treated with this system.

Final disposal sites for urban solid waste

It refers to the burial of waste and there are different types:

- Sanitary landfill.
- Secure landfill.
- Controlled dump.
- Open dump.

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Final disposal

Essential concept:

As much protection as possible, triple-barrier system:

- Barrier 1: waste itself with appropriate restrictions and proper operation.
- Barrier 2: base and surface waterproofing systems, leachate collection and treatment, gas collection, rainwater diversion.
- Barrier 3: geological and hydrogeological conditions, location adequacy.

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Required infrastructure

- Gas collection and treatment: biogas should be collected and treated (biofilters, torches, energy recovery).
- Periodic cover: to minimize wind-blown litter, reduce odors and leachate.
- Final cover: 3 main functions, minimizing leachate, restoration of landscape, preventing gas emissions.

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Required infrastructure

- Waterproofing system: its main function is to avoid the infiltration of leachate into the subsurface soil. It can be composed of natural (clays $k<10^{-7}$ cm/s) or synthetic materials, or combinations thereof.
- Leachate collection and treatment: it should be based on gravity, to reduce operating costs. The treatment will depend on the characteristics of disposed waste.
- Surface water control: avoid the infiltration of rainwater to reduce the generation of leachate.

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Components of a sanitary landfill

- Waiting area: to avoid congestion in access roads.
- Scale with control office.
- Laboratory: random sampling.
- Staff facilities: offices, changing rooms, cafeteria.
- Repair shop for machinery.
- Perimeter fence.
- Internal roads.

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Final disposal

Steps to be followed:

1. Site selection.
2. Design and construction of the landfill according to technical standards and existing financial possibilities.
3. Operation with appropriate technologies.
4. Closure: closure project.
5. Monitoring and surveillance of sites during operation and post-closure stage.

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Final disposal

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Rivera

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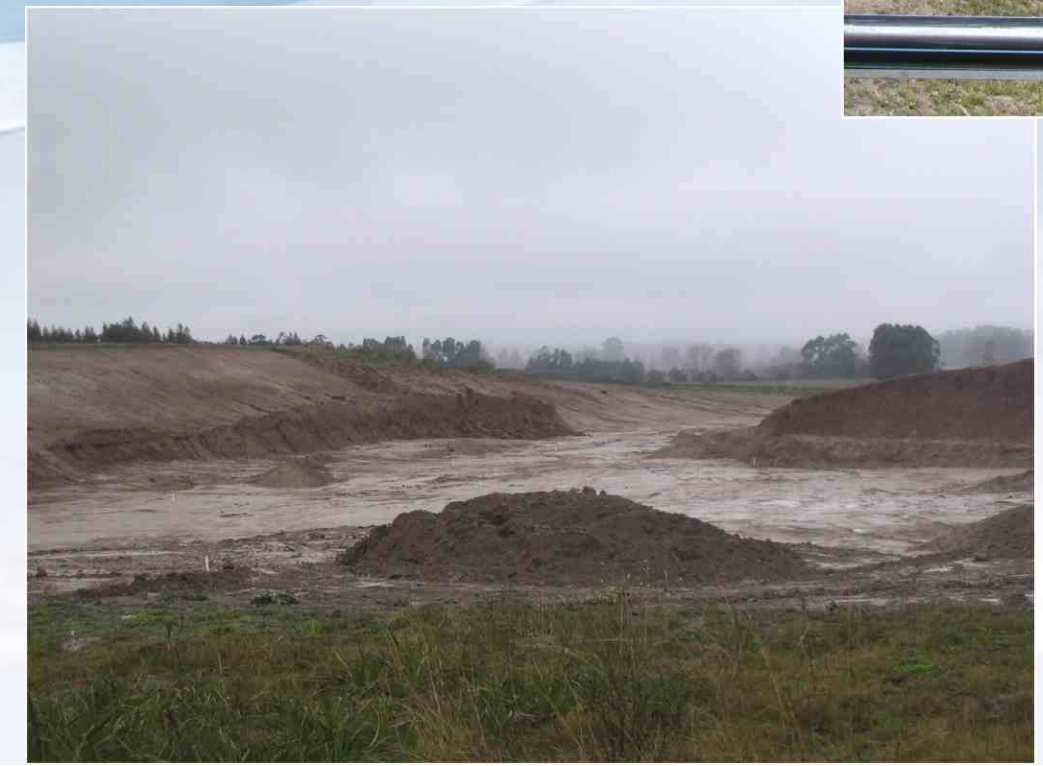
Maldonado



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Additional components of a secure landfill (apart from those of a sanitary landfill):

- Increased thickness of the impermeable layer.
- Leak detection system.

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Final disposal

Sanitary landfill	Secure landfill
Waterproofing system of impermeable mineral layers, geomembrane and geotextile	The system is reinforced by increasing thickness of impermeable mineral layers and the number of layers
Collection of biogas and recovery for EE generation	Collection of biogas, but recovery depends on the type and amount of waste. If it is not possible, it is only burned
Leachate collection and treatment	More complex and expensive collection and treatment due to the presence of hazardous waste
Monitoring of surface and groundwater	Increased frequency, number and type of monitoring

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TRAMONTINA

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Example of landfill construction for non-hazardous waste

Adapted from the presentation by Pedro Schnack

Uruguayan Chamber of Industries (CIU), November 2007

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Soil preparation

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Soil compaction

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Drainage installation

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Synthetic lining started

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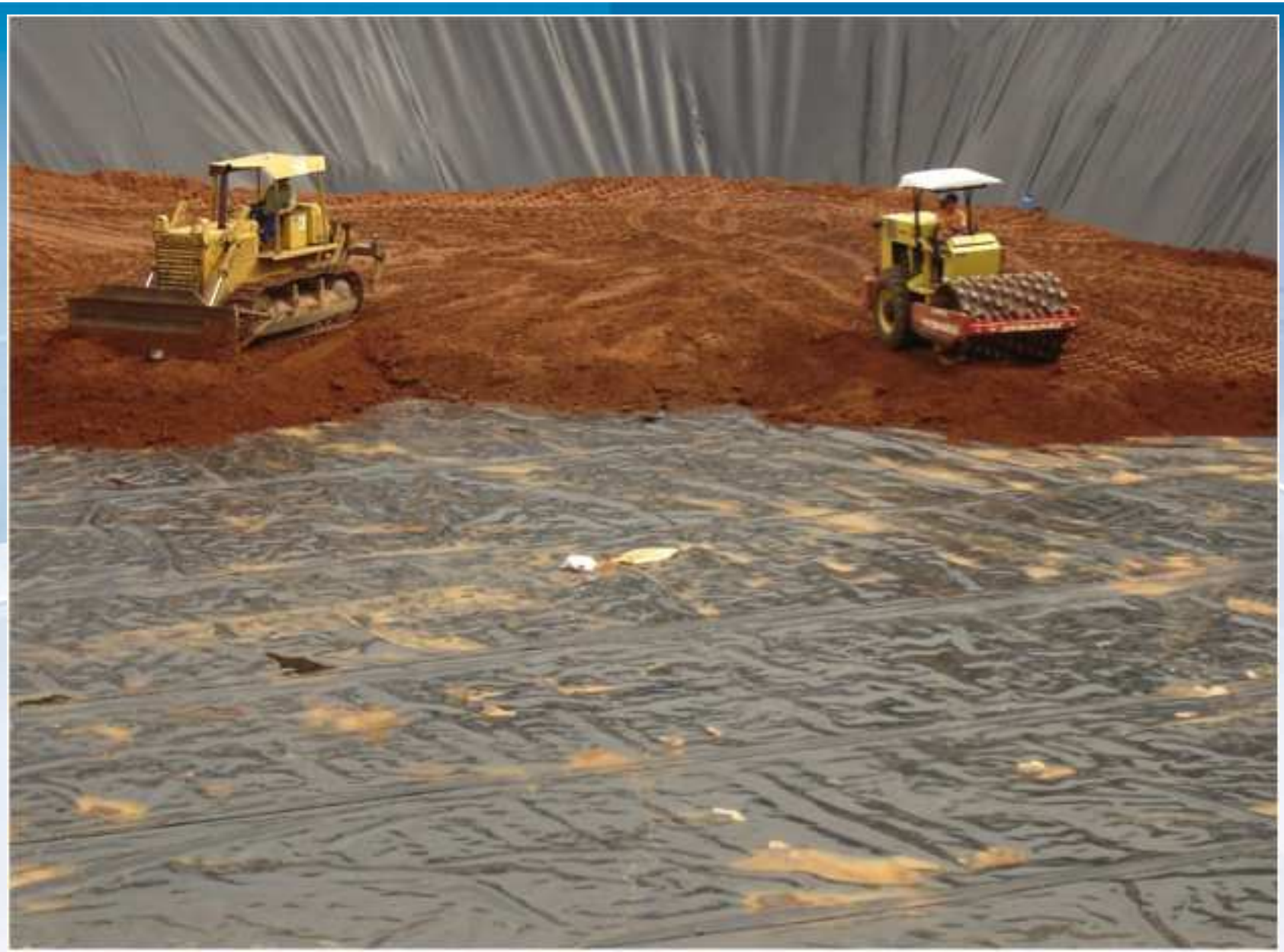
Synthetic lining finished

Pressurization test



Application of protective layer

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Base of the roof metal structure

Foundations for cover

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Pit with cover

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Pit in operation

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Example of landfill construction for hazardous waste

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Leak monitoring

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Leachate drainage

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Leak detection chambers

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Gas drainage

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Landfill finished

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CLOSURE

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