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INDUSTRIAL PLANTS II

Chapter eight (part 2):
Waste treatment plants

DOUBLE DEGREE MASTER IN

“PRODUCTION ENGINEERING AND MANAGEMENT”

CAMPUS OF PORDENONE

UNIVERSITY OF TRIESTE

Preliminary design of a waste to energy plant of municipal solid waste

The problem of disposing of **municipal solid waste** (MSW) is of fundamental importance for the hygiene and public health, causing serious problems for local governments, which must urgently provide for the selection of a suitable and appropriate disposal system.

The problem of disposal of MSW is tackled considering:

- **the disposal technology to be adopted**;
- **the choice on the technical-economic plant solution and the potential of the plant**.

Waste treatment plants

Preliminary design of a waste to energy plant of municipal solid waste

The proportioning and the determination of the potential of an incineration or waste to energy plant are linked to the knowledge of the quantities minimum, average and maximum of MSW to be disposed of, the determination of their calorific value and subsequent predictions of variation of these quantities in the following years.

The quantity, the lower calorific value and the specific weight of MSW are seasonally variable in time and these quantities are related to the standard of living of the community, to the socio-economic fabric concerned and the possible increase in population.

Preliminary design of a waste to energy plant of municipal solid waste

The parameters that constitute the starting point of the sizing are the initial amount of MSW disposed G_o and the lower calorific H_{io} rediscounting over the previous year and, given that the disposal service must always be guaranteed in every period, it is evident that the values of the quantities taken at the base of the design are those for which the product is maximum.

Preliminary design of a waste to energy plant of municipal solid waste

Alongside the actual measurements of the quantities characterizing the situation qualitative and quantitative MSW have to take into consideration the changes in these quantities in the following years; for this purpose it is not considered useful to consider a period of time not more than 20-25 years since the continuous and growing technological development and the maintenance needs and reliability performance of the plants lead obsolescence of the disposal system adopted and thus provide, after this cycle, the need to implement a new industrial realization.

Waste treatment plants

Preliminary design of a waste to energy plant of municipal solid waste

The laws of variation in the quantity of MSW and their calorific value can be derived from the availability of historical data collected in previous years to the period of design or knowledge of statistics from data found in national character. We will consider these data to preserve the generality of the results.

The proposed method is valid for particular applications; for this you can refer to a law of weight variation and annual net calorific value specific.

Another important element is the formulation of the exercise program that best adapts to the needs of users.

Waste treatment plants

<u>Preliminary design of a waste to energy plant of municipal solid waste</u>

It should be borne in mind that one must consider plants with a potential of more than 5 t/day and that exercise programs limited with discontinuous operation are excluded in case you want to equip the furnaces of a energy recovery system, is pre-choosen for the exercise the programs that provide:

- continuous operation of 136 hours per week, between 6 on Monday and 22 on Saturday;
- continuous operation of 168 hours per week, corresponding to a continuous operation 24 hours a day, 7 days a week.

Preliminary design of a waste to energy plant of municipal solid waste

The dimensioning must be conducted according to the choice of an appropriate period of operation that spans a period of time disputed between 20 and 25 years, though, to limit the structures to the origin, may be installed initially a number of lines of incineration less than that resulting from the calculation, however, ensure that the disposal of MSW and then consider appropriate expansions dictated by operational or functional.
If you plan to get a high value of the factor of availability and utilization of the system or single line is a must to make each of them independent of each other and this can be conceived by not serving the same plant system with two or more lines simultaneously (for example power system, ash handling, conveying, cooling and exhaust fumes etc.).

Waste treatment plants

Preliminary design of a waste to energy plant of municipal solid waste

If they are given the variables that characterize the receptivity, the operation and management of the incineration and established a priori choice of the land and its location, right-sizing, which involves the identification of the number and potential of the ovens is directly affected by the potential of finding or less of the areas to be used for controlled discharge during periods of suspension of service for scheduled maintenance or for extraordinary events of an incineration line, the stop will not affect the operation of the other being between their constructively independent.

Preliminary design of a waste to energy plant of municipal solid waste

This difference is not to affect the proportions of the essential components for the storage of waste; the receiving pit has a volume that must be sufficient to contain the MSW during 3-6 days in order to allow a range of operation of 72-144 hours. This value must be considered the maximum allowed for the structures of the plant, but mainly influences the number of lines, the proportioning of single line and exercise programs.

The viability, even if for a limited period, a landfill is conditioned by the availability of areas with characteristics appropriate and adequate dislocation compared to urban centers.

Waste treatment plants

Preliminary design of a waste to energy plant of municipal solid waste

The main criteria that are used to assess the feasibility of a landfill, are based on the choices locations, linked to the nature of the terrain and the local flora, the geological, hydrological and meteorological or constitute a technical choice that the developer intends to do on the basis of special environmental policies, organizational and economic. This is impossible to make use of a control or landfill disposal of an alternative system, where hijack the quantity of excess waste, is a must size the system so as to ensure the incineration during the period of maintenance and recovery of a line.

Preliminary design of a waste to energy plant of municipal solid waste

The two proceedings in the two cases differ and it is good to analyze the peculiar diversity:

a) sizing with the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

The starting point expresses the condition of a complete disposal of MSW at full regime, therefore, it must be ascertained, in the several years, that the disposal capacity obtainable must be greater than or equal to the amount of MSW by burn:

$$P \cdot T \cdot D \cdot L \geq G \cdot n$$

where:

P = potential real of disposal of a combustion line (kg/s)

<u>Preliminary design of a waste to energy plant of municipal solid waste</u>

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a) sizing with the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

$$P \cdot T \cdot D \cdot L \geq G \cdot n$$

where: P = potential real of disposal of a combustion line (kg/s) defined by:

$$P = \frac{C_{s,\max} \cdot V_c}{H_i}$$

$C_{s,max}$ = specific maximum thermal load (kW/m^3); V_c = volume of the combustion chamber (m^3); H_i = lower heating value of MSW (kJ/kg); T = nominal time of operation (s); D = factor of plant availability; L = number of lines of incineration; G = amount of MSW entering the plant daily (kg); n = number of days of the service of collection of MSW per week.

Preliminary design of a waste to energy plant of municipal solid waste

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a) sizing with the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

   Given the number of years that must be guaranteed the disposal, the report of the potential real disposal P allows to determine a range of solutions relating to the number of lines, their potential and the consequent volume of the combustion chamber, corresponding to the different organizational choices , managerial and structural.

Preliminary design of a waste to energy plant of municipal solid waste

The two proceedings in the two cases differ and it is good to analyze the peculiar diversity:

a) sizing with the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

   Note the characteristic variables of input: initial amount of MSW (G_o), lower calorific initial (I), annual change in weight percentage (ΔG), annual change in calorific value (ΔH_i), plant availability factor D, heat capacity specific maximum oven $C_{s,max}$, number of years of operation a, the number of lines L (1 to 4, to the maximum as is preferable in large urban decentralize plants in different areas to reduce the cost of collection and transport of RSU) and nominal time of year (136 or 168 hours/week), the criterion currency various solutions technically acceptable.

Preliminary design of a waste to energy plant of municipal solid waste

The two proceedings in the two cases differ and it is good to analyze the peculiar diversity:

a) sizing with the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

   Given the impossibility of having a continuous series of potentiality of the incineration lines, you must first plot the values obtained from the calculation to those immediately above the detectable ranges ovens products from various manufacturing companies. A decisive step in choosing plant is the assessment of the economic solution among those considered, that determines the lower specific cost of incineration; this can be known to determine that they are the total costs of the various plants and, consequently, the specific costs relating to the treated material.

Preliminary design of a waste to energy plant of municipal solid waste

The two proceedings in the two cases differ and it is good to analyze the peculiar diversity:

a) sizing with the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

   The latter are a function of the following parameters:

   - cost of building works, which is determined by evaluating the space requirements of the various types of buildings and applying the current unit prices; then the costs are increased by 15% to take account of the costs for the landscaping and the expropriation of the land;
   - cost of mechanical constructions, which is calculated by adding the partial costs of the various equipment constituting the equipment of the plant, including the costs of transport and assembly;

Preliminary design of a waste to energy plant of municipal solid waste

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a) sizing with the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

   The latter are a function of the following parameters:

   - annual cost of operating, which is calculated taking into account the personnel concerned, consumption and the effects of annual maintenance. These costs may be increased by 10% to take account of an average share of overhead costs (i.e. the cost of transport to the landfill of incinerator ash). The passage from the operating condition of 136 to that of 168 hours/week is to affect the extent of an increase of 17% of the annual cost of operation, since it is linked to a greater exploitation of the structures and operating cost;

Waste treatment plants

Preliminary design of a waste to energy plant of municipal solid waste

The two proceedings in the two cases differ and it is good to analyze the peculiar diversity:

a) sizing with the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

   The latter are a function of the following parameters:

   - financial amortization, which is calculated in 33 years for the building works and 10 years for those of electromechanical equipment;
   - total annual cost, which is calculated as the sum of the annual financial amortization and the annual cost of operation;
   - total annual net cost, which is determined by reducing the total annual cost of revenues related to the recovery such that heat.

Waste treatment plants

Preliminary design of a waste to energy plant of municipal solid waste

The two proceedings in the two cases differ and it is good to analyze the peculiar diversity:

a) sizing with the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

   Carried out the choice of the plant, the most economically advantageous tender, also coinciding to significant financial commitment that we encounter in the immediate construction of the chosen and the low value of the coefficient of utilization in the first few years of operation, it is appropriate to assess the most appropriate exercise program system in order to ensure the disposal at minimum cost;

Preliminary design of a waste to energy plant of municipal solid waste

The two proceedings in the two cases differ and it is good to analyze the peculiar diversity:

b) sizing without the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

The criterion is to be taken whenever the urban fabric or provincial, concerned by the disposal, does not give the possibility of finding the appropriate areas to be used occasionally as a landfill in the periods of scheduled maintenance of the incineration lines or in the stop periods for events occasional.

Preliminary design of a waste to energy plant of municipal solid waste

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b) sizing without the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

This choice, which may have technical reasons, organizational or economic, implies the adoption of plant structures that provide for a number of lines of combustion greater than or equal to 2, so as to provide, during the exercise period, in addition to the maintenance in rotation of the individual lines for a predetermined period, also the complete disposal, with the remaining ones, the amount of waste discharged into ditches of reception, less than a guaranteed accumulation of the same.

Preliminary design of a waste to energy plant of municipal solid waste

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b) sizing without the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

They are commensurate with a capacity such as to be sufficient to be able to contain the MSW collected during 3 or 6 days, so that on average is:

$$V_f \cdot \gamma = (3 \div 6) \cdot G_A$$

where:

V_f = volume of the ditches of reception (m^3);

γ = specific weight of the partially compacted waste present in the pits (300÷350 kg/m^3);

G_A = amount of waste entering the plant per day (kg).

Preliminary design of a waste to energy plant of municipal solid waste

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b) sizing without the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

The report that express the number of weeks N_r necessary to filling, up to saturation, of the tanks of reception, initially empty, as a function of the operating conditions of exercise, where it carries out the stop of a line of maintenance, it is:

$$N_r = \frac{V_f \cdot \gamma}{G \cdot n - P \cdot T \cdot D \cdot (L-1)}$$

having the sizes the same meaning as in previous reports.

Preliminary design of a waste to energy plant of municipal solid waste

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b) sizing without the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

The value Nr detected in the aforesaid operating conditions must be at all times greater than or at least equal to the time required for proper action Maintenance of a combustion line Nm, detectable by the statistical data encountered in the performance of similar plants. It is should be specified that the maintenance taken as a basis of the considerations concerning the replacement of refractory combustion chambers or ducts conveying fumes and mechanical parts which transported the ash, which require a periodicity of intervention under 5 years.

Waste treatment plants

Preliminary design of a waste to energy plant of municipal solid waste

The two proceedings in the two cases differ and it is good to analyze the peculiar diversity:

b) sizing without the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

The starting point, notes that are the magnitudes qualitative and quantitative of waste, the technical data of the system, the times nominal operating and the number of years of management, is made of the quantity occurred was weekly incoming and potential disposal guaranteed by the L-1 lines, having assumed the remaining stops for maintenance. This is therefore the relationship:

$$P \cdot T \cdot D \cdot (L-1) \geq G \cdot n$$

Preliminary design of a waste to energy plant of municipal solid waste

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b) sizing without the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

Allows to detect the potentiality of the incinerator and the volume of the combustion chamber.

Note these magnitudes, one can estimate, based on the statistical values of exercise, the value of the number of weeks of maintenance N_m necessary to restore the functionality of the combustion line of that determined potential.

Preliminary design of a waste to energy plant of municipal solid waste

The two proceedings in the two cases differ and it is good to analyze the peculiar diversity:

b) sizing without the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

An examination of the relationship is established that the number of weeks needed to fill the tanks from waste is unlimited, so it's inequality :

$$N_r \geq N_m$$

indeed the potential measured is higher than that actually required.

Preliminary design of a waste to energy plant of municipal solid waste

The two proceedings in the two cases differ and it is good to analyze the peculiar diversity:

b) sizing without the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

A series of successive approximations with systematic reduction of the potential of the line provides the actual value of the potential of the oven, which satisfies the condition of disposal previously defined.

Given the different operating conditions and management, the process determines a set of solutions, all technically adoptable, whose values should be reported initially to those obtained from commercially existing ranges of ovens and only then apply appropriate choice of cost-effective solution.

Preliminary design of a waste to energy plant of municipal solid waste

The two proceedings in the two cases differ and it is good to analyze the peculiar diversity:

b) sizing without the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

It is can at this point to assess the most appropriate realization of the works and consequently exercise the programs, so as to satisfy the relation $N_r \geq N_m$ or more simply verify that the saturation index S at that given moment the operating result in greater absolute value of the index saturation limit S_{limite} corresponding to the last year of operation and defined by:

$$S_{\lim ite} = \frac{G \cdot n - P \cdot T \cdot D \cdot L}{G \cdot n}$$

Preliminary design of a waste to energy plant of municipal solid waste

The two proceedings in the two cases differ and it is good to analyze the peculiar diversity:

b) sizing without the possibility of controlled discharge during periods of scheduled maintenance or during stops for extraordinary events

   The latter values are important because they can give indications, at any time, about what is the incineration capacity of the system and assume the possibility of future disposal notes that it is the quality and quantity of MSW.

<u>Other systems of treatment of solid waste</u>

Among these treatment systems, although limited in number or in testing phase, are found:

a) pyrolysis

It is a transformation process at temperatures between 400-600°C or higher in the presence of limited amount of air of the organic fraction in CO_2, H_20, and the various compounds was reduced both volatile ($CO + CH_4 + C_xH_y + NH_3$), which solid.

It is a process of physical-chemical decomposition of organic materials in the waste, which occurs in the absence of oxidizing agents.

Waste treatment plants

Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

a) pyrolysis

The percentage of each phase, that generates:

- char: Solid product (coal, tarry residues), which is then gasified and has a lower calorific value averaged and 6000 kJ/kg;
- tar: liquid product for condensation of the steam. This residue is generated in an amount of 50-60% by weight on the total, and has a lower calorific value on average between 2500 and 4500 kJ/kg;
- fuel gas: CO, CO_2 and tracks H_2 in variable percentages depending on the temperature of pyrolysis in an amount of 15-30% by weight of the organic matter present. Its calorific value is assumed to be 3000 kJ/m^3;

varies as the temperature changes and the speed of the process.

Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

a) pyrolysis

It operates at high temperature, but in lack of oxygen, in order to determine the thermal cracking of organic substances or breakage of the more complex organic molecules up to produce simpler molecules to the state of gas or liquid, depending on the operating temperature, leaving a solid residue. All these residues are in the reduced state or with the presence of molecules susceptible to oxidation (carbon in addition to the inorganic fractions of rejection.

The pyrolysis reactions are endothermic. The heat required and the subsequent recovery of energy is implemented through the subsequent combustion of the products of pyrolysis.

Waste treatment plants

Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

The gasification is a thermochemical conversion process, in the presence of a gasifying agent, of a liquid or a solid containing carbon in a fuel gas called syngas and ash.

The gas thus obtained is composed ofCO_2, CO, H_2, CH_4, H_2O, and other heavier hydrocarbons. It is the latter, such as oils present in vapor form, may create problems in the use of the gas generator, especially in systems with gas turbine and internal combustion engines.

Waste treatment plants

<u>Other systems of treatment of solid waste</u>

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

The process of gasification of the organic waste is :

$$C+\frac{1}{2}O_2 \rightarrow CO \quad C+O_2 \rightarrow CO_2 \quad 2C_xH_y+\left(2x+\frac{y}{2}\right)O_2 \rightarrow 2xCO+H_2 + \text{ heat (exothermic)}$$

if the gasification agent is oxygen you have :

$$C+CO_2 \rightarrow 2CO - \text{ heat (endothermic)}$$

$$C+H_2O \rightarrow H_2+2CO \quad C_x+H_2O \rightarrow \left(2x+\frac{y}{2}\right)H_2 \rightarrow xCO_2 - \text{ heat (endothermic)}$$

Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

Identify the following operational areas:

- drying zone, in which are dried the waste into fedding, to work of the pyrolysis gases, before reaching the zone of pyrolysis real. Overlying this area is a section of the furnace kept full of solid waste to prevent the ingress of air from the outside;
- pyrolysis zone, which is traversed by the hot fumes produced by the underlying combustion zone. The set temperature will implement transformations pyrolysis of waste, with separation of a fuel gas (hydrogen and light hydrocarbons) maintaining the solid phase fixed carbon;

Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

Identify the following operational areas:

- gasification zone, carried out at a higher temperature and in the presence of oxygen (adduct through the so called "gasifying agent"), the fixed carbon reacts giving rise to carbon monoxide (gasification process). The gasification takes place in the absence of oxygen, because, in the presence of sufficient amount of O_2 would further oxidation of CO a CO_2 and H_2 in H_2O (combustion), releasing the chemical energy of the gas in the form of heat (exothermic reaction).

Waste treatment plants

<u>Other systems of treatment of solid waste</u>

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

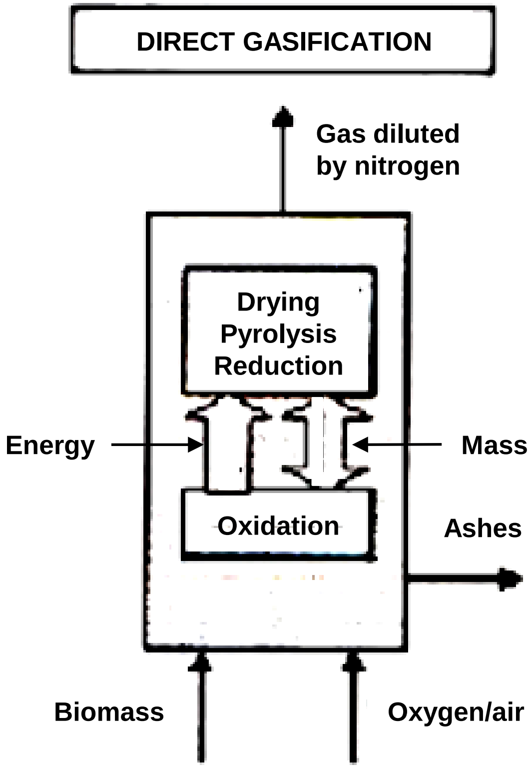
In the gasifier operating in the absence of oxygen and then formed limited quantities of CO_2. The drying and pyrolysis processes are endothermic, while the total gasification is exothermic and the heat needed to supply the initial stages of the process (endothermic) comes from the reaction of partial combustion that characterizes the final gasification. The nature of the gasifying agent also determines the type of process. In fact, if the gasifying agent is also an oxidizing agent one has the direct gasification and in this case the partial oxidation of the organic mass (between 12 and 30%) provides the energy for the conversion of the remaining part of the waste.

Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

The typical gasifying agent to the gasification direct (Figure) is air, although there are applications that use pure oxygen.

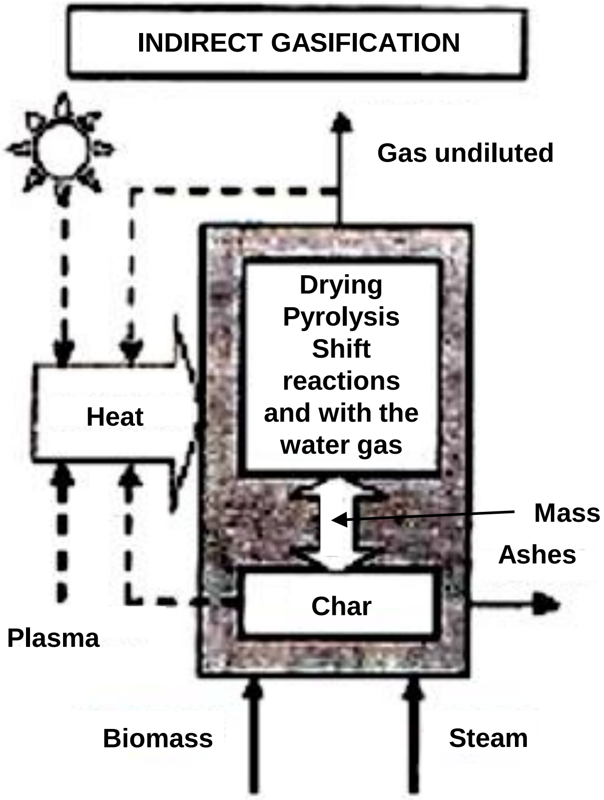


Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

If the gasifying agent contains no oxygen, the process requires an external power source and is called indirect gasification (Figure); in this case, the gasifying agent is generally steam, both for the high volume and to the increase which entails the fraction of hydrogen gas.



Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

The main advantage of indirect gasification, also common to the gasification directed to pure oxygen, is that the product gas is not diluted by nitrogen contained in the air, for which the calorific value of the syngas is therefore equal to 15 MJ/Nm^3 against a value 5.5 MJ/Nm^3 for direct gasification. The sucked gases from the reactor are subjected to combustion to implement the recovery of energy as superheated steam to produce electricity. Alternatively, the gas may be intended for industrial users outside.

Waste treatment plants

<u>Other systems of treatment of solid waste</u>

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

The plant should include the reactor for the production of the gas and the system for energy recovery. However not always the gas can be used by technologies can be quite delicate as gas turbines or internal combustion engines. To improve the characteristics of the fuel gas leaving the reactor, it is subjected to special pretreatments and technology of use of the gas.

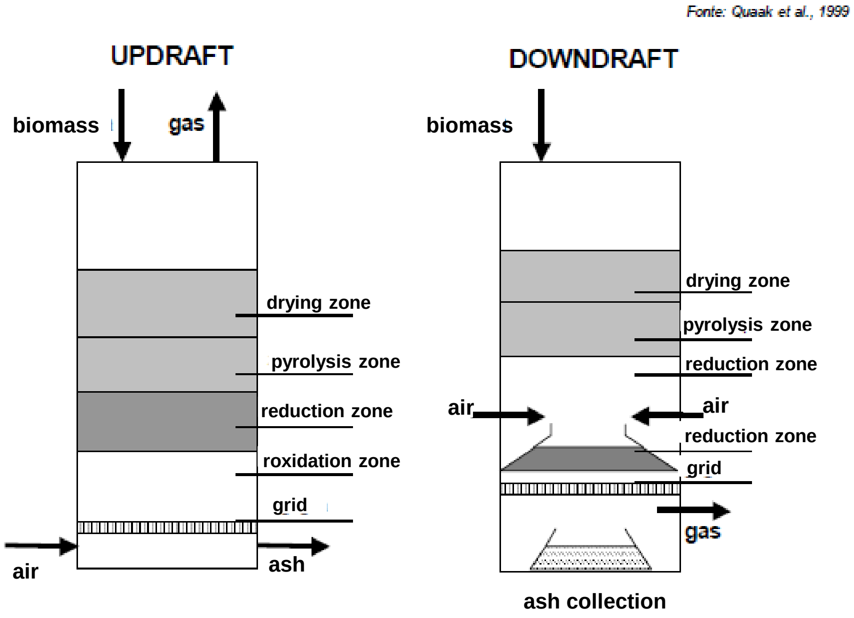
Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

The gasification reactors are normally divided into three categories: fixed bed, fluidised bed and indirect gasifier.

The fixed bed reactors can be classified based on the orientation of the body of the chamber of gasification in: horizontal fixed bed - HFB and vertical fixed bed - VFB - (Figure)



Waste treatment plants

<u>Other systems of treatment of solid waste</u>

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

The reactors of the type indicated updraft are the simplest and are also called "countercurrent", because in them the waste are loaded from above and moves downwards, while the product gas back in countercurrent to be taken in the upper part of the reactor . The solid passes through from top to bottom four different well-defined zones where it is subjected respectively to drying, pyrolysis, reduction and oxidation (as indicated in the Figure above). In this area you can reach the higher temperatures around 1200°C.

Waste treatment plants

Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

The inert solid residue (ash) is withdrawn below the grid and removed. This arrangement means that the tar produced in the pyrolysis is carried away by the upward flow and then is found in large quantities in the gas; on the contrary the thermal exchanges between the various zones are extremely efficient.

Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

In reactors downdraft the solid waste and the gases travel the same route from the top down. The areas in which the various reactions occurring take on a slightly different shape from the reactors updraft. In this way, all the gas produced through the oxidation zone by implementing an effective thermal cracking of tar, while the exchanges of heat, however, are less effective as due only to the convective motions. Often to emphasize the cracking of tar is performed, in correspondence of the oxidation zone, a restriction of the section of the reactor.

Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

The fluidized bed reactors are characterized by a bed of inert (silica sand), which is made similar to a fluid by placing the bottom of a gas at high speed (gasifying agent). Such systems have been developed to overcome two major limitations of fixed-bed gasifiers related to the inability to treat materials with large ash content and the low specific capacity, which limits the large-scale application. Other consequences are related to the large thermal inertia provided by the bed of inert and implemented by the agent to the vigorous mixing of gasification.

Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

The fluidized bed reactors are divided into Bubbling Fluidised Bed (BFB) and Circulating Fluidised Bed (CFB). In BFB gasifiers the gasifying agent is the speed between 1-3 m/s; this speed does not allow the expansion of the bed throughout the useful volume of the reactor, and this prevents the leakage of inert gas in the product, but slightly limits the specific capacity. In the case of CFB speed is about 5-10 m/s; This allows you to use all the reactor, but because the escape of inert ash and not treated along with the syngas.

Waste treatment plants

Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

To contain this escape and encourage the full treatment of the ashes, there is a high efficiency cyclone that recirculates in the lower part of the reactor the solid fraction contained in the gas. The main beneficial effects, aimed at increasing the reactivity of the fuel, are: increased retention time of "char", mechanical disruption by means of the energetic mixing, combustion of ash recirculated, which already been treated by the process of gasification in the upper part of the reactor.

Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

b) gasification

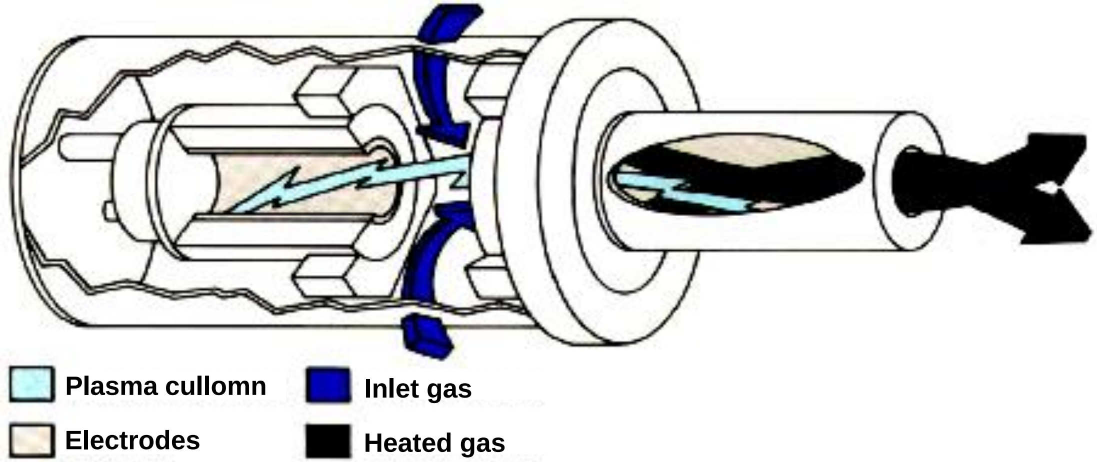
The process of indirect gasification, which employs the plasma torches in order to feed the chemical reaction energy of disintegration thermal characteristic takes the name of "plasma gasification" and is often referred to by the acronym PPV (Plasma Pyrolysis and Vitrification). The plasma is generated by special devices called "torches" and substantially consists of an ionized gas at high temperature and characterized by a high energy density. The application of the plasma torch waste allows to generate a reaction zone where the temperature is between 3000 and 4000°C.

Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

c) application of the plasma torch

In the case of waste treatment, the plasma is created by ionizing the air through an electrical discharge between two electrodes. In this way it is thus able to create in the reactor in which is situated the torch a zone at very high temperature (about 4000°C) in almost total absence of air (Figure)



Other systems of treatment of solid waste

Among these treatment systems, although limited in number or in testing phase, are found:

c) application of the plasma torch

Combustion processes do not occur, but the plasma "atomizes" the molecules of the substances introduced into simple products such as N_2, H_2, CO, CO_2, CH_4 and HCl.

There is no emission of toxic gases or fly ash containing heavy metals.

Organic compounds produce combustible gases, inorganic ones are melted and cooled-vitrified in a totally inert material.

It is ideal for the treatment of toxic waste.

Waste treatment plants

Solid waste landfill

The **landfill site of waste** is a device designed to deposit in a non-selected (the undifferentiated is absolutely avoided) solid waste and all waste from human activities (such as construction debris, industrial waste etc.), Who has not willing or able to recycle, send to the mechanical-biological treatment to produce energy through bio-oxidation to, gasify or burn and use as fuel in incinerators or waste to energy plants.

Waste treatment plants

Solid waste landfill

The Italian legislation with Legislative Decree no. 36/2003 transposing Directive 99/31/CE, which provides three different types of landfill:

- landfill for inert waste (e.g. construction debris);
- landfill for non-hazardous (e.g. MSW);
- landfill for hazardous waste (e.g. ash from incineration).

Waste treatment plants

Solid waste landfill

Once taken to the landfill, the solid residues are buried and this can be considered a method of recovery of abandoned land.

Any system of waste disposal can not be separated from the integration with a sanitary landfill (e.g. incinerator ash, waste from street cleaning, scrap stranded etc.).

The extent and type of work of setting the place of unloading depend on the composition and compacting the waste and the nature of the area.

The legislation defines the surveillance and control with the necessary chemical parameters, chemical-physical, hydrological, meteorological and topographical be determined periodically with a fixed frequency of measurements.

Waste treatment plants

<u>Solid waste landfill</u>

The European Union with Directive 99/31/CE established that the landfill must be conveyed only materials with low organic carbon content and non-recyclable materials, giving priority to the recovery of materials (recycling and composting).

The MSW, the special waste similar to urban and non-hazardous sludges are placed in landfills first class must:

- avoid any damage or danger to the health, safety, welfare and safety of the community;
- ensure compliance with the sanitation needs and avoid any risk of pollution of air, water, soil and subsoil, and any inconvenience caused by noise or odors;
- preserve the fauna and flora and to avoid any degradation of the environment and landscape;
- respect the demands of economic planning and territorial.

Waste treatment plants

Solid waste landfill

The main requirements to be considered for the choice of the area to be used as a landfill plant are (Figure):

- il territorio deve essere il più vicino possibile alla zona di raccolta, in posizione baricentrica, e nel caso di più zone deve essere spostata verso quella dalla quale proviene la maggior parte dei rifiuti (utilizzo del triangolo ubicazionale);

Waste treatment plants

Solid waste landfill

The main requirements to be considered for the choice of the area to be used as a landfill plant are:

- the ground chosen will be easily accessible with a suitable roads passable in all weather conditions by an adequate number of vehicles. The approach routes to the landfill should be such as to minimize disturbance to the centers crossed. The area should be equipped with appropriate parking areas;
- landfills, where there are machining unhealthy, are kept away from population centers or industrial areas. The minimum distance prescribed by the World Health Organization is 200 m from a residential area, but generally must be at least 500 m;

Waste treatment plants

Solid waste landfill

The main requirements to be considered for the choice of the area to be used as a landfill plant are:

- landfill should not be located in the area declared in the General Plan Municipal area as residential or industrial;
- are suitable land of little agricultural value, unproductive, degraded or unhealthy;
- the areas chosen must be stable or potentially compressible or costipabili after verification that the predicted settlements also due to overloading of the waste do not cause damage to the works;
- are suitable abandoned quarries of sand, gravel, clay etc. The choice is always subject to the execution geological, geomorphological, hydrological, climatic and hydrochemical;
- the area must be used for a period of at least 10-15 years.

Waste treatment plants

Solid waste landfill

The location of a landfill must take into account the geological conditions of the land chosen and the availability of communications infrastructure. Must be implemented in fixed installations (warehouses, offices, weighing and washing plant of vehicles etc.) and acquired of machines for the handling of the materials of coating or constipation waste.

You must do the preliminary investigation of an urban planning, natural, geological, hydrogeological and geotechnical site allocation of future landfill. In fact, you must respect the geological constraints, the landscape protection or nature, proximity to floodplains of streams or rivers, shores of lakes, residential areas and major communication routes, airports, supply points hydro-drinking, existence of risk seismic, karst or active volcanic and geologically unstable soils.

Waste treatment plants

Solid waste landfill

The geological survey, hydrogeological and geothermal must evaluate the nature and the characteristics of permeability of the soil, the thickness of the soil and/or the nature and thickness in different permeability, the water retention capacity and cation exchange, the location of aquifers, the flow direction of the flap, the bearing capacity of the soil and the stability of embankments.

The survey hydrographic, hydrological and meteorological must assess the situation hydrographic and hydrologic surface neighboring areas (possibility of interaction of the landfill with water bodies such as infiltration and runoff, possibility of flooding or periodic flooding within the area considered, the availability of an address for storm water and leachate after purification), the data of rainfall (average annual intensity and distribution of monthly precipitation, number of rainy days of the wettest months, heavy rains of short duration) and the direction and intensity winds (estimated risk of spread of strong smelling gases).

Solid waste landfill

The survey on urban aspects, landscape and nature must judge the distance of the nearest houses, the access road and the preservation of natural features from the effects arising from environmental impacts.

In addition to the investment costs due to the purchase of the land to which you must deduct the residual value at the end of the filling of the landfill, to works and equipment, costs of study and investigation on the ground, you should consider the costs such as energy costs to run the machines and the area, personnel and monitoring, retrieval of inert material coverage, disinfectants, derattizzanti etc., the final accommodation and contributions, insurance and administrative costs.

The landfill must be designed, built and operated so that the leachate does not cause pollution of surface water and groundwater groundwater.

Waste treatment plants

Solid waste landfill

In the case in which the uses of artificial materials for making waterproof the landfills, should have the following conditions:ioni:

- the thickness and the strength characteristics of the artificial waterproofed materials must be such as to prevent discharge of the percolate from the bottom and sides of the same;
- the bottom of the landfill must be above the level of maximum excursion of the aquifer, with a clearance of at least 1.5 m;
- the mantle waterproofed artificial material must be adequately protected from the weather and the risk of damage during construction and operation and in any case placed on a layer of soil with permeability ≤ 10 cm/s and a thickness of 0.1 m;

Waste treatment plants

Solid waste landfill

In the case in which the uses of artificial materials for making waterproof the landfills, should have the following conditions:ioni:

- must be taken of drainage systems and leachate collection such that any discharge must respect the limits of accessibility of Legislative Decree no. May 11, 1999, n. 152. These systems and any leachate treatment plant will be kept in operation even after the closure of the landfill and at the expense of the operator for a period specified by the competent Authority.

Solid waste landfill

The plant must be equipped with devices for collecting and recovery of biogas. If not practicable the use of tapped biogas energy, the same must be burned on the spot with torches running lights (Figure).

Waste treatment plants

<u>Solid waste landfill</u>

Only for small landfills, the competent Authority may authorize the free dispersion in the atmosphere as long as they found that the latter does not cause danger to human health or the environment and does not cause trouble. In fact, the effects on the environment are bad smell (mercaptans and volatile acids), danger of fire and explosion (concentration limit 5 to 15%), health risks (carbon dioxide), damage on vegetation (asphyxiation root zone), pollution of groundwater (solubility components) and effects on the climate (greenhouse effect of methane and other gases).

You must include the demolition condensate (traps at low points of the pipeline, silica gel), particulate abatement (traps filled with gravel, filtration ceramic filters in candle or similar) and the removal of CO_2 (absorption in water under pressure, chemical absorption, adsorption on active carbon, alumina, molecular sieves)

Waste treatment plants

Solid waste landfill

The reuse of the biogas provides for the use as fuel in boilers or internal combustion engines (figure), the production of electricity and/or heat through cogeneration systems, the actuation of gas engines couplant to mechanical loads or cogenerated, the use as domestic gas and use as fuel for vehicles.

Waste treatment plants

Solid waste landfill

It is important to enable an effective and efficient environmental monitoring system with the purpose to follow the time evolution of the quality level of the environments concerned with the effects of the landfill.

It is advisable to install a monitoring network, prior to the start of the deposition of waste, the quality of water bodies and the air inside and outside the landfill. It must:

- prevent the pollution and implement interventions warranty;
- provide a correct interpretation of environmental impacts;
- provide information to the populations of environmental quality and to demonstrate that the disposal of waste can be environmentally sustainable;
- provide guidance for subsequent monitoring network.

Waste treatment plants

Solid waste landfill

The network of monitoring the roll out of the landfill and after topping must perform:

- monitoring of groundwater and surface water (analysis of temperature, pH, alkalinity, electrical conductivity, BOD, COD, nitrogen, dry residue, metals, salinity);

  The biochemical oxygen demand BOD (Biochemical Oxygen Demand) is an indirect measure of the content of biodegradable organic matter present in a water sample. It is used to estimate the overall quality of water and its degree of pollution and is a parameter used in the management of water quality and purification. It is often used as a measurement parameter for evaluating the efficiency for the installations of wastewater treatment.

  The chemical oxygen demand COD (Chemical Oxygen Demand), expressed in mg O2 per liter, representing the amount of oxygen required for the complete oxidation of organic and inorganic compounds present in a water sample. Is an index that measures the degree of water pollution from oxidizable substances, mainly organic. Italian law allows discharging sewage systems of water whose COD is not more than 500 mg/liter, otherwise it must be previously treated. To discharge into surface waters (rivers etc.) The permitted limit is 160 mg/liter.

Waste treatment plants

Solid waste landfill

The network of monitoring the roll out of the landfill and after topping must perform:

- air monitoring (methane concentration in the atmosphere and in the overlay final waste, concentration specific volatile compounds, aerial thermography to detect emissions of biogas, electrical resistivity to identify biogas in depth, index of the overall effect of the environmental bad smell);
- monitoring settling landfill waste;
- monitoring weather conditions;
- monitoring time evolution of the quality of waste in landfills;
- monitoring biological indicators of ecosystem next to the landfill.

Waste treatment plants

Solid waste landfill

The collection devices, recovery and combustion of biogas (Figure) must be kept in operation even after the closure of the landfill for a period specified by the competent Authority.

Waste treatment plants

<u>Solid waste landfill</u>

The landfill shall be conducted in a manner and with technical means such as:

- limit the area of waste exposed to the elements;
- proceed by overlapping layers and compacted to a limited extent for promoting recovery gradual and immediate area used to landfill;
- provide for the daily cover of waste with a layer of protective material of appropriate characteristics and thickness.

Waste treatment plants

Solid waste landfill

It is required to make adequate pest control operations such as not to inhibit or delay the cycle of mineralization of organic matter present in the waste.
It is forbidden to burn wastes landfilled and perform a manual selection of the same.
In the exercise period, the rainwater must be removed from the perimeter of the landfill through the appropriate ducts depending on the intensity of the rains in the last 10 years.
The landfill shall be equipped with appropriate systems and fire trucks and a fence high enough to prevent access to unauthorized persons or animals, prevents the dispersion of waste outside, controls access to the landfill and prevents abusive collection of materials.

Waste treatment plants

Solid waste landfill

Completed the spillage of waste, should be carried out the final covering with waterproof materials of adequate thickness to prevent the infiltration of rainwater.

The plan of arrangement and recovery of the area must provide for the use of the area taking into account the phenomena of settling of waste, the formation of leachate and the need to encourage the flow of rainwater.

It is mandatory use of registers loading and unloading of waste.

Waste treatment plants

Solid waste landfill

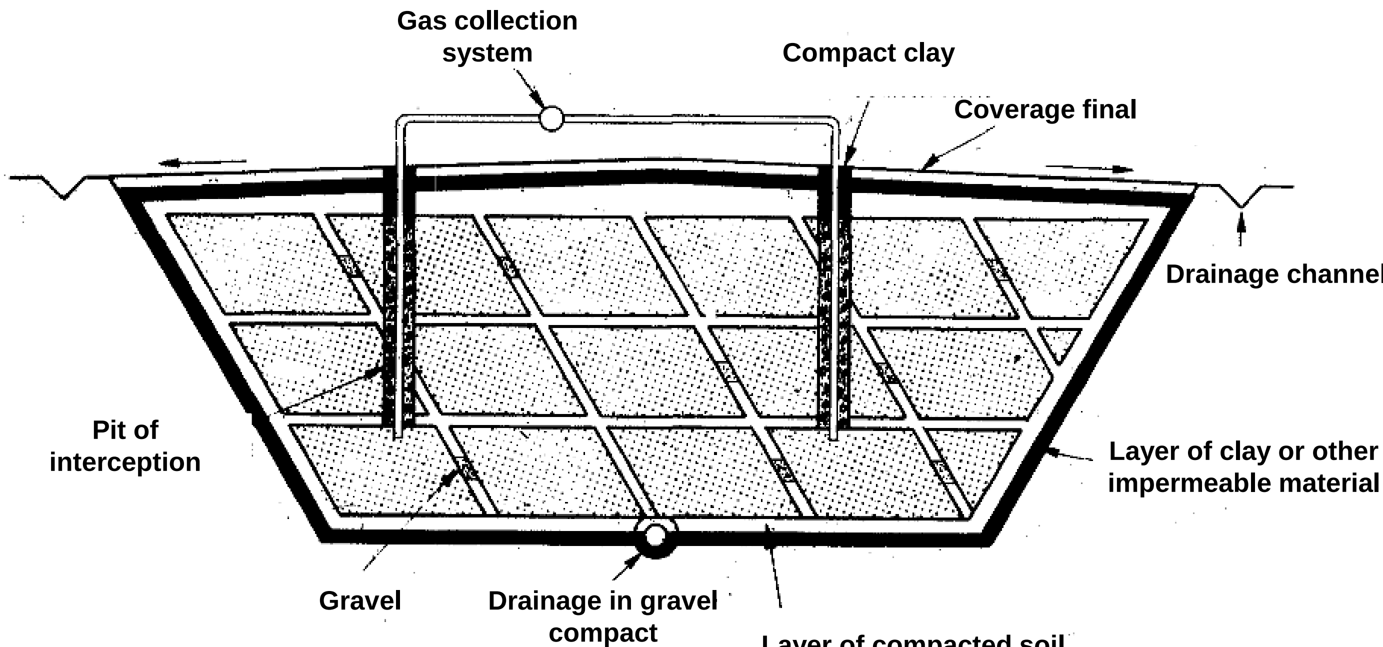
The landfill can be filled according to the::

a) method of exhaust for compartments or trenches

Solid waste landfill

The landfill can be filled according to the::

a) method of exhaust for compartments or trenches



Waste treatment plants

Solid waste landfill

The landfill can be filled according to the::

a) method of exhaust for compartments or trenches

The compartment to place the waste can be dug or raised. In the first case, the excavated material is stored in proximity to then be used to build the levees side, while in the second case they build three dikes side with inert material.

It is suitable for flat land and environmental recovery of depressed areas or abandoned quarries.

The filling is carried out by successive layers also for waste source muddy.

Vehicles entering an access ramp (magazine dug) or side remained open (overhead compartment).

<u>Solid waste landfill</u>

The landfill can be filled according to the::

a) method of exhaust for compartments or trenches

When compartment will be filled, is positioned above the roofing material that is not only to the excavation, but also of the other if necessary.

This method allows the use of progressive cell surface available, avoid the front exhaust and provides the roofing material needed. Therefore, when the trench is full you dig another parallel to the first trench, so as to obtain a succession of parallel trenches separated by diaphragms of the natural ground.

Solid waste landfill

The landfill can be filled according to the::

a) method of exhaust for compartments or trenches

There may be two types of trenches:

- **narrow trenches**

Having a maximum length of 3 m, waste deposited in a single layer and covered with excavated material, waste with dry content of at least 25-28% and thickness of the final cover of at least 0.6 m

- **large trenches**

Having a maximum width of 15 m, excavators operating within the trench, the waste with dry content higher than those in the narrow trench so that the machines can move above the waste and increases the dry content can increase the width of the trench

Waste treatment plants

<u>Solid waste landfill</u>

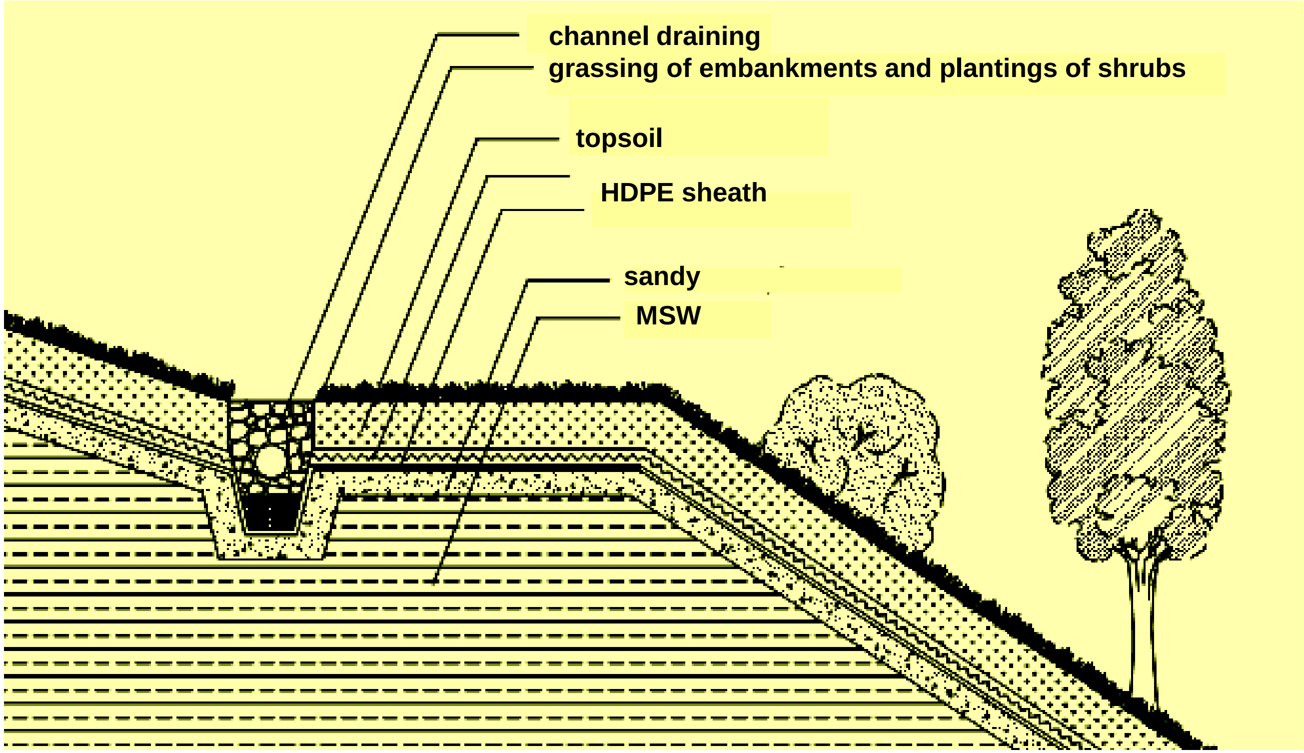
The landfill can be filled according to the::

b) method at layer or surface

Solid waste landfill

The landfill can be filled according to the::

b) method at layer or surface



Solid waste landfill

The landfill can be filled according to the::

b) method at layer or surface

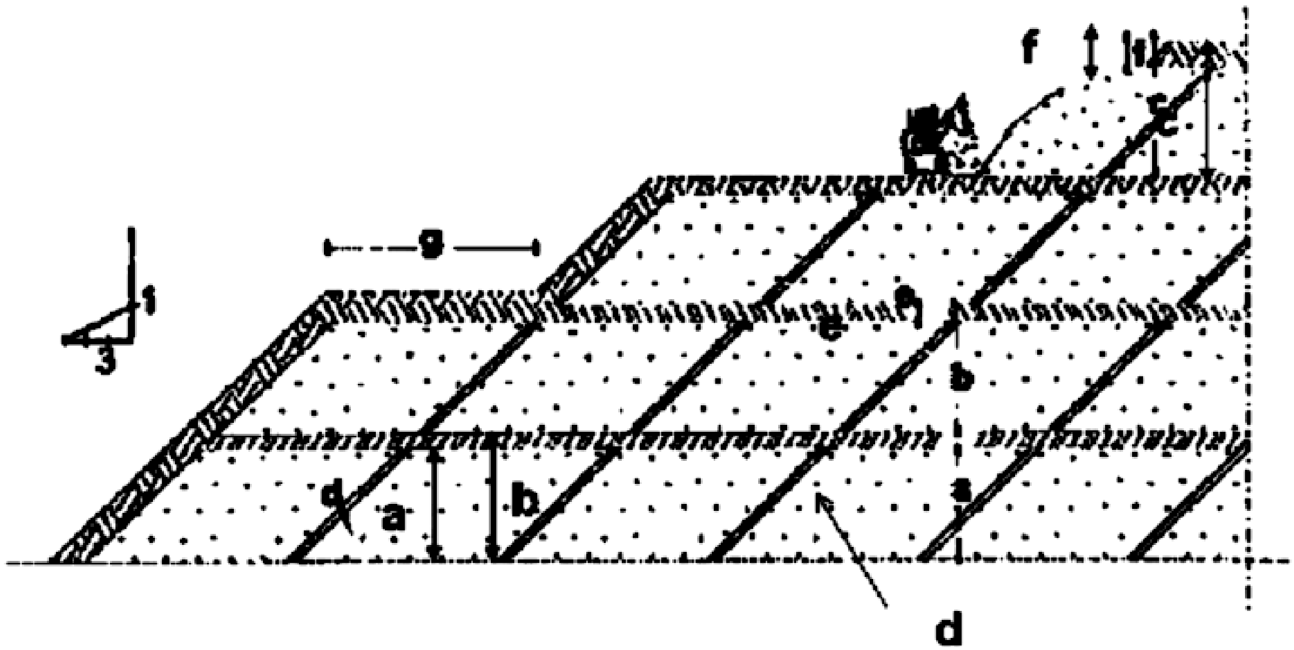
It is suitable when you have an area of lower level than the surrounding land. The waste is dumped on the surface of the landfill and spread on land.

The waste is arranged in layers with a thickness of 2-2.5 me compacted mechanically to prevent the development of aerobic conditions. The layer is then covered with earth or inert material (e.g. earth) taken elsewhere and transported on site by truck. The filling is done in successive layers according to the shape of the terrain and the final settlement expected. Expect a few months before holding with other wastes to avoid the triggering of anaerobic fermentations.

Solid waste landfill

The landfill can be filled according to the::

b) method at layer or surface



a) height of the cell, b) height of layer, c) height of the final layer, d) thick of covering daily, e) think of covering intermediate, f) think of covering final, g) width of the terracing

Solid waste landfill

The landfill can be filled according to the::

b) method at layer or surface

If it is a flat ground, it can be expected a relief in the shape of a hill or plank, while if it is a hollow or a cavity can provide for a progressive filled to obtain a flat ground.

The front exhaust must be in slight slope (30-40°) to prevent erosion of topsoil by water precipitation and the subsequent re-emergence of the waste.

You have difficulty operating in the case of waste so muddy that you use of the dams of restraint.

Waste treatment plants

Solid waste landfill

In addition to the nature of the night chosen and management techniques (flat, trench or depression), differ depending on the treatment of waste:

- **landfill normal without pre-crushing**

  The waste is collected and discharged in the system as they are every day covered with about 0.2 m of inert materials or land;

- **landfill with pre-crushing**

  Before being coated, the waste is shredded that allows a reduction in the volume and the problems related to the rodent control for the presence of a more compact mass;

- **landfill with compaction**

  The waste is first compacted with a press which can be placed in proximity of collection points to reduce the shipping costs.

  The blocks, smooth surface and cubic shape, are stacked before the definitive cover with inert material landfill or land.

Waste treatment plants

<u>Solid waste landfill</u>

Besides having the input of the system of signs of a sign as the hours of opening/closing, allow people to deposit waste, the destination of the future and other information.

If the system works even at night, you must provide for the creation of a lighting system at the entrance and in the streets of internal circulations.

Must be present services for personnel working in the landfill at least for the duration.

At the entrance of the system is a control station to verify the quantitative characteristics of the waste.

Waste treatment plants

Solid waste landfill

As regards the determination of the volume that has to possess the landfill must be known:

- the quantity and quality of waste, which is a function of the population, living standards etc.);
- the density of the waste once placed and compacted in a landfill (300-500 kg/m^3 to 600-700 kg/m^3);
- the ratio between the quantity of waste and that of ground covering, which is generally equal to 1 part of ground for 4-5 parts refusal with a covering factor on average between 1.2 to 1.25;
- depth of the landfill;
- lifetime of the landfill (always greater than 5 years).

Solid waste landfill

The required annual volume V (m^3/year) is:

$$V = \frac{365 \cdot P \cdot Q}{D} \cdot F$$

where:

P = number of inhabitants served;

Q = mount of solid waste disposed per capita per day (kg/inhabitant per day);

D = density of the compacted solid waste (kg/m^3);

F = covering factor.

The surface S used for each year (m^2/year) is the ratio between the required annual volume V and the average depth of the landfill.

The total profit for the years of operation of the same is then increased by 30% to take account of the infrastructure, offices and services.

Solid waste landfill

The overlap of the waste may be indicated depending on the duration of exposure to the atmosphere:

- **daily**

  With an exposure time of a few days is applied and leveled a layer of inert material or earth of about 0.15 m on waste to prevent the phenomena of erosion and water stagnation, isolation from insects and rodents and humidity control the mass of waste;

- **intermediate**

  With an exposure time of less than one year, is spread a blanket of inert material or earth of about 0.3 m which is periodically leveled and compacted if on it passing vehicles. If you feel any bumps or cracks for settlement, you must take action by spreading a new blanket of inert material or earth;

Waste treatment plants

Solid waste landfill

The overlap of the waste may be indicated depending on the duration of exposure to the atmosphere:

- **final**

  With an exposure time of more than a year, is spread a minimum thickness of the covering of topsoil to 0.6 m depending on the use to which the area will be used. It must take account of the landfill bedding, as the 90% final bedding is realized in the first five years and the remainder for longer periods.

Solid waste landfill

The surface should have a slope of 1-2% to facilitate the flow of water, while that of the side embankments must be less than the 1:3 ratio to avoid subsidence.

You can not recover the air for building, while you can use to:

- **green space**

  The landfill must be slightly sloping to allow natural drainage. Overburden final consists of sterile material and humus;

- **reforestation**

  The landfill must have a slope of 1-3%. The cover is made of earth and topsoil;

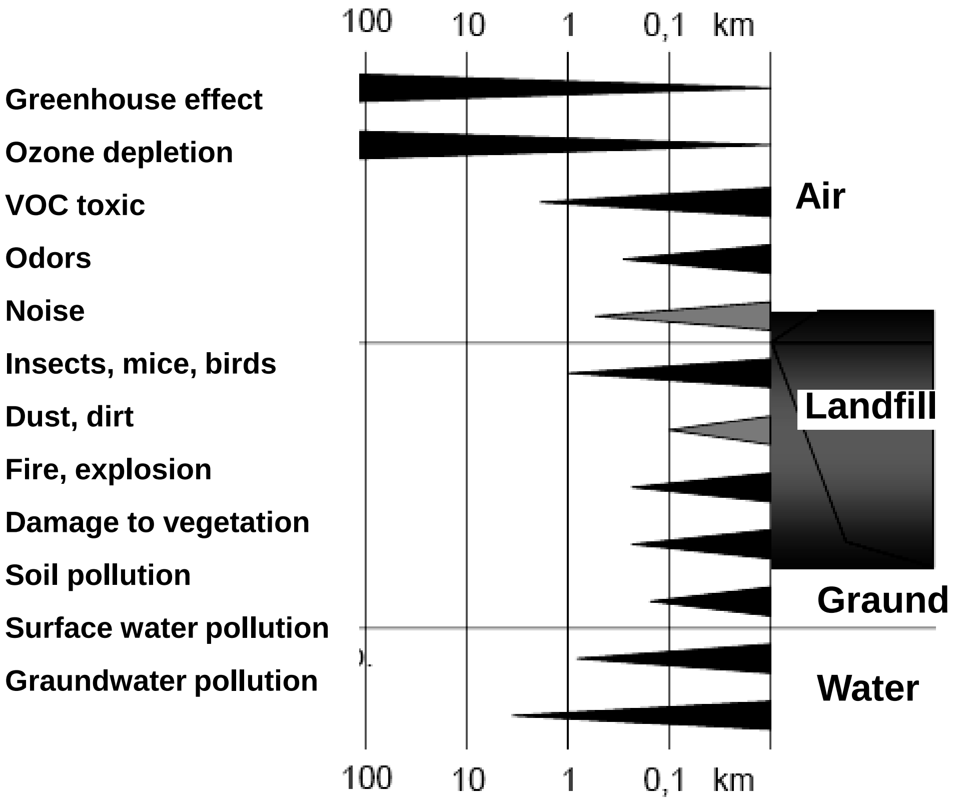
- **agricultural use**

  The landfill shall be flat, but can not be used as food products. The cover consists of topsoil.

Waste treatment plants

Solid waste landfill

Gli impatti ambientali delle discariche controllate e la loro rilevanza spaziale è riportata in figura



Waste treatment plants

<u>Solid waste landfill</u>

Next to the impacts of large-scale, related to the fact that landfills are major producers of methane and carbon dioxide (greenhouse gas), in landfills are issued by artifacts waste containing them chlorofluorocarbons banned in industrial production, we have numerous impacts of small-scale, the effects of which are felt in the neighborhood of a few kilometers. The latter are the ones that create problems of acceptance by the people concerned, and that still weigh on the sustainability of the landfill.

Looking at the individual impacts is observed as the majority of these (dark gray color of the figure) is associated with the presence of biodegradable organic matter contained in the waste deposited.

If then the impacts described are associated engineering problems related to inadequate systems, leachate collection and the inevitable clogging of drainage materials, there are drawbacks that emphasize the negative effects arising from landfills.

Waste treatment plants

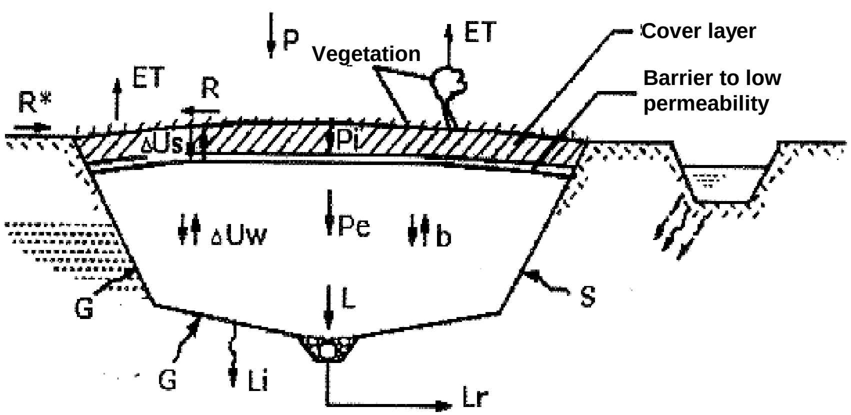
Solid waste landfill

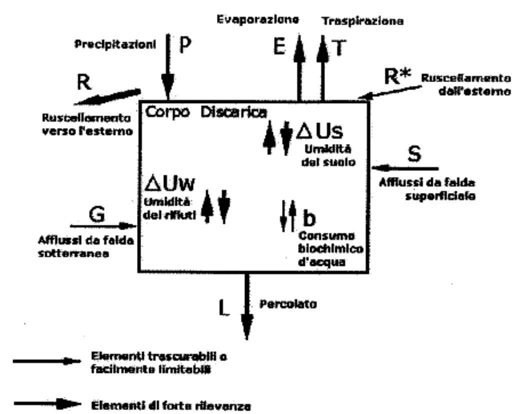
Among these additional major drawbacks are:

- increase in the speed of infiltration into the groundwater. A swing of 10 m is equivalent to increase of 10 times the permeability of the layer clay mineral arranged on the bottom of the landfill;
- the high flying leachate prevent a regular distribution of the depression through the wells of biogas, with the formation of zones of overpressure and uncontrolled emission of gases and odors;
- increased pore pressures within the mass of waste with increased risk of mechanical instability and the possibility that the formation of landslides;
- uncontrolled leakage of leachate.

Solid waste landfill

Whereas kiss as a sector of the exhaust already grasped, the quantity of leachate that is formed is related to the mass balance related to the flows of water in input and in output from the sector, as well as the accumulation and internal productions. The general scheme of the budget ideological implant with the related flows are presented in Figure





P = precipitations, R = runoff from the landfill, E = evaporation, T = transpiration, S = infiltration of surface water, G = infiltration of groundwater, R* = runoff from surrounding areas, ΔUs = change in water content roofing material, ΔUw = variation of the water content of the waste deposited, b = production/consumption of water associated with the biochemical reactions of aerobic and anaerobic degradation of the organic matter of the waste, Li = leachate that infiltrates into the ground below, Lr = amount of leachate collection, L = quantity of leachate produced globally, Pi = rainfall that infiltrates in the overlay, Pe = rain percolating in layers of denial

Solid waste landfill

The leachate must be quickly eliminated because it could cause an increase of the contact time between the liquid and the waste and the resulting chemical nature of interactions with the materials of the waterproof layer, the raising of the hydraulic load on the bottom of the landfill that promotes the motion of filtration through the layer of waterproofing and the decrease of the stability of the controlled drainage.

It must therefore create a collection system which provides for the lowering of the level of the saturated zone within the mass of waste comprising a drainage layer of high-permeability

The design of the drainage layer should be carried out assuming the most severe conditions of leachate (first months of life in correspondence of meteorological events critical for the system 10-20 mm/day).

Solid waste landfill

Important are the waterproofing systems which have the purpose to avoid the contact between the leachate and groundwater, for which you have to make the works of waterproofing the bottom and walls by means of:

a) natural systems

The choice of material is carried out on the basis of:

- geological, hydrological and meteorological site;
- characteristics of the waste to be disposed of;
- specific functions of the barrier;
- materials on the site and used as such;
- materials laid and compacted reported from areas of the quarry;
- processed materials before installation.

The types of materials used are clay, clay products (bentonite), and mixtures of soils with low permeability (sands more bentonites);

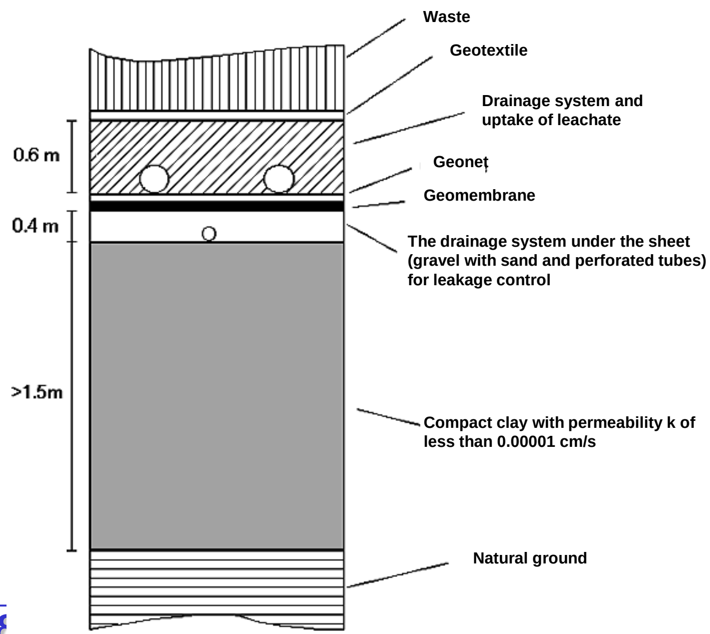
Solid waste landfill

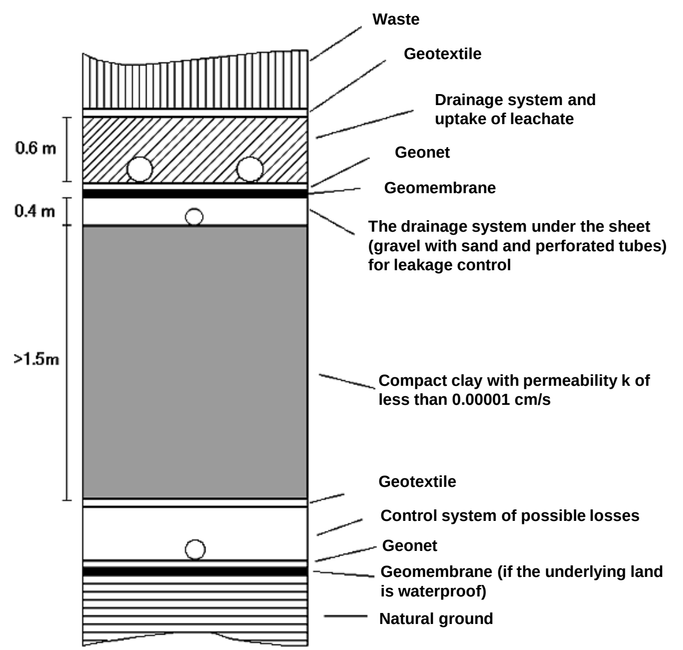
Important are the waterproofing systems which have the purpose to avoid the contact between the leachate and groundwater, for which you have to make the works of waterproofing the bottom and walls by means of:

b) artificial systems

Are different depending on which consider:

- waterproofing of the bottom (Figure)





Solid waste landfill

Important are the waterproofing systems which have the purpose to avoid the contact between the leachate and groundwater, for which you have to make the works of waterproofing the bottom and walls by means of:

b) artificial systems

Are different depending on which consider:

- Bottom sealing

It is consists of:

- layer of soil permeability ≤ 10-6 cm / s and thickness ≥ 1m;
- geomembranes: high density polyethylene with a thickness of 2 ÷ 2.5 mm;
- drainage system above the impermeable layer;
- minimum distance of the bottom of the landfill from the highest level of the groundwater excursion: 1m.

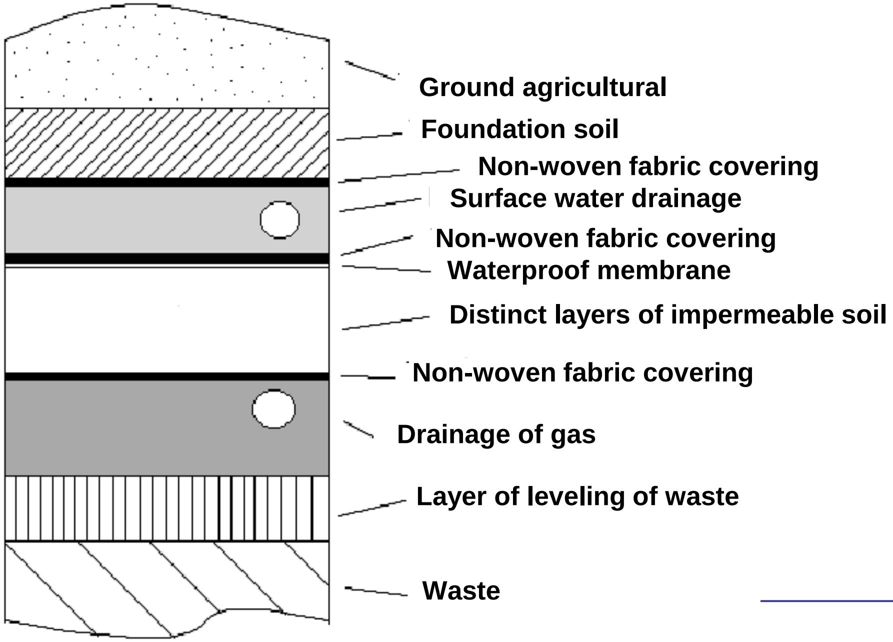
Solid waste landfill

Important are the waterproofing systems which have the purpose to avoid the contact between the leachate and groundwater, for which you have to make the works of waterproofing the bottom and walls by means of:

b) artificial systems

Are different depending on which consider:

- waterproofing coverage



Solid waste landfill

Important are the waterproofing systems which have the purpose to avoid the contact between the leachate and groundwater, for which you have to make the works of waterproofing the bottom and walls by means of:

b) artificial systems

Are different depending on which consider:

- Waterproofing coverage

The materials used are:

- synthetic turf, clay soils (sealing function);
- channels and networks synthetic, natural aggregates and is (drainage function);
- farmland, networks, synthetic or natural, soil-compost mixtures (regenerative function).

Solid waste landfill

Important are the waterproofing systems which have the purpose to avoid the contact between the leachate and groundwater, for which you have to make the works of waterproofing the bottom and walls by means of:

b) artificial systems

Are different depending on which consider:

- Waterproofing coverage

They must prevent the entry of rainwater into the aggregate.

They must have a limiting function to:

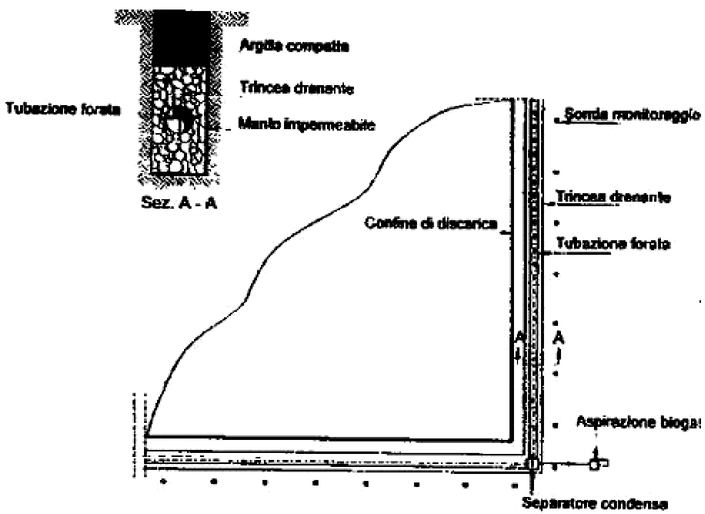
- gases and odors;
- lateral leakage of leachate;
- waste dispersion;
- aesthetics of the site.

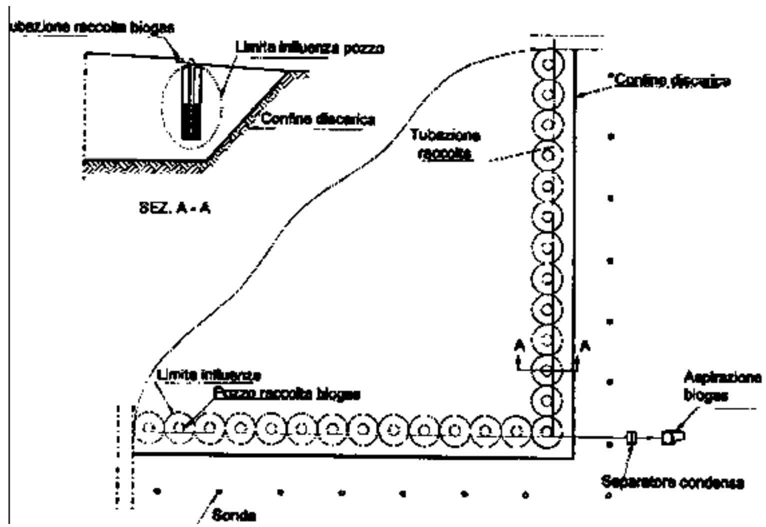
Solid waste landfill

The drainage of biogas can be done by following two methods:

- **drainage trench in perimeter development**

  Used for landfill shallow (<7 m) has a dig outside storage of waste, but adjacent, depth equal to the landfill. In it houses a perforated pipe in a bed of gravel with a sealant layer of compact clay, which is connected to a suction system (Figure)





Solid waste landfill

The drainage of biogas can be done by following two methods:

- **vertical pits perimeter**

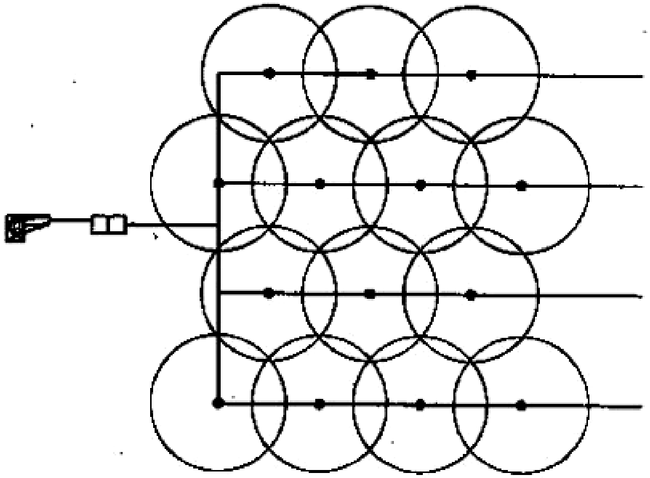
  They are used to the depth of the landfill more than 7-8 m. In each well are made more sections of pipe with a diameter of 0.1 m. The lower portion of the shaft has a series of holes and stayed on the gravel, while the upper part is surrounded by compacted clay or bentonite. The pits are connected at the top to a vacuum system such that the depression which draws the biogas is exercised in an area of influence in spherical form. The distance between the pits varies between 10-15 m depending on the depth of the landfill.

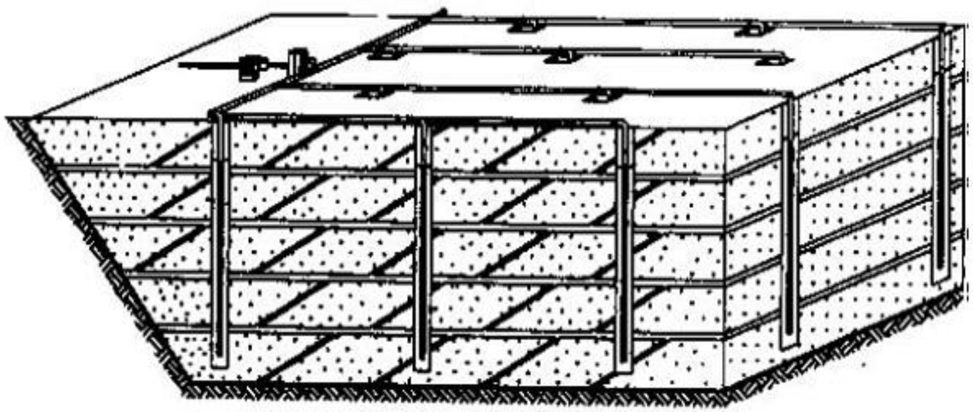
Solid waste landfill

The drainage of biogas can be done by following two methods:

- **vertical pits perimeter**

  The vertical wells can be used for the collection of the biogas within the body of the landfill. The number of wells is such that the areas of influence overlap and affect the whole surface of the landfill (Figure). Are obviously made to dump completed (Figure)





Solid waste landfill

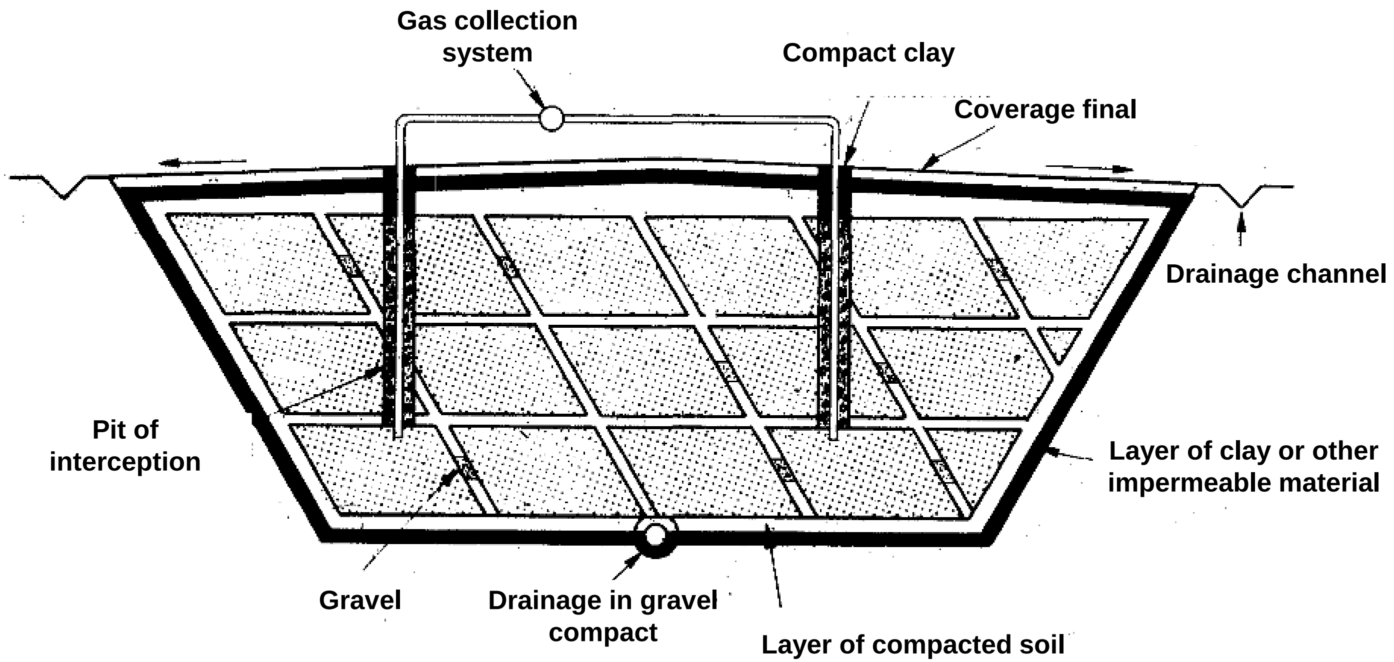
Alternatively using the drainage trenches that are carried out during the filling of the trench. A alternating layers is carried out an excavation width of 0.6-0.7 m and a height of 2 m, in which are included the perforated pipes, having a diameter of 0.3 m, and embedded in a bed of gravel. The filling of the excavation is completed with a blanket of inert material or earth, and a covering of topsoil.

The leachate is rapidly cleared as it may increase the contact time between liquid and waste and generate the iterations of a chemical nature with the materials of the waterproof layer, raise the hydraulic load on the bottom of the landfill favoring the motion of filtration through the waterproofing layer and decrease the stability of the controlled drainage.

Waste treatment plants

Solid waste landfill

The figure shows the system of collection of biogas and leachate in a landfill in the trenches.



Waste treatment plants

Solid waste landfill

There are three classes of landfills according to the types of waste placed in residence: landfills for first, second and third category.
Those of the second category are divided into subclasses: type A, B and C, for a total of five groups: 1, 2A, 2B, 2C and 3.
Passing from the first to the third category the complexity of setting up the system increases with the increase of the level of toxicity of the waste to the environment. The waste that must be disposed of in a certain type of landfill, can be disposed of in a landfill of a higher order, but not in a lower order; economic reasons we do not recommend this solution