Analysis of Practicality for The Place of an Incinerator of Urban Solid Residues in The State of Tlaxcala

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Abstract: The present study takes as a purpose to analyze the environment in general to propose the location adapted for the implementation of an incinerator of urban solid residues with catalytic cells in the state of Tlaxcala, to reduce the weight and garbage volume in the sanitary fillings of the state of Tlaxcala, which have a reception of 1,100 daily tons of residues that are deposited in the spaces of committal, this in accordance with the information provided by the dependence on general coordination of Ecology. The main elements of the problem of the garbage in urban municipalities of the state of Tlaxcala are the increasing total of urban solid residues that are rejected and that demand major infrastructure for compilation and its disposition.

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Keywords: Landfills, urban solid waste, feasibility, incineration.

1. Introduction:

Over time, economic and population growth in recent years has resulted in a process of growing urbanization, which has influenced the modification of consumption patterns, which is reflected in an increase in the amount and Heterogeneity of the solid waste produced, colloquially known as "garbage".

In Mexico, this problem has been increasing over the years and as a result the contamination of solid waste that this provokes. Taking into consideration that the existing infrastructure in the country is insufficient, for the garbage that is generated daily, combining with this, the bad habits of the society and sometimes the bad service on the part of the public servants, Not only is it degrading the quality of life of society, but it directly affects the environment.

Currently, the state of Tlaxcala has four landfills, which capture the following amounts of garbage; Huamantla 130 tn, Nanacamilpa de Mariano Arista 120 ton, Panotla 500 tn y Ejido de Morelos 350 tn, Giving in a totality the amount of about 1,100 tons per day. It is estimated that 65% are inorganic garbage and 35% organic garbage.

The volume of urban solid waste that is recycled in the state of Tlaxcala although it has increased is still very low; it is known that a large part of the 1.100 tons of daily garbage produced will go to landfills operating in the state. The Materials considered as recyclable in order of importance, in terms of the information obtained from general coordination of ecology Tlaxcala are the products of paper, glass, metal (aluminum, ferrous and other non-ferrous), plastic and textile. Of each of these products the average proportion that is recycled with respect to what is generated in the last five years has been: (see Figure 1), among the different sanitary problems that generate urban solid waste, we can cite the effects on the environment in its various environmental factors such as water, air, soil, greenhouse gas generation, soil contamination and aquifers, etc. As can be seen in Figure 2, which brings as consequence disorders to the population and irreparable damage to the ecosystems (pollution of rivers, lakes, and extinction of plant and animal species, etc.).

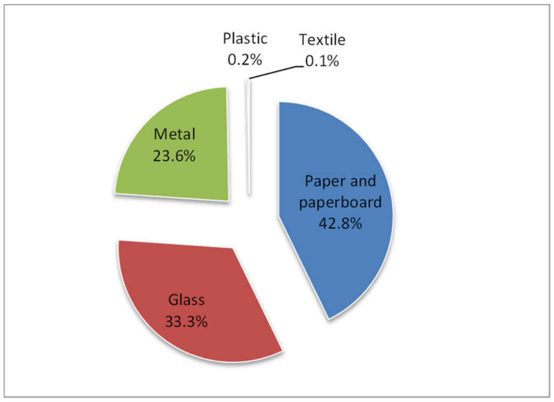


Figure 1. urban solid waste

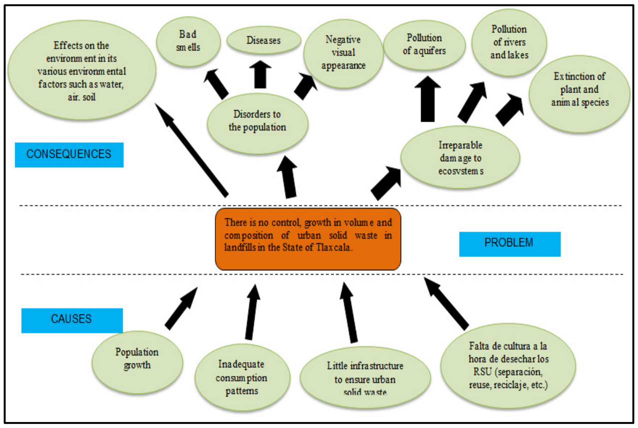


Figure 2. Materials considered recyclable in the state of Tlaxcala.

1.1. Urban Solid Waste:

In terms of waste, the current reference is la Ley General para la Prevención y Gestión Integral de los Residuos (LGPGIR, 2015) and its regulation (Regulation of LGPGIR, 2006), the integral management implies a sustainable management of the waste, as well as a series of procedures and actions that seek to minimize the production of waste (Bernache, 2014).

1.2. Urban Solid Waste in Mexico:

In Mexico, there are difficulties in achieving sustainable waste management, when the daily production of urban solid waste (USW) reached in 2010 1,020 grams per capita (Bernache, 2014). The main urban areas of the country generate waste that is accounted for in hundreds and thousands of tons per day. These huge amounts of urban solid waste present a complex problem for the coverage of the collection, for its use and especially in the final disposal.

The generation of waste in Mexico during 2012 was 41.4 million tons, equivalent to 0.99 kilograms per person daily, which means 90% more than the total generation of 1992, so it has had a total of 21.9 million tons (Jiménez, 2015).

1.3. Urban Solid Waste Treatment in Europe and Mexico:

Historically, the treatment of urban solid waste most common among the countries that today make up the European Union has been landfilling. It is also called controlled discharge and waste is addressed here that will be reused or valued through another management system. In recent years, most countries have reduced the use of this final disposal of waste due to various environmental problems that can be generated, such as leachate contamination; the new uses of the ground after the landfill will be limited, etc. (Perona, 2016). While in 2012 34% of waste was deposited in landfills, in 2013 it decreased by 3% it is expected that by 2030, landfill deposits will be eliminated, except for 5% of non-recoverable waste. On the other hand, one of the waste treatments that has slightly increased its popularity in recent years has been incineration, which has gone from 21% in 2007 to 26% in 2013. This method allows you to recover the energy of the residue and to treat many types of waste, but it also entails environmental problems derived from this treatment such as the toxic gases and ashes generated during the incineration and that need a treatment Added (Perona, 2016).

Faced with these changes and the persistence of traditional practices in the disposal of solid waste, there are evidently numerous open-pit landfills, which constitute a source of pollution for water, air and soil, as well as a means suitable for the development of harmful fauna that can constitute danger vectors for the health of the population; all this without forgetting the deterioration of the image of the place (Nuñez, Treviño, & Rodriguez, 2009).

1.4. Urban Solid Waste Incineration:

During the 1960s, the elimination of urban solid waste by incineration was shown as the definitive treatment system. Many projects were commissioned and the implantation of incineration plants acquired a great boom. This was maintained until 1975 when the construction works and the projects carried out in reference to this method of waste management decreased considerably. The success of the system was especially important in northern and central Europe, as well as in the United States. Incineration consists of a controlled combustion process that transforms waste into inert materials (ashes) and gases. (Fernández, 2018)

The main objective of any incineration is to try to reduce the weight and volume of landfills and to destroy potentially harmful substances. Incineration processes can also provide a means for recovering the energy, mineral or chemical content of the waste.

Advantages

- The possibility of energy recovery.
- Opportunity of treatment of many types of waste.
- Effective installation in near urban nuclei.
- A small area of land is required.
- Reduces the volume of waste by 90%-96%.
- Eliminates toxic contaminants.
- Incinerates all types of waste.

Its main disadvantage lies in the fact that it is not a total waste disposal system because although its weight is reduced by 70% and its volume by 80-90%, it generates ashes, slags, and gases. In addition, it needs a high economic investment, because it requires a high supply of external energy since these wastes have a very low calorific value. Likewise, it is necessary to allow for the possible contamination derived from the combustion gases. (Fernández, 2015).

Disadvantages

- ❖ Landfill for the deposit of ashes coming from the incineration.
- ❖ Reduces a weight by 70% and its volume by 80-90%
- ❖ They need a contribution of external energy for its operation.
- ❖ Low flexibility to adapt to seasonal variations in waste generation.
- ❖ Economic investment and treatment costs are high.
- ❖ The possibility of breakdowns, so an alternative treatment system is needed.

Nowadays many of the countries that generate solid urban waste have wanted to implement the new waste incineration plants, which is why they are often not accepted by the population due to the uncertainty or what will happen when these devices are installed, In cases of failure, they know they are doing something wrong, however it is known that those who have the lead with this type of treatment technology, power generation thanks to the calorific of these wastes are the European Union (See table 1 European plants in operation). So many countries travel to Europe to see the process of these plants in which there is no complaint by the people nearby.

Table 1. *Incinerating plants for urban solid waste in operation*

N°	PLANTS IN OPERATION	YEAR
1	Herefordshire & Worcestershire, United Kingdom	2017
2	Poznan, Poland	2016
3	Severnside Ukraine	2016
4	Buckinghamshire, united Kingdom	2016
5	Jabalpur, India	2015
6	Ferrybridge, United Kingdom	2015
7	Vantaa, Finland	2014
8	Lucerna, Switzerland	2014
9	Cleveland 4+5, United Kingdom	2013
10	Barcelona, Espain	2013
11	Vaasa, Finland	2013
12	Hinwil, Switzerland	2012
13	Newhaven, United Kingdom	2011
14	Oslo, Norway	2011
15	Riverside, United Kingdom	2011
16	Roosendaal, Netherlands	2011
17	Mallorca, Espain	2010
18	Bamberg, German	2009
19	Zistersdorf, Australia	2009
20	Cleveland, United Kingdom	2008
21	Stassfurt, German	2008
22	Issy-les-Moulineaux, France	2007
23	Lausanne, Switzerland	2006
24	Erfurt, German	2006
25	Zorbau, German	2005
26	Thun, Switzerland	2004
27	Liberec, Czech Republic	1999

2. Materials and Methods:

To meet the research objectives, the following methodological stages were developed.

a) Information collection: of primary character depending on the way in which urban solid wastes are constituted and characterized in the state of Tlaxcala, Europe, and Latin America.

b) Identification of research variables and how they should be measured to obtain results.

c) Information Processing: The bibliography was read and the appropriate information was selected for the enrichment of the research.

d) Representation: of the data obtained based on the optimal location of the urban solid waste incineration plant in Tlaxcala with support for a topographic study to allocate the surface of the machinery.

2.1.The operational definition of variables:

In order to make known the different variables found in the investigation, in table 2 you can see the type of variable identified and the representation as it should be measured so that both the research and the analysis of results have more coverage of veracity in the final result.

2.2. Topographical Study of the Land to Be Used:

A topographic study was carried out with Theodolite to analyze the terrain and locate the plane that is required to fill the surface in figure 4. the results obtained in the topographic survey are observed. A result of the curves of the study was also obtained, see figure 3.

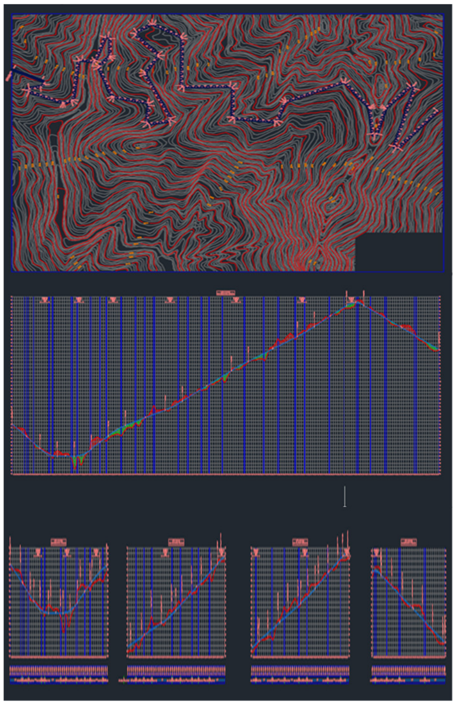


Figure 3. Level curves of the topographic study

Table 2. *Operational table of the variables:*

VARIABLE INDEPENDENT	TYPE OF VARIABLE (LEVEL)	DIMENSION	INDICATOR
DISCONTENT OF NEIGHBORS	**ORDINAL**	Search for alternatives to improve the state of discontent in the neighbors surrounding landfills	*Neighbors dissatisfaction
AIR QUALITY	**INTERVAL**	Assess air quality through studies on air pollution	* Pollution analysis by IMECAS (Índice Metropolitano de la Calidad del Aire)
WEIGHT	**INTERVAL**	Knowledge of the quality that comes from waste according to weight	*m3
VOLUME	**INTERVAL**	Knowledge of the quality that comes from waste according to volume	Tonnage
ENVIRONMENTAL REGULATIONS	**INTERVAL**	Study of the objectives that are fulfilled by the regulations provided by the environmental dependencies	*Grade of implementation of the results obtained in market research.
	INTERVAL		*Review of your current sample against the trend

DIFFERENTIAL LEVELING

PLACE: Tlaxcala, Mex
DATE: October 28, 2017
LEVELED BY: JAVIER SANCHEZ SANCHEZ
LEVEL BANK ON WALL CHAIN

EJE 8

STATION	L+	A	L-	COTA
BN-1	1.340	101.340		100.00
0+000			1.520	99.820
0+001			1.530	99.810
0+002			1.525	99.815
0+003			1.525	99.815
0+004			1.525	99.815
0+005			1.515	99.825
0+006			1.515	99.825
0+007			1.515	99.825
0+008			1.515	99.825
0+009			1.530	99.810
0+010			1.525	99.815
0+011			1.530	99.810
0+012			1.530	99.810
0+013			1.530	99.810
0+014			1.535	99.805
0+015			1.530	99.810
0+016			1.535	99.805
0+017			1.530	99.810
0+018			1.525	99.815
0+019			1.530	99.810
0+020			1.535	99.805
0+021			1.545	99.795
0+022			1.545	99.795
0+023			1.545	99.795
0+024			1.545	99.795
0+025			1.535	99.805
0+026			1.535	99.805
0+027			1.540	99.800
0+028			1.545	99.795
0+029			1.540	99.800
0+030			1.540	99.800
0+031			1.545	99.795
0+032			1.555	99.785
0+033			1.560	99.780
0+034			1.560	99.780
0+035			1.565	99.775
0+036			1.565	99.775
0+037			1.570	99.770
0+038			1.560	99.780
0+039			1.570	99.770
0+040			1.560	99.780
0+041			1.570	99.770
0+042			1.570	99.770
0+043 PL	1.500	101.260	1.580	99.760
0+044			1.500	99.760
0+045			1.505	99.755
0+046			1.505	99.755
0+047			1.510	99.750
0+048			1.510	99.750
0+049			1.515	99.745
0+050			1.510	99.750
0+051			1.510	99.750
0+052			1.520	99.740
0+053			1.525	99.735
0+054			1.525	99.735
0+055			1.525	99.735

CLIENT: ECOLOGY, TLAXCALA, MEX
SPECIFICATION: TOPOGRAPHY STUDY
LOCATION OF THE PROJECT: FILLING SANITARY PANOTLA TLAXCALA
DEVELOPED BY: ING. OSVALDO FLORES SÁNCHEZ
STAGE DIRECTION: METERS
ESCALE: NO

Figure 4. Topographic Survey with Theodolite.

2.3. Optimal Location of the Urban Solid Waste Incinerator:

To determine the optimal location of the plant, experts used the location method by weighted factors that allow the objective evaluation of the critical points to be considered in relation to the location of the installations. The four locations chosen by the ecology coordination that were subject to evaluation are listed in table 3 below.

Table 3. *Location alternatives:*

Alternative A	Ejido Morelos (Tetla) sanitary landfill
Alternative B	Huamantla sanitary landfill
Alternative C	Panotla sanitary landfill
Alternative D	Nanacamilpa de Mariano Arista sanitary landfill

In the first step to start the method, the localities are chosen based on appreciation the best conditions for the installation of the plant, however, it is a choice that will be subject to a qualification to obtain a successful result.

The development of the method covers the following stages:

1. Identification of the factors relevant to the operation of the plant.

FACTORS
Greater capacity of catchment
Garbage coverage
Workforce Availability
Communication Route (transport)
Useful life
Tamaño del área

2. Assigning a weight to each factor to reflect its relative importance

FACTORS	RELATIVE WEIGHT %
Greater capacity of catchment	25
Garbage coverage	20
Workforce Availability	5
Communication Route (transport)	20
Useful life	10
Size of Area	20
Total score	100%

3. Definition of a scale to qualify each factor for possible locations.

For this factor, it was used the capacity of the catchment of each of the four sanitary landfills that count the state of Tlaxcala.

SANITARY LANDFILL	Daily tonne
Ejido Morelos (Tetla) sanitary landfill	350
Huamantla sanitary landfill	130
Panotla sanitary landfill	500
Nanacamilpa de Mariano Arista sanitary landfill	120

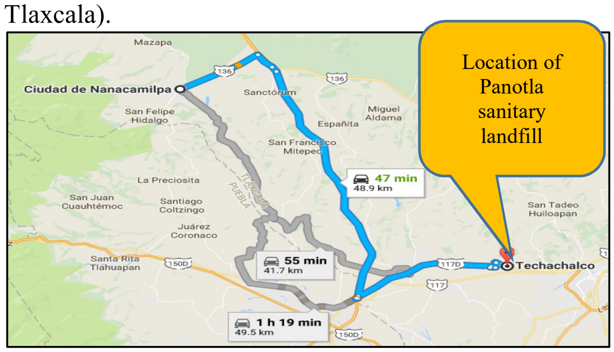
To qualify workforce availability, the scale is used with respect to the amount of economically active population in each location. Is attached rating scale for this factor.

Factors	Relative Weight %	A	A*weighting	B	B* weighting	C	B* weighting	D	B* weighting
Greater capacity of catchment	25	3	0.75	7	1.75	9	2.25	6	1.5
Garbage coverage	20	7	1.4	7	1.4	7	1.4	7	1.4
Workforce Availability	5	7	0.35	7	0.35	7	0.35	7	0.35
Communication Route (transport)	20	9	1.8	9	1.8	9	1.8	9	1.8
Useful life	10	2	0.2	4	0.4	6	0.6	6	0.6
Size of Area	20	5	1	7	1.4	9	1.8	7	1.4

The availability of workforce has extracted the information from the base of INEGI in the 2015 census of the total population of the municipality, for the score, we chose to choose from 1 to 5, depending on the available labor force.

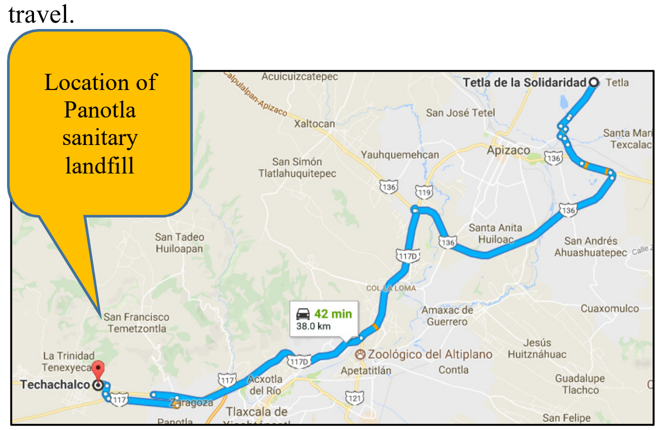
Transport. For the transport factor, the access lines available to the different locations are evaluated, the qualification scale is as follows.

Transportation routes from Nanacamilpa from Mariano Arista to Santa Cruz Techachalco (Panotla, Tlaxcala).

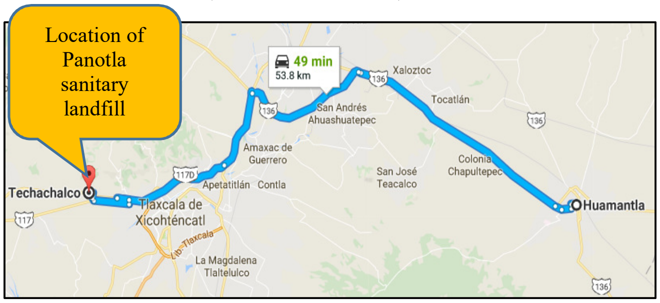


There is an excellent communication of transport routes so there is no impediment for the collection trucks to reach the destination, with approximately 47 minutes of travel. Transport routes from Tetla de la Solidaridad to Santa Cruz Techachalco (Panotla, Tlaxcala).

There is an excellent communication of transport routes so there is no impediment for the collection trucks to reach the destination, with approximately 42 minutes of travel.



Transportation routes from Huamantla to Santa Cruz Techachalco (Panotla, Tlaxcala).



There is an excellent communication of transport routes so there is no impediment for the collection trucks to reach the destination, with approximately 42 minutes of travel.

In conclusion it can be seen that of the three Municipalities that have sanitary landfills, transporting them to the proposed destination for the incineration of solid waste has a similarity between distances, so it is a good location strategy, it is worth mentioning that possibly the arrival time is less so that the drivers of the routes tend to use transport routes (shortcuts) that allow them to arrive sooner.

3. Results

Alternative B and C are better than A and D, so they are rejected, alternative B and D have a small difference between alternative C in the capacity of capture and the size of the area as an alternative, Alternative C is chosen as the best alternative. Where you get the greatest possibility of recruitment, as well as the means of transport and the best conditions to be able to carry out the study getting a score of 8.2.

3.1. Location and Type of Technology:

As the final result of the localization study determined that the optimum place is in Panotla, therefore it has the best means of transport and the capacity of the catchment of urban solid waste.

3.2. Technology Required for The Incineration of Urban Solid Waste:

Analyzed the localization study and knowing the capacity of catchment daily solid waste in the state of Tlaxcala, it proposes the implementation in the treatment of urban solid waste. Roosendaal / Netherland Energy-from-Waste Plant it is an urban solid waste plant from the Netherlands with the capacity to generate electric energy, itself that will be used for the machinery's operation in addition that its functioning is active since 2011 with a

4. Assign the value for each factor taking into account all the characteristics. It multiplies the qualification obtained by the importance weighting of the factor.

Factors	Relative Weight %	Alternatives			
		(A*weighting)	(B* weighting)	(B* weighting)	(B* weighting)
Greater capacity of catchment	25	0.75	1.75	2.25	1.5
Garbage coverage	20	1.4	1.4	1.4	1.4
Workforce Availability	5	0.35	0.35	0.35	0.35
Communication Route (transport)	20	1.8	1.8	1.8	1.8
Useful life	10	0.2	0.4	0.6	0.6
Size of Area	20	1	1.4	1.8	1.4
Total score	100	5.5	7.1	8.2	7.05

5. Finally, by means of the total sum by factor, the location that represents the highest rating among the proposals is obtained.

Factors	Relative Weight %	Alternatives			
		(A*weighting)	(B* weighting)	(B* weighting)	(B* weighting)
Greater capacity of catchment	25	0.75	1.75	2.25	1.5
Garbage coverage	20	1.4	1.4	1.4	1.4
Workforce Availability	5	0.35	0.35	0.35	0.35
Communication Route (transport)	20	1.8	1.8	1.8	1.8
Useful life	10	0.2	0.4	0.6	0.6
Size of Area	20	1	1.4	1.8	1.4
Total score	100	5.5	7.1	8.2	7.05

capacity of 291 TN per year, Figure 5 the proposal is shown.

4. Discussion

The collection of urban solid waste in the state of Tlaxcala is in charge of the municipality, who provides the service directly to the 60 municipalities that count the state, being the only responsible. The coordination of ecology is committed to following up all these wastes generated by the inhabitants so that they are taken to their final destinations, landfills which catchment about 1,100 tons of solid waste daily Urban, this in order to give him a treatment that does not alter the ecological equilibrium.

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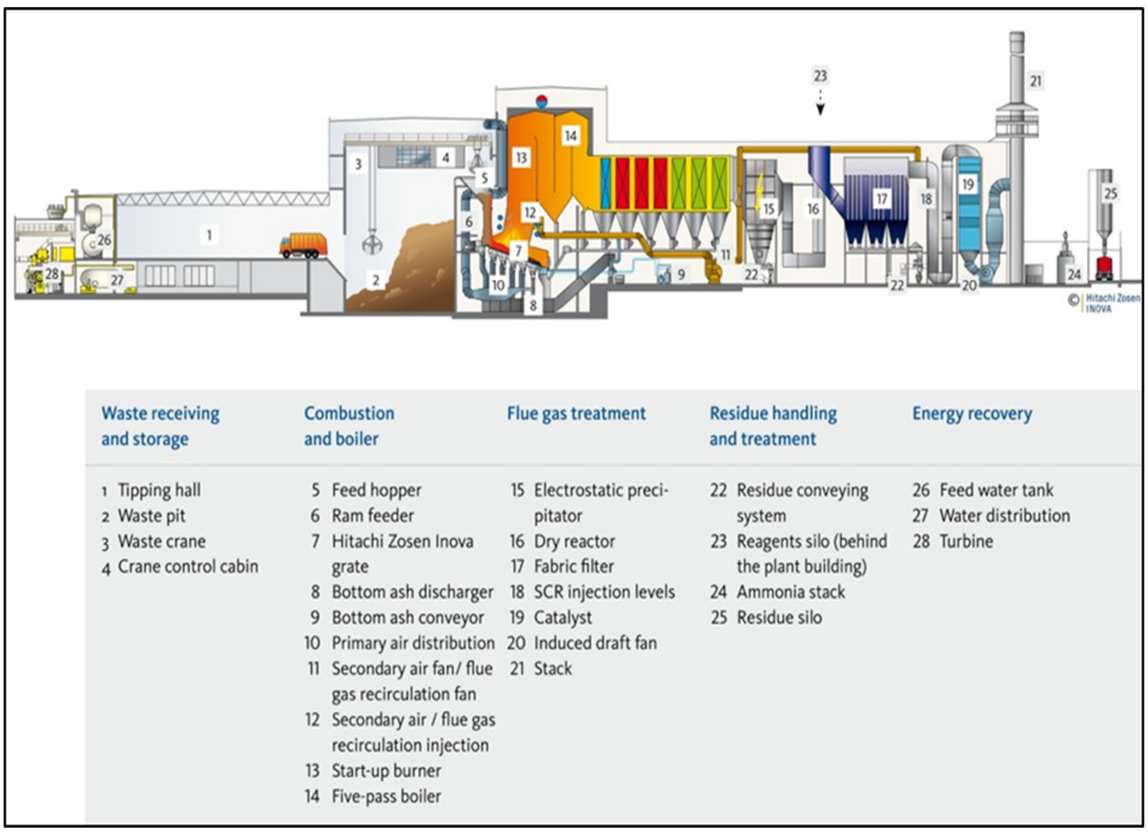

Figure 5. Roosendaal / Netherland Energy from Waste Plant.

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