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ENVIRONMENTAL REHABILITATION OF AN AREA DEVOTED TO THE CREATION OF A LANDFILL

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ABSTRACT

Properly sited, designed, and operated sanitary landfills represent a viable alternative to open dumps in the protection o public health and preservation of environmental quality. Aim of this work is study the use of a quarry tuff no longer exploited, located in the outskirt of Naples. The study of the project led to the smallest detail has the perfect environmental recovery as well as the possibility of reinstatement in even allowing the creation of an area intended for sports and entertainment venues. The first step to be taken in the design of a landfill, is the location of the site suitable. To do this it must first assess the volume and surface needed. For the identification of these two sizes is necessary to assume a minimum term of life of the landfill, in this case set equal to 25 years. In this case the area is made up of an old abandoned quarry tuff and located in the outskirt of Naples, affected by serious problems of disposal and storage of municipal solid waste (MSW). Special features of this project is the total recovery of an area used for disposal of waste, allowing the realization of a green piece of equipment area devoted to recreation and leisure.

Key words: landfill; environmental risk; MSW; environmental engineering.

INTRODUCTION

The study case considered is a landfill for municipal solid waste and similar situated in the hinterland of the Province of Naples and more precisely in the area of the municipality of Quarto. In this plant, in 2002, was disposed of 25.62% of all the local production of solid waste. The province of Naples is characterized by a very high population density equal to 2612 inhabitants per square kilometer (2001). The catchment area served by the landfill interested 17 municipalities that dispose their waste in Quarto landfill area. The quantity of municipal solid waste collected and disposal in this landfill each year is estimated to average around 60,000 T of which 60% consists of MSW, while the remaining 40% similar and assimilated. The plant is located in an old quarry tuff. In 1989 it was finally abandoned, that was eventually used for the construction of a landfill for the provision of municipal waste is not hazardous (class I) and non-hazardous special waste as well as some special waste hazardous (class II type B), landfill became operational in 2000.

MATERIAL AND METHODS

Area has a global reach of about 60000 m2, located in it we found: a storage facility for solid waste and assimilated (I Class), industrial solid waste plant (II Class, Type B), temporary storage of hazardous waste, compost production plant, electricity production plant from biogas. The upper portion of the plant is used as landfill in the II Class, while the bottom is the area used for disposal of municipal solid waste and assimilated, it has a capacity of almost 2.6 million m3.

Year	(Nm3)
2002	n/a
2003	6.260.358
2004	6.415.652
2005	6.369.388
2006	6.369.160
2007	6.012.808
Total	31.427.366

Tab. 1. Biogas captured from 2002 to 2007.

The dump was created from a collection of biogas intercepted by a network of wells. The recovered gas is partially burned with a torch and partly conveyed to a facility for the production of electricity with a power of 2400 KW activated at the end of 2002. The plant producing an average of 650,000 kWh/month and to date have been produced 54,602,229 kWh. The biogas captured is piped into two sub-treatment, it is saturated with steam at 40 °C before dehydrated and assigned to a cooling system to facilitate the condensation of steam. The gas is then delivered through a separator, at the exit it has a temperature between 1°-3 °C with very low water content. The gas is sucked and channeled to the cogeneration plant, where used for internal combustion engines; seven engines are connected to generator of electricity. The energy produced is directly sold to electricity Italian manager. Extraction wells have a diameter of 600 mm, is placed inside a slot in the tube with diameter of 160 mm, designed to collect the gas. Between the pipe cracked and the accumulation of waste is placed in the gravel, silica or basalt, with a particle size variable. Biogas aspiration is modulated automatically to optimize the yield and composition of the biogas plant extract. Indeed, it is necessary that the percentage of methane is between 46% and 52%, when this percentage goes down, the biogas is burned directly from torch.

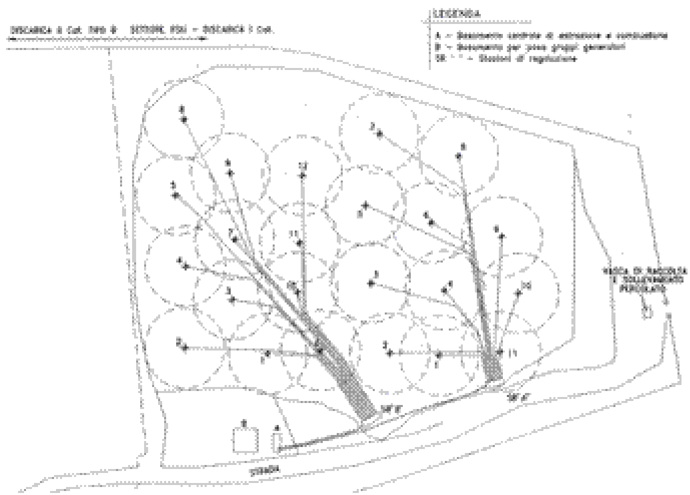

Figure 1. Biogas collection system.

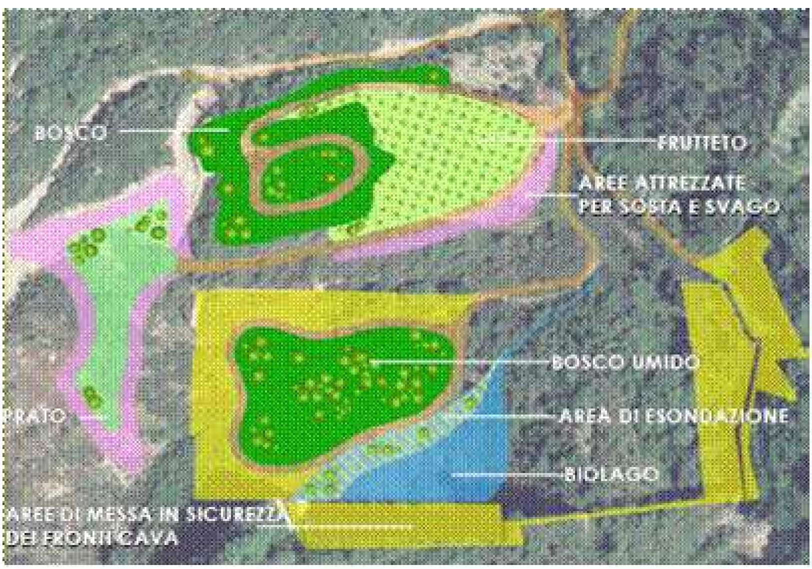

Figure 2. Area recovery project.

Figure 3. Different recovery project phases.

The landfill class II type B has been achieved with a total capacity of approximately 1,565,000 m3, the actual rhythm of delivery is now scheduled to run for it, more or less, another 20 years. The plant for the production of compost has been active since 2004 and occupies an area of around 156,000 m2. In the year 2005 have been processed more than 25,000 T of materials. In terms of landscape and visual impact, it is noted that the location of the plant in an area sheltered from the main roads and towns, making it very visible. Once exhausted the life cycle, thanks to interventions intended recovery area will allow the reintegration into the landscape and environment.

The intervention of recovery of the quarry, once discharged the landfill, provides for the construction of a photovoltaic vertical development. Moreover, in a depression will be done later obtained a pool of rainwater collection and purification, feasible for sports with small rowing boats and sailing. The other sides will be made vertical connections (stairs, lifts) to gain access to the upper edge where it will sit a sightseeing trip, in part arcade, with accommodation, catering and sports facilities.

At current rates of injection of MSW we expected exhaustion of the first class compartment for the year 2025. To examine the adequacy of theoretical models to generate biogas case study, and properly assess the results, it is essential to have quantitative data on the actual biogas captured from the installation of suction. The data are measured in cubic meters related to the plant collection, and therefore include the share of biogas that is flared. These data are shown in the table below. Even the technical and functional parameters of the plant uptake are important, especially for the determination of parameters specific to the site in question and used the model LandGEM. In particular, the observation of the draft design of the collection of landfill gas have been obtained from the average radius of influence of each chimney, approximately 20 meters. The average depth of wells is more or less than 15 meters and depends on the area of the landfill. According to data collected in the literature and those made available by the management of the fourth is evaluating the applicability of mathematical models of management. The need to carry out special tests on plant inlet biogas, to obtain the necessary parameters, makes the application of the method of "Pressure Rebound is more difficult. Some requested data were obtained through the use of special instruments. The application of the model of "Simplified Reaction ", as that of the model LandGEM, requires knowledge of complex data. These data cover the amount of waste brought to landfills in different years of operation and, in the first case, the chemical and physical characteristics of the same. Given the above considerations and the data available it was considered worthwhile to proceed to the application of the methods of "Simplified Reaction and LandGEM” and analysis of results from them.

The methods are, however, to make forecasts of maximum and refer both to the biogas generated from the theoretical mass of waste. The amount of the latter is always significantly different from that of actually available biogas. In fact, several external variables can intervene by modifying the quantity of biogas available. Moreover, although the plant may have been well designed, are ever present phenomenon of migration of landfill gas through the overburden and the side walls that can not be remedied, and there are always areas within the overlapping waste, in which there is stagnation of biogas resulting changes in chemical reactions. In any case in optimal conditions can recover about 65% compared to the total gas generated. The application of the simplified reaction method requires detailed information on product composition and chemistry of MSW processed. The used model is essentially based on a simplified chemical reactions that occur in reality, in order to make the calculations we have need to know both the elementary chemical composition of different classes of goods, the average humidity present in the waste.

Production fraction	% total weight	
	partial	total
Celluloid materials		29,5
Paper	12,5	
Cardboard	11,0	
Other	6,0	
Textile		3,0
Wood		3,0
Metal		4,0
Plastic materials		13,6
Different plastic	13,1	
Rubber	0,5	
Glass and inert materials		7,5
Organic material		28,3
Domestic	18,4	
Mowing and pruning	7,1	
Utilities	2,8	
Batteries and expired		1,1
Under sieve		10,0

Tab. 2. MSW composition

Were then fixed rates of biodegradation of various classes of goods. About this parameter does not exist many studies on waste which can be related, and this, unfortunately, a decisive influence on the accuracy of the model results, since this parameter depends on the amount of matter that in response, gives rise to the biogas also would be useful to know the rate of biodegradation in order to negotiate separately the amount of matter react more quickly and those which, in contrast, are degraded in the long run.

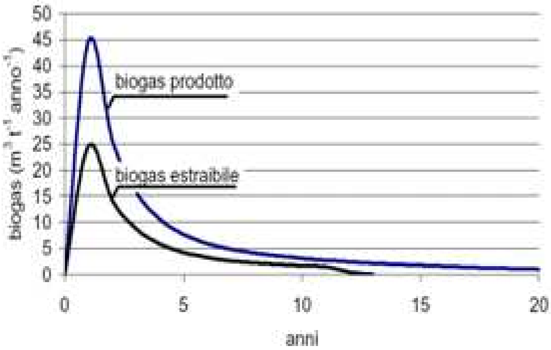

Figure 4. Biogas produced vs. removable ratio

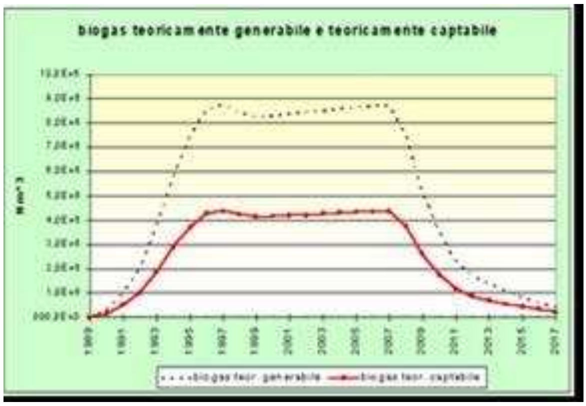

Figure 5. Theoretically biogas produced and captable.

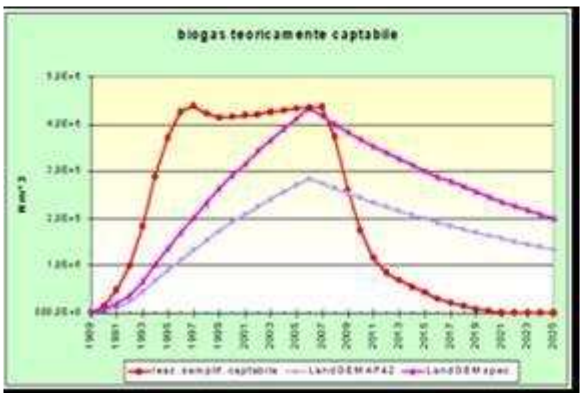

Figure 6. Comparison of applied models

In order to perform calculations quickly and easily the model parameters to analyze the trend of earnings in line with changes made, was created a complex spreadsheet, it can be adapted to various "scenarios" and also allows you to change all the parameters of quality and quantity of the waste. The method used allows to calculate the amount of biogas generated from the theoretical mass of waste. The amount actually generated, and therefore theoretically be broadcast in optimal conditions, is actually much lower than would be achieved in the case that all matter is anaerobically degradable react completely. Indeed, not all of the degradable material deposited in landfills can decompose further in the first period following the disposal of waste in landfills prevail and there is aerobic methane production. This is clearly represented by a graph obtained with real data from the case study and assuming a constant stream of waste amounted to 142,000 tonnes per year. In order to verify the compliance of the model to real data recorded by the equipment of the plant, it was considered a period of production between 1999 and 2017. The other graph shows a substantial correspondence between the curves of biogas theoretically be broadcast and actually picked up. The application of the LandGEM model, is apparently more simply, to give an estimate of emissions of biogas as well as individual chemical compounds, and the ability to use remaining site would be sufficient to insert in the table, the annual amounts waste deposited in landfills. The program also allows the setting or calculation of the value of parameters with plant specific information entered by the user, so as to simulate more operations corresponding to reality. To observe the differences between the two models applied you tried to compare the results obtained in both cases. It should be noted that the two models start from different considerations and address the problem of prediction of the biogas generated in different ways from each other in the model LandGEM not require any knowledge of the composition of the waste. It is easily as the model of "simplified reaction " follows a pattern best suited to situations commonly reported in most plants and are characterized by an initial period of rapid increase in the production of biogas followed by a stationary phase and an equally rapidly declining phase. Capital investment for the plant building described is around 500 - EUR 600 per KW. The electricity produced using biogas, can be sold to the operator with revenues of about 8.5 cents per kWh. Thus spending on construction of the plant is recovered in 36 - 48 months of operation, obviously that realization turns out to be convenient only if you have a range exceeding 200 m3 / h of biogas and installed power from 400 KW.

Production fraction	C	H	O	N	Inert	H2O
Paper	44,4	04,4	40,9	00,1	10,2	15,00
Cardboard	44,0	05,9	44,6	00,3	5,2	12,50
Other celluloid	44,2	5,15	42,75	0,2	7,7	20,00
Textile	39,6	06,5	25,3	05,6	23,0	20,00
Wood	49,5	06,0	42,7	00,2	01,6	22,00
Plastic	60,0	07,2	22,8	00,0	10,0	6,00
Rubber	78,0	10,0	00,0	02,0	10,0	2,00
Glass and inert materials	00,5	00,1	00,4	00,1	98,9	2,50
Metals	04,5	00,6	04,3	00,1	90,5	4,00
Domestic organic	28,70	3,10	29,20	1,90	37,10	75,00
Mowing and pruning	45,5	08,7	20,1	01,8	23,9	50,00
Organic	28,70	3,10	29,20	1,90	37,10	75,00
Under sieve	26,3	03,0	02,0	00,5	68,2	40,00

Tab. 3. Elementary chemical composition.

Production fraction	% biodegradability
Food waste	65 %
Paper, cardboard, celluloid	52 %
Plastic	0 %
Textile	50 %
Rubber	0 %
Organic	65 %
Mowing and pruning	60 %
Wood	65 %
Glass	0 %
Metal	0 %
Under sieve	20 %

Tab. 4. Biodegradability percentage.

RESULT AND DISCUSSIONS

Among the models tested, that of "simplified reaction" is one that provided the best results as regards the case study, the quantity of gas collected corresponds to approximately 60% of what is estimated to be the actual production of biogas landfill (calculated with the model of "simplified reaction"). On these results, it can be concluded that controlling the production of biogas, aided by the use of a suitable mathematical model estimate, which may be their “simplified reaction", can play an important role of a careful management of landfills, to obtain the minimum environmental impact and the maximum possible recovery of energy from waste.

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