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DETECTION OF CARBON MONOXIDE EMISSIONS FROM URBAN SOLID WASTE IN SERRINHA DOS PINTOS/RN: STUDY CASE

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ABSTRACT

The objective of this work was the elaboration of a case study aimed at the detection of the carbon monoxide (CO) emission caused by the incineration of municipal solid waste from the public waste dump of the municipality of Serrinha dos Pintos/RN, as well as its effects Toxicological. For the study, the portable four-gas detector, which has the capacity to detect combustible gases (% LEL), hydrogen sulfide (H_2S), carbon monoxide (CO) and Oxygen (O_2) was used. Regarding the environmental impacts, that waste can offer human health, a socioenvironmental questionnaire composed of closed-ended questions and eight objective questions was applied, since after obtaining the answers, the data were tabulated in Excel, which More viable its use, due to the spreadsheets and graphs for a quantitative analysis, where through the obtained results, the

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interviewees obtained a use of 70.4%, demonstrating knowledge about the most common diseases caused by garbage, among them, the most cited In the questionnaire were dengue and tetanus. It was verified that the most common symptoms presented by the study population were moderate headache and dizziness, considering that the levels of CO emissions average 77.6 ppm, which is above the standard established by NR15. Thus, the results encompass several areas that are linked not only to the emission of CO, but also to waste, because according to the empirical tests, many procedures occurring on the site directly affect safety, health and the environment.

Keywords: Carbon Monoxide; Work Safety; Regulatory Norm 15; Solid Waste

1. INTRODUCTION

The destination and treatment of solid waste can produce emissions of the main gases that contribute to the generation of socio-environmental problems, as well as causing serious health consequences for the people who are directly exposed to these emissions. According to Medronho (2003) the relationship between health and work has been studied in the last two decades, this object of study has a theoretical reference based on the analysis of the process of this relation.

Solid waste is any undesirable solid or semi-solid material which needs to be removed because it has been considered useless by the user (MONTEIRO, et al, 2001). It is important to note that these materials must be managed in order to reduce environmental impacts (GUERRERO; MAAS; HOGLAND, 2013; MARSHALL; FARAHBAKHSH, 2013). When the solid waste is dumped in the open dumps it is inevitable that there will be a high concentration of garbage in the course of the day. Thus, the only solution to this waste is incineration. As a result, high levels of carbon monoxide (CO) are released causing serious environmental problems and making the workplace harmful for those responsible for that activity (DEVECI, et al., 2004; FAZLZADEH, et al. 2015)

According to Freitas and Longo (2005), the fires have four phases of evolution that are: ignition, flames, embers and extinction. The release of CO and carbon dioxide (CO_2) occurs in the flame phase, where the high temperatures cause ruptures of the molecules constituting the biomass, causing the release of the gases already mentioned, making possible the contraction of occupational diseases.

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According to Sandilands and Bateman (2016, p. 151) "carbon monoxide poisoning may be accidental or deliberate. The principles of treatment are rapid removal from source and high-flow oxygen therapy".

Agreeing to Conceição and Cavalcanti (2001), occupational diseases are those in which workers are exposed to environmental, ergonomic or accident risks. According to Mohammadfam et al. (2017, p. 156) “risks endanger the workforce, equipment, the working environment, and impact the competiveness and economic performance of both industries and communities”. They are characterized when it establishes a connection between the aggravations analyzed in the health of the worker and the exposure to certain occupational risks.

In this way, to prevent accidents in the workplace and not to harm the health of workers is essential the use of personal protective equipment (PPE). According to Conceição and Cavalcanti (2001), Personal Protective Equipment (PPE) is defined as all equipment for personal use aimed at preserving the worker's safety while performing their duties.

The objective of the present study related to the analysis of the emission of carbon monoxide and its IMPACTS TO HEALTH OF THE WORKER, WELL LIKE THE ENVIRONMENT, in a public dump in the city of Serrinha dos Pintos, located in the state of Rio Grande do Norte (RN). Thus, it was verified in comparison with the levels of emission delimited by Regulatory Norm 15 - NR 15, if the workers responsible for such activity have possibilities to contract occupational diseases, as well as analyzed the possible socio-environmental problems, caused by both the emission and the form of the management and its due treatment.

2. THEORETICAL REFERENCE

2.1. Work safety

Work Safety is a set of norms and regulatory laws that propose measures and actions to be adopted to minimize and even eradicate occupational accidents and diseases. Therefore, its main goal is to protect the integrity of the workers in the workplace, guaranteeing them all the necessary support so that they can develop their activities in the most efficient way possible.

However, to develop the application of these norms and laws requires very strict planning, because from it will arise the need to adopt specific measures for

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each type of problem encountered. Therefore, points such as: Work environment study, study of occupational safety legislation, regulatory technical standards and employer responsibilities, are fundamental activities to take the necessary measures, in which sometimes can be resolved through administrative actions.

According to Martins et al. (2010), it is convenient that all companies have professional staff trained to understand and solve health and safety problems at work. With this, the organization will have a specialized and dynamic dimension, since the professional will have capacities to act in all sectors in order to prevent and protect accidents in the scope of work.

Therefore, some preventive actions are more prominent because they are basically the most common in relation to work safety, thus becoming initial parameters for an analysis for decision making. They are: Study of the occupational scope, analysis of causes of work accidents, lectures and capacitive training, implementation of EPCs (Collective Protection Equipment) and PPE, correction of the adopted administrative methods, medical examinations, psychological evaluation of the worker, among others. Thus, the execution of these actions is necessary so that there is a control of the risks of accidents, being able to prevent them and even solve the problem directly from the source. Therefore, the lack of a system of prevention and control in the management of safety at work can lead to enormous losses, the consequences for both the company and the worker, can be of great impact.

In spite of being a relatively new context, the subject has been showing a very large social impact, as companies are increasingly leaving behind the philosophy of management applied to activities and their level of productivity, adopting the philosophy oriented to the worker, being the main one the people for a better income in the execution of its activities.

In Brazil, there is a Work Safety Legislation in which it is basically based on regulatory standards, but also by decrees, ordinances and even conventions of the International Labor Organization, which serves as the basis for several technical measures, many of them adapted to the scenario Brazilian.

Regarding the administrative actions whose competence belongs to the organization itself, there are multidisciplinary groups or commissions responsible for

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supervising the occupational activity in the sectors of the institution in which the group is inserted. One of them is CIPA, which means Internal Commission for Accident Prevention, and is regulated by Regulatory Standard 5 - NR 5, and its purpose is to reduce the large number of accidents in the industries. For Rossete (2015), CIPA will be implemented according to the activity of the institution, regardless of whether it is private or public.

2.2. Emission of Gases from Urban Solid Waste

According to Resolution Number 05/93 of the National Environmental Council (CONAMA, p. 592), it presents the concept of solid waste in accordance with Brazilian Standard (NBR) 10.004 / 87 of the Brazilian Association of Technical Standards (ABNT), as: "Residues in the solid and semi-solid states, resulting from activities of the community of origin: industrial, domestic, hospital, commercial, agricultural, service and sweeping".

According to the National Survey of Basic Sanitation (PNSB), conducted in 2008, 50.8% of Brazilian municipalities used solid waste in open-air landfill, specifically in the Northeast region.

As a result, the inadequate form of waste management leads to the release of gases called biogas, the main component being methane (CH) and carbon monoxide (CO). In addition, leachate is released. Together with these gases has serious consequences for the health of people who are in direct contact with waste.

Humidity is a factor that influences the biogas release process. According to Qian et al. (2001) the moisture present in the residues after the composition affects considerably the biogas production.

For Ruiz and Loeri (2011), the density of carbon monoxide is lower than that of air (0.967), it presents a colorless, odorless appearance and non-irritating onset of airways. The same originates from the incomplete combustion of organic and inorganic material, it contains carbon atoms and the combustion occurs under conditions related to the lack of oxygen, resulting in the formation of CO.

The residences and commercial residues of a municipality are mostly of the biodegradable type, so their composition affects considerably in the production of gases, so the greater the amount of biodegradable waste the greater will be the biodegradation of the waste, increasing the rate of generation of chemical agents.

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According to Junqueira (2000), in the rainy season it allows the addition of dissolved oxygen in the water, allowing an increase of the aerobic bacteria manifestations, leading to an increase in temperature and, especially in the mass of the residue due to the exothermic activities of microorganisms. This means that this whole process causes an imbalance of the anaerobic microorganisms, thus causing a decrease in the rate of degradation of the residues and, consequently, the decrease of biogas proliferation.

2.3. Health Impacts

Health is defined as the good state of normal operational of the human body, in addition to being in good physical and mental disposition. According to the World Health Organization (1946), "health is the state of complete physical, mental and social well-being and not just the absence of disease."

Gouveia (2012) states that the incorrect disposal of solid waste causes impacts on human health. Thus, there is an increase in disease-transmitting factors, populations living near the dumps are exposed to "various types of cancer, congenital anomalies, low birth weight, abortions and neonatal deaths," reminding the garbage collector that their work is considered unhealthy and because they are in direct contact with the garbage the possibility of acquiring diseases such as: tetanus, dermatitis, cholera, typhoid, verminoses, among others. Non-use of PPE makes them more vulnerable to being infected by diseases.

For Tavares (2008), is considered inappropriate disposal any waste thrown on the floor, streets, lakes, rivers, parks, schools and any other passive location of illegality. The consequence of this irregular practice it ends causing the accumulation of garbage. Thus, when this happens one of the ways to dispose of the waste accumulation is to use the method of incineration, from the moment they adopt such practice entails the emergence of problems such as the high emission of carbon monoxide, causing environmental and social consequences.

When people are exposed for a long time to carbon monoxide, it can cause serious health consequences. According to Prockop and Chichkova (2007), they say that CO causes negative effects in people; it combines with hemoglobin, forming carboxy-hemoglobin (COHb) in the blood, thus avoiding oxygen binding to hemoglobin, leading to the reduction of the oxygen carrying capacity of the blood.

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The manifestation of symptoms caused by CO depends on the intensity of exposure, as well as on the amount inhaled and the time of exposure. According to Ruiz and Loeri (2011), the symptoms are proportional to the concentration of COHb in the blood and in general, about 90% of the cases patients complain of headaches, accompanied by nausea, vomiting, diarrhea, deep fatigue, among other symptoms. In more severe cases you may experience fainting or coma in high degrees.

2.4. Sampling Analysis of CO

According to ABNT, in Regulatory Norm 15 - NR 15 (1978), each sample collected in the data referents should not exceed the values obtained in the following equation; otherwise, it is considered a serious and imminent health risk situation.

Therefore, the analysis is done for each sample, having as parameter this maximum value obtained through Equation 1. Thus, one can individually evaluate the risk that each sample represents.

In addition, according to Table 1, adapted from NR 15 below, the tolerance limit for Carbon Monoxide (CO) is 39 ppm.

$$\text{Maximum value} = \text{T.L} \times \text{D.F} \quad (1)$$

Where:

T.L. = Tolerance limit for the chemical agent, according to Table 1 of NR 15.

D.F. = Deviation factor, as defined in Table 2 of NR 15.

Table 1: Tolerance Limits Table

CHEMICAL AGENTS	Value Ceiling	Absorption also for skin	Up to 48 hours / week		Degree of insalubrity to be considered in the case of its characterization
			Ppm*	Mg/m³**	
Monomethyldidrazine	+	+	0,16	0,27	Maximum
Carbon monoxide			39	43	Maximum
Negro de fumo				3,5	Maximum

Table 2: Deviation factor

TABLE N. º2	
T.L.	D.F.
(ppm, or mg/m³)	-
0 to 1	3
1 to 10	2
10 to 100	1,5
100 to 1000	1,25

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Above 1000	1,1

3. METHODOLOGY

The study consists of the emission analysis of the gases in an open landfill located in the city of Serrinha dos Pintos / RN, the same one receives the waste discharge of the entire urban and rural zone, besides the hospital waste that is also deposited in the place. The incineration of the waste is based on its daily accumulation. For the detection of the emission of gases, a portable four-gas detector model DG-500 is used, as shown in Figure I. This apparatus has the capacity to detect combustible gases (% LEL), hydrogen sulphide (H_2S), carbon monoxide (CO) and Oxygen (O_2).

The research method used was a case study, which according to Yin (2001), it consists of an empirical analysis, comprising a comprehensive procedure, with plans to obtain and observe the data.

In this way, the management of the data collected in the research follows a procedure for the elaboration of the work. For Gil (1991), the case study does not consist of a strict roadmap for its limitation, being possible to establish four processes that present its design: a) limitation of the case; B) data collection; C) selection, analysis and interpretation of the data, d) elaboration of the work.

According to Lüdke and Meda (1986), using the case study as a research strategy is the approach of a case, simple and specific or complex and abstract, always being well demarcated. It may be the same as other studies, but there is a certain difference, since it has its own exclusive and characteristic interest.

Data collection, using the gas detector, started at 1:00 p.m., defining 16 samples (measurements) at intervals of 20 minutes each. For the evaluation of the results it is necessary to define parameters in different environmental conditions, that is, the collection of samples with and without the presentation of the garbage burning. Thus, the study of the two situations allows to evaluate the consequences present in the working conditions described. The interpretation of the results depends on a basic knowledge of statistics, being taken as reference values for the emission of CO to Regulatory Norm 15 - NR 15. Finally, Excel software was used to tabulate and analyze the data obtained in the research.

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For the identification of the environmental impacts, the method of detailed observation of the landfill was used, recording the main conditions that harm the environment through photographic images, thus allowing a better evaluation of possible environmental problems.

Nearby the place where the waste is deposited, there are residences, with this the high emission of CO caused by the burning of the trash can cause social problems, to detect possible consequences for the health of the residents. Applying the questionnaire in 10 (ten) residences located near the landfill, the questionnaires were composed of closed questions and 8 predominantly objective questions, once after obtaining the answers to the data tabulation more feasible through spreadsheets and graphs for a quantitative analysis.

4. RESULTS AND DISCUSSION

4.1. Occupational Exposure Limit to CO

According to Silva (2008), there was no control of occupational exposures in the workplace during the 1990, while typical work-related injury rates began to fall considerably, and occupational disease rates tended to remain stable or even in the coming years.

According to Formigoni (2015), the limits of exposure to chemical and environmental agents consist of values where it is believed that workers can be exposed in their working hours without harming their physical and mental integrity. Thus, Regulatory Norm 15 - NR 15, defends the worker from the activities related to the exposure of chemical agents, whose unhealthiness is characterized by the tolerance limit and inspection in the workplace.

NR 15 presents a table with the tolerance limits of the chemical agents that the worker may be exposed to, the respiratory inhalation limit of these agents is given in Parts per Million (PPM). As the object of the study is closely related to the emission of carbon monoxide, then the tolerance limit value for this agent is 39ppm.

When measuring with the gas detector the emission of carbon monoxide in the waste dump without the incineration it is noticed that it was not possible to detect any CO rate, as shown in Figure 1, which represents the measurement of the apparatus, in addition to Figure 2 and 3 that represent the state of the environment at the time of testing. The explanation for obtaining this result is because it is located

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in a locality where it does not have a frequency of transport flow and of any eventual factor that causes the release of the chemical agent.

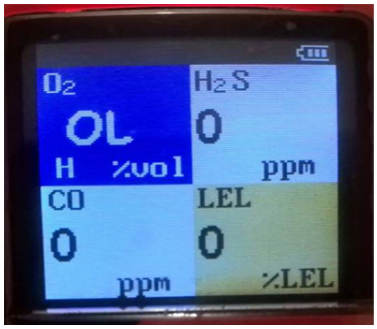

Figure 1: Detection of CO emission under normal conditions.

Figure 2: Environment in normal conditions: lateral view.

Figure 3: Environment under normal conditions: front view

4.2. Carbon Monoxide Emission

The emission of carbon monoxide was obtained by collecting sample data during the 5-hour period in the public dump of the city of Serrinha dos Pintos / RN, with each sample being collected every 20 minutes. In order to determine the period of data collection, the time of burning of the solid waste during the daily working day was taken into account, since the initial data represents the beginning of the incineration of the garbage, and consequently the final data represents the final phase of the burning, which occurs at the end of the working day. The data are shown in Table 3:

Table 3: Sample data collected in the public dump of Serrinha dos Pintos / RN

Time (min)	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
CO (ppm)	35	40	43	87	85	108	100	43	127	101	78	130	53	92	55	64

The collection began around 1:00 p.m. and lasted until approximately 6:00 p.m., during which time it was possible to obtain data on the various phases of incineration of the waste, from the initial phase to a very advanced phase of the burning, in the which compounds are disposed in place until there is a process of mobilization of the remaining residues. Figure 4 describes the behavior of the incineration according to the order of presentation.

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Figure 4: Phases of waste incineration.

It is possible to observe that the values have some proportionality with the time due to the incineration of the residues, which in the initial state are relatively low given the conditions of the environment and grow with their apex around 3:00 p.m. to 4:00 p.m. hours in which the stage of the carbon monoxide emission shows maximum, and finally, the values decrease considerably since the residues are in the final phase of the burning.

In order to analyze the significance of the samples collected in relation to the level of sample risk, Eq.1 is used. In this case, the tolerance limit, according to NR 15 is 39ppm. The deviation factor as defined in Table 2 of NR 15 is 1.5. With this, applying in the equation we have:

$$\text{Maximum value} = T.L \times D.F$$

$$\text{Maximum value} = 39 \times 1.5$$

$$\text{Maximum value} = 58.5\text{ppm}$$

It means that each sample that presents values higher than 58.5 ppm is considered to be a serious and imminent risk situation. When analyzing the sample data presented in Table II, it can be seen that of 16 samples collected, only 6 presented values lower than the maximum sample value allowed. Thus, because there is a greater number of samples that have higher values than allowed, the possibility for all of them to be considered a risk to occupational health is effectively high.

In relation to the data set, according to Regulatory Norm 15 - NR 15 in Annex 11, item 8, it is necessary to analyze the data based on the arithmetic mean of the samples to consider the tolerance limit if the average exceeds the value defined by NR 15, which in this case is 39ppm.

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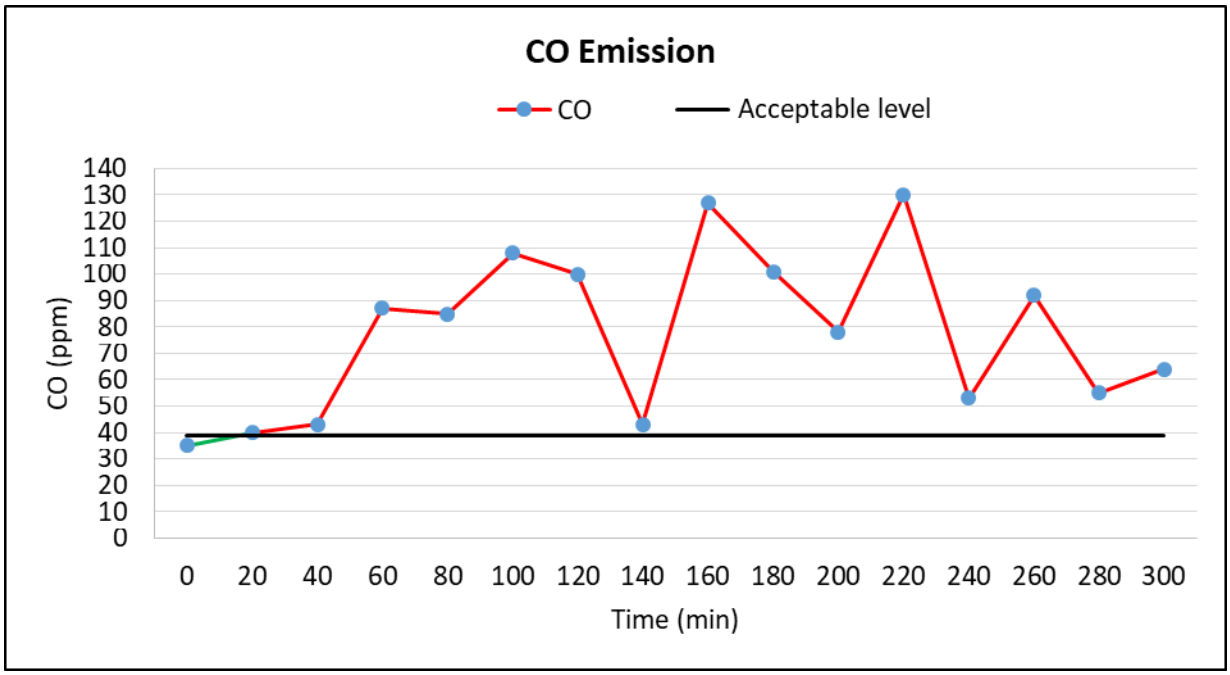
With regard to the study of all the sample data, first with the intention of having a notion about the behavior of carbon monoxide emission in relation to time, the graph was elaborated according to the data presented in Table II.



Graph 1: Carbon Monoxide Emission in the Landfill

As for the representation in Graph 1, it is perceived that the value normalized by the norm corresponding to the occupational tolerance limit that is 39ppm is represented by the black coloration, the samples that are above this value are in red color, while the ones that are below Is represented by the green color.

It is noteworthy that in the first 20 minutes the result obtained is considered acceptable, the explanation for this result is because it is the beginning of the waste incineration process; the elapsed time was not enough to cause the CO emission to be considered health risk.

From 20 minutes to 300 minutes, it is notable that all values are above the level that is considered acceptable, but according to Regulatory Norm 15 - NR 15 in Annex 11, item 8, it is necessary to make analysis of the data set based on the arithmetic mean of the samples to consider the tolerance limit. The arithmetic mean of the data obtained is 77.6ppm, as the mean exceeded the value defined by NR 15, thus it is considered as an occupational health risk.

The explanation for the high rate of emission of the gas after 20 minutes is due to the fact that the burning of the waste is at an intensity sufficient to generate

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high rates of carbon monoxide, that is, the stage in which the incineration was allowed High rate of CO release, as occurs specifically at the point of 220 minutes, where a rate of 130ppm is presented, with this it is noticeable that the other values collected in the same phase of the burning have a certain proportion, in the interval of 100 to 220 minutes , Thus causing consequences on workers' health, as well as still causing social and environmental impacts.

According to Conceição and Cavalcanti (2001), personal protective equipment should protect the individual against the risks of work environments, and provide protection against uncomfortable and unpleasant working conditions; being able to even more fully protect the region of the body threatened directly. Thus, the workers responsible for handling and throughout the incineration of waste are essential the use of PPE, thus enabling the reduction of health risks and preserving the physical integrity of workers.

When assessing the conditions that workers were subjected to in the work environment, it was noted that they lacked the use of some PPE as masks that protect the airways and glasses for the protection of the eyes.

4.3. Toxicological Effects of Exposure to Carbon Monoxide

Factors such as pollution, emission of gaseous materials, space of the environment, and displacement can have a great impact in the execution of the tasks, in the health and safety of those who carry out any type of duty in these places. Thus, in this case, it was possible to observe several of these factors, including the emission of carbon monoxide, the main objective of the study. In addition to chemical and biological risks, physical and accident hazards were also observed at the site, such as heat, inadequate arrangements and even venomous animals.

In relation to the emission of carbon monoxide from the solid wastes allocated to the environment, it is possible to analyze several possible clinical effects that the exposure to this gas can cause to human health.

> "[...] Carbon monoxide has an affinity for hemoglobin 240 times greater than that of oxygen, which causes a small amount of carbon monoxide to saturate a large amount of hemoglobin molecules (CANÇADO et al. 2006, p. 3). "

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Resulting in decreased blood capacity to carry oxygen, and even tissue hypoxia, which is caused by a lack of oxygen supply to the tissue. According to Reis (2016), these toxicological effects are caused by the so-called acute exposure to carbon monoxide, which in the body is combined with hemoglobin, forming carboxyhemoglobin (HbCO), which in turn has no ability to carry the Oxygen, because CO and O_2 react with the same group on the hemoglobin molecule.

In addition, exposure to carbon monoxide can cause short- and long-term problems. Thus, these problems are analyzed in minor intervals, since they are better adapted to the workers' exposure situation, thus being in line with the problems addressed according to the parameters presented in Table 4.

Table 4: Effects of acute carbon monoxide poisoning

CO (ppm) on air	Accumulation time (minutes)	Carboxy-hemoglobin concentration (%)	Symptoms
50	150	7	Light headache
100	120	12	Moderate headache, and dizziness.
250	120	25	Severe headache and dizziness
500	90	45	Nausea, vomiting, collapse
1.000	60	60	Coma
10.000	5	95	Death

Source: American Petroleum Institute, 2009.

Table III shows the effects caused by the level and time of exposure to the gas, and thus it is possible to have a consistent basis for analyzing the exposure of employees and workers performing tasks in the landfill. Therefore, according to the results obtained in the data collection, as well as the time of exposure of that in the place, the most common symptoms are the moderate headache, and dizziness, since the levels of CO emission has on average 77.6ppm.

4.4. Socio-Environmental Impacts Caused by the Emission of Carbon Monoxide

The detection of the carbon monoxide emission in the landfill obtained in the tests also represents socio-environmental consequences besides the risks to the health and safety of the civil servants and of who carries out some type of activity in the place. Thus, it was possible to observe considerable impacts in the community and in the environment, validating a better study of such effects.

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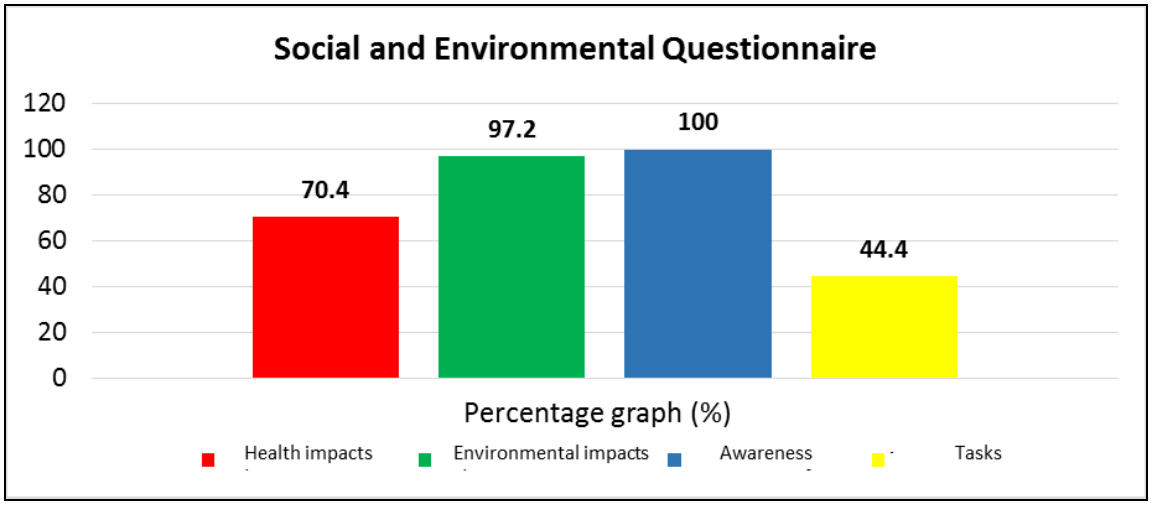
In order to analyze the socioenvironmental impacts caused by the emission of CO from solid waste in the Serrinha dos Pintos dump, it is necessary to observe several social and environmental factors. Therefore, to close the empirical analysis of popular methods and thoughts, a socioenvironmental questionnaire was applied with the ten (10) residents living near the landfill.

Thus, a qualitative analysis becomes necessary to understand the behaviors and thoughts of these residents, but it is also necessary a qualitative analysis of some questions asked.

Graph 2 describes the main socio-environmental aspects addressed in the questionnaire applied, in addition to other factors that are generally not addressed, nonetheless which are of public importance.



Graph 2: Socio-environmental Questionnaire: Analysis of responses
Source: Group personal archive

The results presented by the graph are simple and effective, because in all the series the answers were made consistently, that is, in almost all the questions the residents showed a good performance in relation to the questions addressed. Thus, with respect to the impacts that the residues can offer to human health, the interviewees obtained a use of 70.4%, demonstrating knowledge about the most common diseases caused by garbage, among them, the ones most cited in the questionnaire were dengue fever and tetanus.

Regarding the environmental impacts that the public waste disposal site can offer, all the residents presented coherent and assertive opinions on the subject. Thus, the questioning applied was answered correctly by 97.2% of respondents. Among the impacts, the most evident were, according to the interviewees, the

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deforestation, pollution and aggression to the fauna, since the place presents a certain variety of wild animals and even domesticated ones, as the case of the cattle raising.

As far as residents' awareness was concerned, it was possible to observe that in all of them they showed full awareness of the proper disposal of waste, as well as the importance and usefulness of a landfill, as discussed in the questionnaire. Although everyone knows about these factors, in practice, what happens in some cases is the inappropriate disposal of household waste, and there are even reports that garbage is sometimes disposed of in nearby wastelands. However, public officials responsible do the collection and transport of this waste for the handling of the waste to the site, through the bucket, which is the vehicle commonly used.

In relation to labor activities, it was reported that in almost 50% of the cases, there are family members of the interviewees doing some kind of activity near the dump. In this case, all activities are focused on agriculture and livestock.

In addition to all these factors, a case of respiratory disease caused by smoke expelled in the air due to the waste incineration was also reported in one of the residents closest to the place, including a problem diagnosed.

Throughout the visits made in the open landfill, it was possible to observe several factors that are detrimental not only to the health and to safety of the workers, but also diverse forms of aggression to the environment. In addition to the great pollution, deforestation and disturbance to the fauna, a major problem was detected related to the handling of the remaining waste compounds after incineration.

The public dump of Serrinha dos Pintos is located in a peripheral area, and due to the city being mountainous and is approximately 615 meters of altitude, the place chosen to deposit the waste is located in a ravine in the top of the mountain range, and it is precisely for this bank that the remaining composites from the garbage burning are thrown.

It is possible to observe in Figure 5 the wastes thrown by the bank, which affects the valley that divides the mountains.

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Figure 5: Waste pushed

And according to the reports of the public servants themselves, this method has always happened since the place was chosen to be deposited all the garbage produced by the inhabitants of the city, that is, there is a lot of garbage thrown down for many years, a technique of immeasurable irresponsibility of the municipality.

5. CONCLUSION AND RECOMMENDATIONS

Based on all the results obtained during the period of tests, conversation and observation, it was concluded that the open-air dump offers numerous risks to the population of the municipality of Serrinha dos Pintos, being socio-environmental risks and, mainly, health and safety risks of work. In this way, it was possible to evaluate such risk factors with a satisfactory and evident analysis of the high level of carbon monoxide emission. It can thus measure this agent considered of high unhealthiness.

In addition, the results are consistent with the unfortunate reality that occurs in Brazilian cities, especially in small cities where enforcement is lacking, and methods based on regulatory norms are rarely implemented, such as the lack of use of most PPE needed to perform activities in places like this.

Another important aspect that should undoubtedly be discussed and repaired is the public irresponsibility on the part of the municipality committed in the act of improper displacement of part of the waste, since, besides the affected land, it is privately owned, the environmental impact caused by this part act may be irreparable.

Regarding the emission of carbon monoxide in the working environment, it is necessary to point out the high detected indices of the gas that is released in the incineration of the solid waste, as shown by the average of the samples, which is

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77,6ppm, which exceeds 99% of the limit tolerated according to NR 15, leaving the work environment completely covered by clouds of smoke, making activities practically inaccessible due to the difficulty of seeing and breathing, and with this the lack of adequate PPE for these conditions leads to prolonged exposure and risks to workers. And an aggravating factor for this exposure is the fact that employees stay in place during the incineration to control firing for an indeterminate time, thus posing a great health risk due to this exposure to toxic gas.

In this case, there are simple and adaptable procedures to reduce and inhibit most agents from health, safety and environmental hazards. The adoption of methods such as: using PPE suitable for activities in dumps, controlling the amount of waste burned per session, and even the way the waste is burned can offer better working conditions for those who carry out some kind of activity in the area. Regarding the garbage that is pushed from the top of the mountain, there are no plausible explanations for such an act, since the same is of immense irresponsibility of the municipality. An act that goes unnoticed due to lack of supervision, but that in the future may cause countless consequences for the municipality and for the environment.

Therefore, a more effective solution to this problem would be the construction of a sanitary landfill, but it would be unfeasible for the municipality to carry such a large amount of investment. However, there is a project since 2010 regulated by Federal Law 12,305 / 2010, for the construction of a In the municipality of Pau dos Ferros/RN, which would have delivery deadline in 2014, and would be used by about 40 municipalities in the region, including Serrinha dos Pintos. Thus, it would treat a serious problem found in the state, but the project was stopped.

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