

Analysis of the confined spaces atmospheres in a wastewater drainage network

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Abstract: There is an underground technical infrastructure for the disposal of wastewater in most of urban areas, which is periodically targeted for maintenance and rehabilitation by specialized workers, or even used more specifically by authorities or emergency forces. Each entry point can be considered a separate confined space, where there are hazardous atmospheres to the physical integrity of the workers.

To understand the hazards to which all subjects are exposed, a systematic and exhaustive analysis was carried out in the interior atmosphere of the manholes in the wastewater drainage network, in the entire eastern zone of the city of Beja, the gases produced and at those facilities.

The collection of the data was performed when the network was its normal state of exploration, had minimum flows. The flow rates were classified as minimum, after analyzing the readings of recording of the flow meters installed in the zones of measurement and control of the water distribution network, in two very distinct periods.

Keywords: *Safety in confined spaces, Dangerous atmospheres, Drainage network, Combustion and fermentation gases*

1. INTRODUCTION

The research in question is regulated by specific legislation that obliges companies to comply with all requirements issued, thus safeguarding the health and physical integrity of their workers by introducing prevention procedures based on the legislation described.

Portuguese law, Portaria 762/2002 of July 1 aims to establish a set of requirements to ensure the safety, hygiene, and health of workers in the operation of public water distribution systems and public drainage systems for domestic, industrial, and rainwater [3].

It states that specific risk factors inherent to the operation activities of water supply systems and wastewater systems are those that result, namely, from the following situations: - Insufficient atmospheric oxygen and the existence of dangerous gases or vapors in the network in question, more specifically in the manholes of the wastewater drainage network.

The circular manholes are composed of prefabricated rings and eccentric cone obeying, respectively, the Portuguese standards NP 881 and NP 882. These manholes have, as a rule, body in prefabricated concrete rings of 1.00 m diameter for heights up to 2.50 m and 1.25 m diameter for greater heights.

According Portuguese Law, Decreto Regulamentar 23/95, 23th of August, they are composed of:

- Threshold, formed in general by a concrete slab that serves as a foundation for the walls;
- Body, formed by the walls, with layout in plan usually rectangular or circular;
- Roof, flat or asymmetrical truncated cone-shaped, with a vertical generator in the continuation of the body to facilitate access;
- Access device, formed by recessed steps or a fixed or removable ladder, the latter to be used only for depths of 1.7 m or less;
- Strong locking device.

2. TECHNICAL REQUIREMENTS

The collection method is based on quantitative data, taken in a real context from the interior atmospheres of the manholes of the wastewater drainage network in the urban East zone of the city of Beja., Portugal

A 5% sample of each interval of the level quotas that compose the same drainage network was considered, being that for the East zone, readings were collected in about 61 cases during two distinct periods of the day, one in the morning between 10 am and 12 pm and the other in the afternoon between 3 pm and 5 pm [1].

The method used for the collection was based on the comparison of readings of the flow meters that record the daily consumption of water distributed to the network, where by its analysis, it can be verified in the normal operating regime the time intervals in which the water network is with reduced values in its daily distribution which, in turn, gives the indicator of minimum flow in the network of wastewater drainage due to consumption being reduced in the distributed water [2].

Parameters analyzed:

- Hydrogen Sulfide (H₂S)
- Methane (CH₄)
- Carbon Monoxide (CO)
- Oxygen (O₂)
- Depth
- Temperature

Methodology:

- Collection of outdoor temperature reading near the manhole cover
- Calibration of the multi-gas detector with reference to the outside atmosphere
- Opening the manhole cover
- Simultaneous introduction of the probes into the manhole, collection of readings and depth measurement
- Closing of the manhole cover

3. RESULTS

The data were collected at all elevations in the eastern part of the city of Beja, Portugal, between elevations 156 and 290 m above the sea line.

In the morning period, eight hydrogen sulfide readings are collected in eight manholes throughout the analysis area. In the afternoon period the number of manholes with Hydrogen Sulphide records increases by 4 more, increasing the record values to the amount of 12 manholes in the urban network that present Hydrogen Sulphide values. The results taken in the morning period are higher at higher elevations than at lower elevations (fig 1).

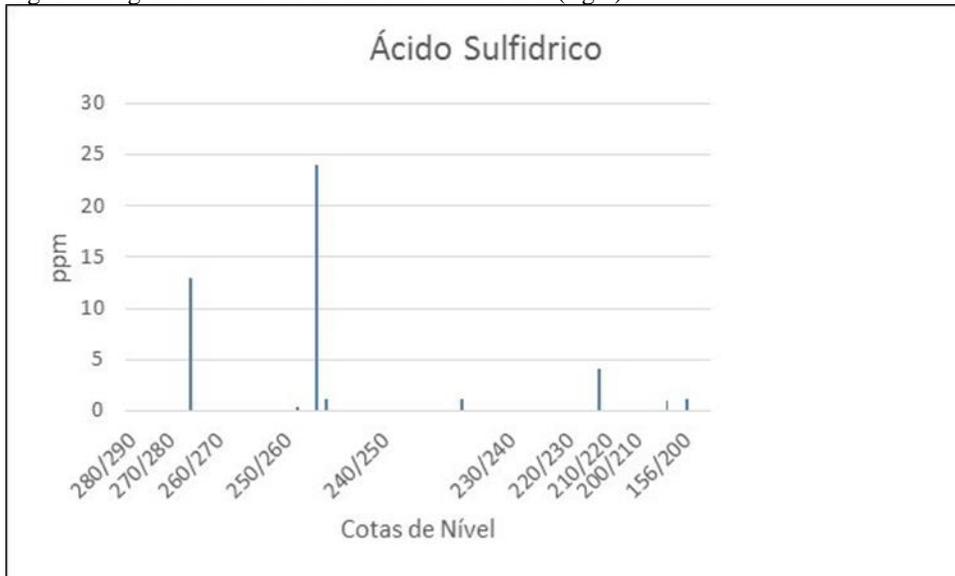


Figure 1 - Hydrogen Sulfide concentrations in the morning reading periods

In the afternoon period there is an inverse behavior, with higher values at lower levels while at higher levels the records made show lower values (fig. 2).

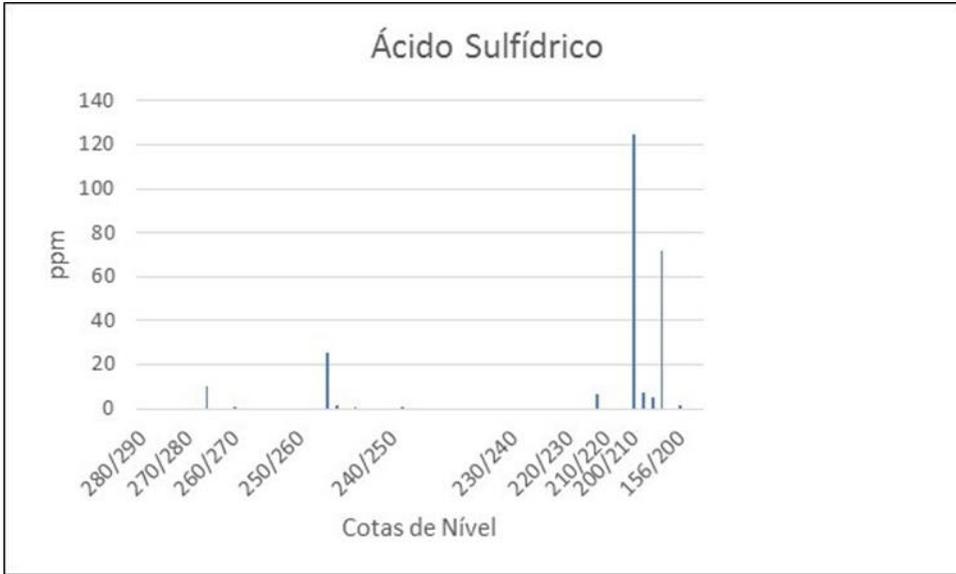


Figure 2 - Hydrogen Sulfide concentrations in the afternoon reading periods

Methane is recorded at elevation level in the morning in 1 manhole, in the afternoon, it is also recorded in 1 manhole at elevation level, throughout the entire analysis area in the other elevations there are no recorded values for methane, with a reading of 0 % LEL (fig. 3 and fig. 4).

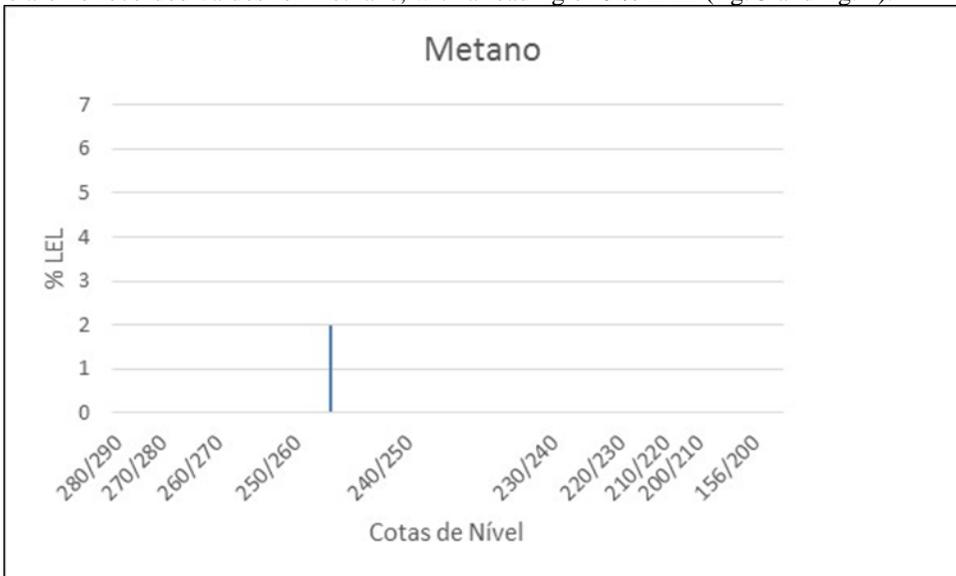


Figure 3 - Methane concentrations in the morning reading periods

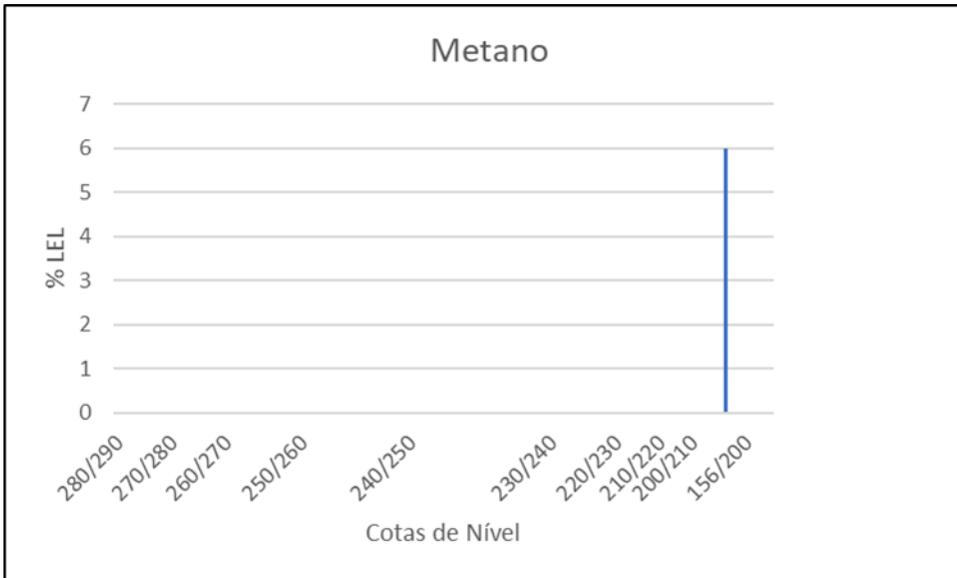


Figure 4 Methane concentrations in the afternoon reading periods

The Carbon Monoxide is observed during the morning. In the afternoon period besides the registers being maintained in the same elevations of the morning, this is also witnessed in 2 more manholes in the middle elevations, in the other elevations of the analysis area no register values are obtained for the gas, this presents a reading of 0 ppm (fig. 5 and fig. 6).



Figure 5 - Carbon monoxide concentrations in the morning reading periods

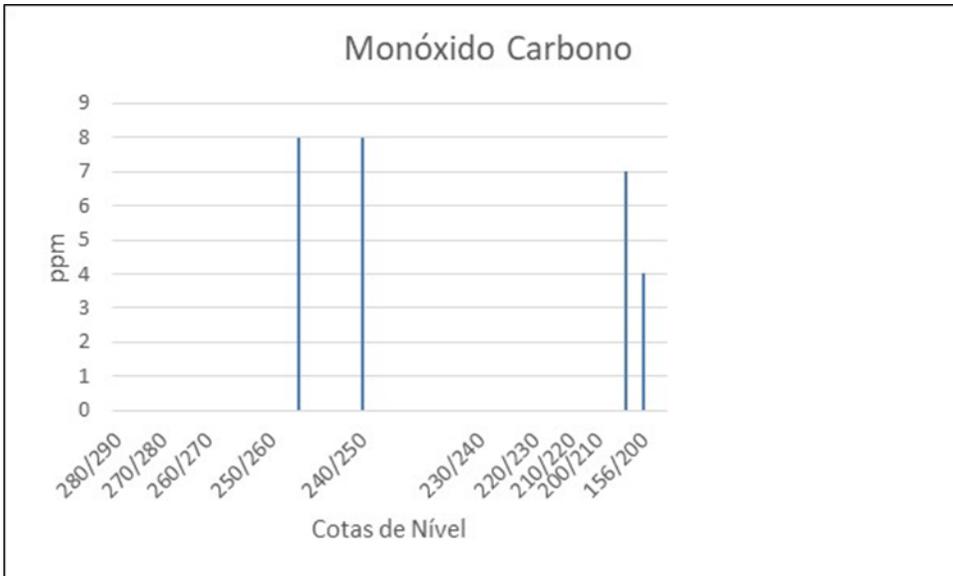


Figure 6 - Carbon monoxide concentrations in the afternoon reading periods

The values of Oxygen, these, present themselves reduced with some expression in two distinct cases. In the other the values within the permissible parameters for the presence of workers (fig. 7 and fig. 8).

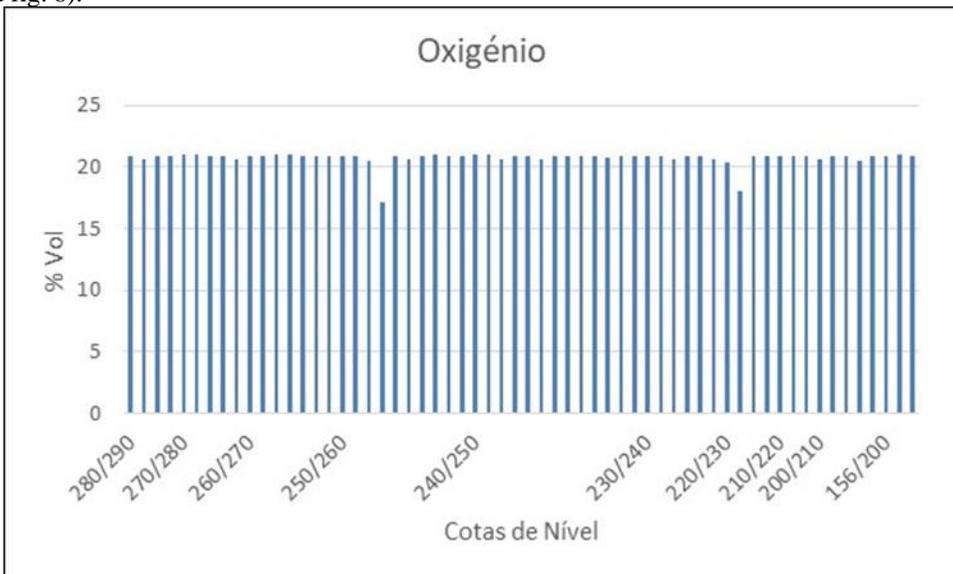


Figure 7 - Oxygen concentrations in the morning reading periods



Figure 8 - Oxygen concentrations in the afternoon reading periods

The manholes studied vary in depth between 0.73 m and 5.48 m.

In the morning period the outside temperatures were always higher than the inside temperature, with the range of 24°C - 34°C for the inside temperatures and the range of 24.4°C - 39.5°C for the outside temperatures.

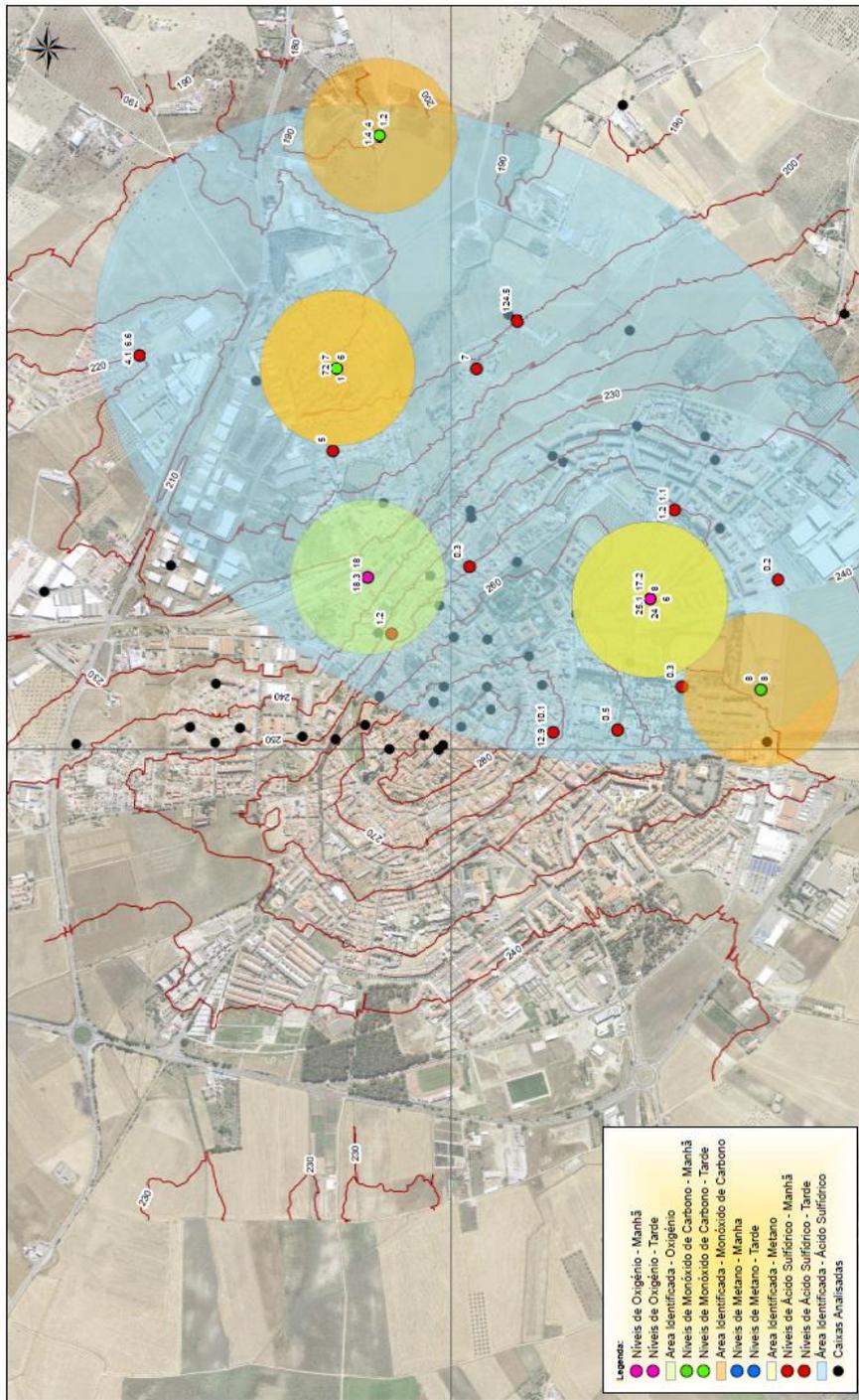
As for the analysis made in the afternoon, the outside temperatures were always higher than the inside temperatures, with the range of 30°C - 40.9°C for the inside temperatures and the range of 31.3°C - 43°C for the outside temperatures.

4. CONCLUSION

By the values obtained, it is verified the existence of the most problematic areas for the integration of workers in future works in the manholes of the urban wastewater network.

It was then elaborated the risk map relative to the manholes of the city of Beja, obtained through the collection and analysis of the collected data (fig. 9).

These maps will be very important to safeguard the integrity of the company's workers, as well as other entities that may have to resort to this infrastructure, such as paramedics, firefighters, subcontractors, among others.



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Figure 9 - Risk map related to manholes in Beja, Portugal

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