THE MOST DANGEROUS MANHOLES IN THE GRAVITY SEWAGE NETWORKS : CASE STUDY

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ABSTRACT

The most dangerous manholes in the gravity sewage networks have been estimated from the field. The emissions from each manhole were inspected from the field at different seasons to determine the most serious manholes in terms of emissions generation. Further, the deaths from emissions exposure have been collected from the news through the last thirteen years (2003-2016). The field inspection revealed that some manholes act as biological reactors gases stripping from sewage according to the fall energy of the wastewater inside these manholes. Further the most serious manholes in terms of emissions generation are those manholes, which contain the largest fall energy for wastewater. Further, the emissions amount which are accumulated inside the serious manholes is directly proportional to fall energy for wastewater and the ambient air temperature outside the manholes, so maximum and minimum accumulation were occurred at summer and winter respectively. The emissions exit rate from the serious manholes is inversely proportional to ambient air temperature outside the manholes. So, in winter, emissions accumulation inside manholes is limited, and its exit rate is fast when the manholes are opened, thus suffocation and death are unlikely. Conversely, in summer, much emission is accumulated within the manholes, then emissions go out at slow rate when the manholes are opened, thus suffocation and death are expected. In Egypt, through the last thirteen years (2003-2016), the maximum and minimum deaths due to the exposure to emissions from sewer lines were recorded at July and January respectively.

Keywords: Sewage, manholes, emissions, temperature, death

1 INTRODUCTION

Generally, gravity sewer system has widespread applications in many countries of the world in general and in the Middle East and Egypt in particular (Short et al., 2014; Pandey, 2016). These networks have many advantages, including ease of operation, as well as lower construction and operating costs compared to other alternatives such as vacuum and tunnel networks (Liu, 2015; Fouad et al. 2014). However, gravitational drainage systems still suffer from some disadvantages, such as repeated deposition and emissions, leading to increased mortality and bottlenecks for maintenance and operation workers (Liu, 2015; Shammay et al., 2016).

Generally gravity sewer systems produce and emit significant amounts of emissions. Many researchers have been interested in studying emissions from gravity sewer networks such as Carrera et al. (2016), Chaosakul et al. (2014), Guisasola (2008), and Liu et al. (2015). They have confirmed that the amount of emissions is increasing with the amount of sediment and biofilm in the network as well as the flow characteristics and conditions (Matias et al., 2017; Liu et al., 2014). However few of these researchers have been interested in studying the dangerous zones and locations of the emissions (Foley et al., 2009). So observation and measurements have been made for clean and unclean gravity sewer networks. Drainage lines online as well as have revealed and field data confirmed that, every network contains a critical zone at which the emission is maximum (Eijo et al., 2015).

The aim of this work is to study the most dangerous parts in gravitational drainage networks, which produce high emissions after monitoring these areas in the field and comparing them with the theoretical studies and previous studies in this regard, in addition to determining the critical periods and times when the highest emissions occur.

2 MATERIAL AND METHODS

In two villages (Al-Raseef and Om-El-Shoaour) of Kafr El-Sheikh Governorate (North Egypt) the manholes were opened on several main sewer lines and their emissions were estimated periodically. With refer to figure 1 and photo 1, the approximated depth of emissions was estimated using lighted candle and thermostat. The amount of emissions approximately was estimated as the raise in temperature in the thermometer. During measurements the emissions in some manholes were exploded and the measurement was canceled. The candle light was clearly enhanced during the measurement s of accumulated emission layer in the majority of manholes.

Several sewage lines were selected One of these sewer lines has a water fall. The observations were repeated every season (Jan, March, July, and September) and for the same the sewer lines. So, maximum and minimum gases-accumulations were observed at summer and winter respectively. The work was carried out during the daylight. For each manhole, the average air temperature, approximate emissions volume, the wastewater discharge, and the fall head of the discharge were estimated by measuring the fall death as well as the sewer diameter, the water depth in the pipe, and pipe slope. Further, the emission time out from each manhole was estimated. Therefore critical manholes in terms of emissions were estimated from field measurements. In addition, critical seasons in terms of emissions were also estimated. Finally the total mortality due to exposure to wastewater was estimated from the published news. The total mortality was observed from 2003 up to 2016 for all zones in Egypt. The total mortality were collected and classified according the months for all zone in Egypt from the news paper and media.

3 RESULTS AND DISCUSSIONS

Figure (2) shows the number of deaths due to exposure to sewage emissions in all zones in Egypt against months in the last 13 years (2003 to 2016). The main death reason was suffocation. The figure shows that about 96 deaths were recorded and published on newspapers and the media. It is clear that the maximum number of deaths was recorded in the summer months (June, July and August) with a total of 54 deaths, i.e. more than half of the total deaths. Conversely, in the winter months (December, January, and February), only five death were recorded. The main reasons of these results in summer months were that: there is low oxygen content in the atmosphere, increase the time period for emissions from the manholes, and increase the amount of emissions. Conversely, in winter months were that: there is high oxygen content in the atmosphere, decrease the time period for emissions from the manholes, and decrease the amount of emissions.

Figure (3) illustrates maximum gases volume inside manholes after two months during summer. The manholes were exactly opened at the end of July. It is clear that, the manhole that has maximum fall energy as (maximum discharge and maximum fall head) has also maximum emissions. It can be concluded that the fall energy inside the manhole causes gases striping according to its fall energy.

Figure (4) illustrates maximum gases volume inside manholes after two months against the fall energy value (Q*H). It is clear that the gases volume increase directly with the fall energy and the air temperature.

Figures (5) and (6) illustrate maximum gases volume inside manholes after two months during summer for such manholes without water fall. It is clear that the gases volume increase directly in the middle part of the line and increase directly with the air temperature. The critical distance is found after 300m from the beginning of the sewer line and before 600m.

Figure (7) illustrates the relation between emission volume against expected exit time it is clear that the exit time of emissions from the manholes is dependent on temperature.

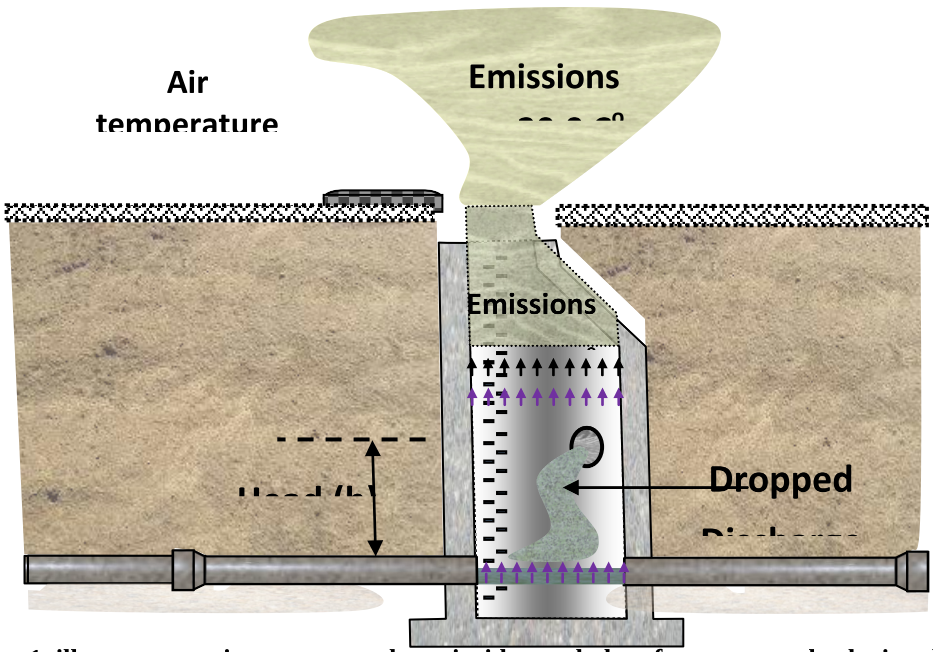

Figure 1. illustrates maximum gases volume inside manholes after two months during different seasons

Figure 2. illustrates the estimation of emissions and manhole properties

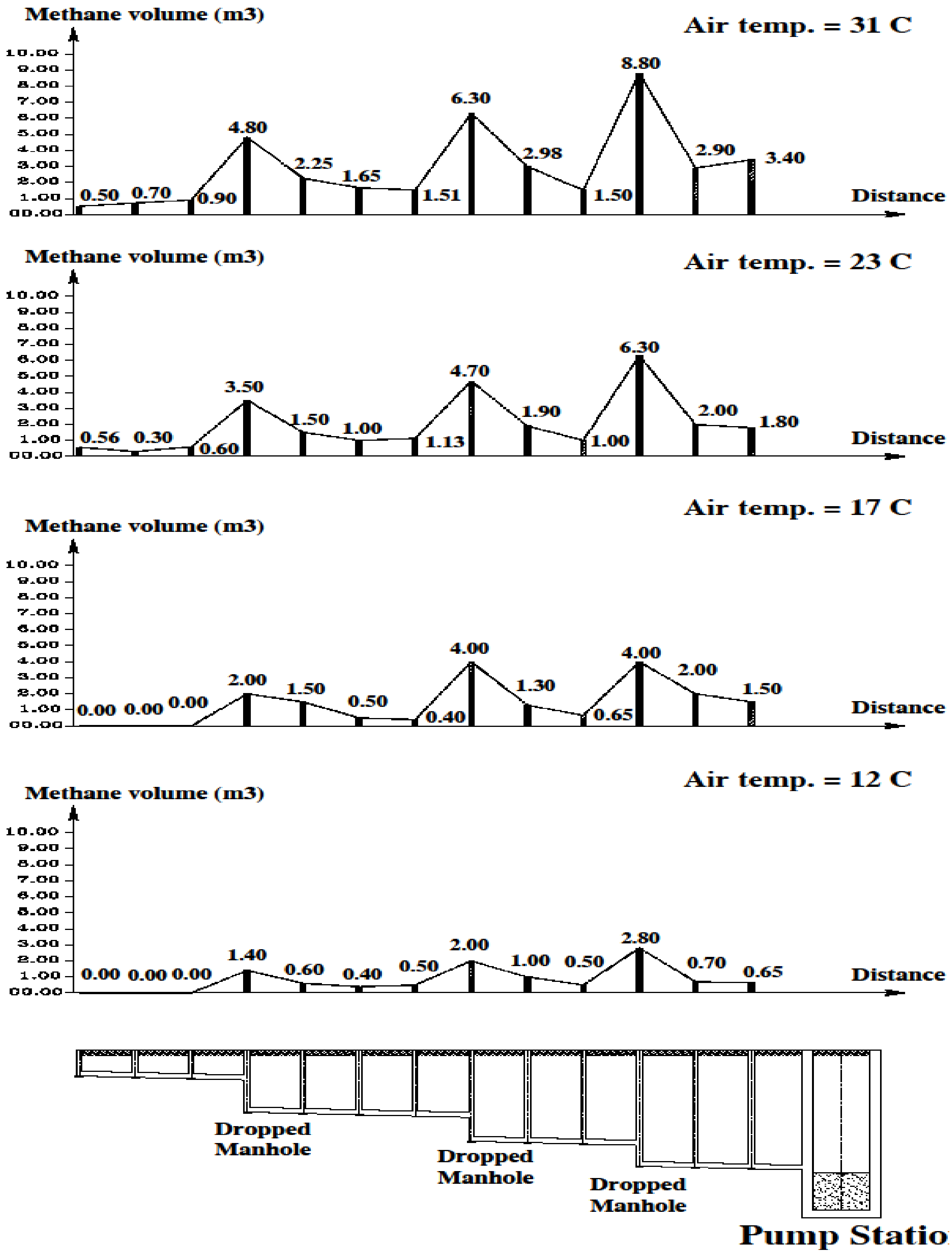

Figure 3. illustrates maximum gases volume inside manholes after two months during different seasons

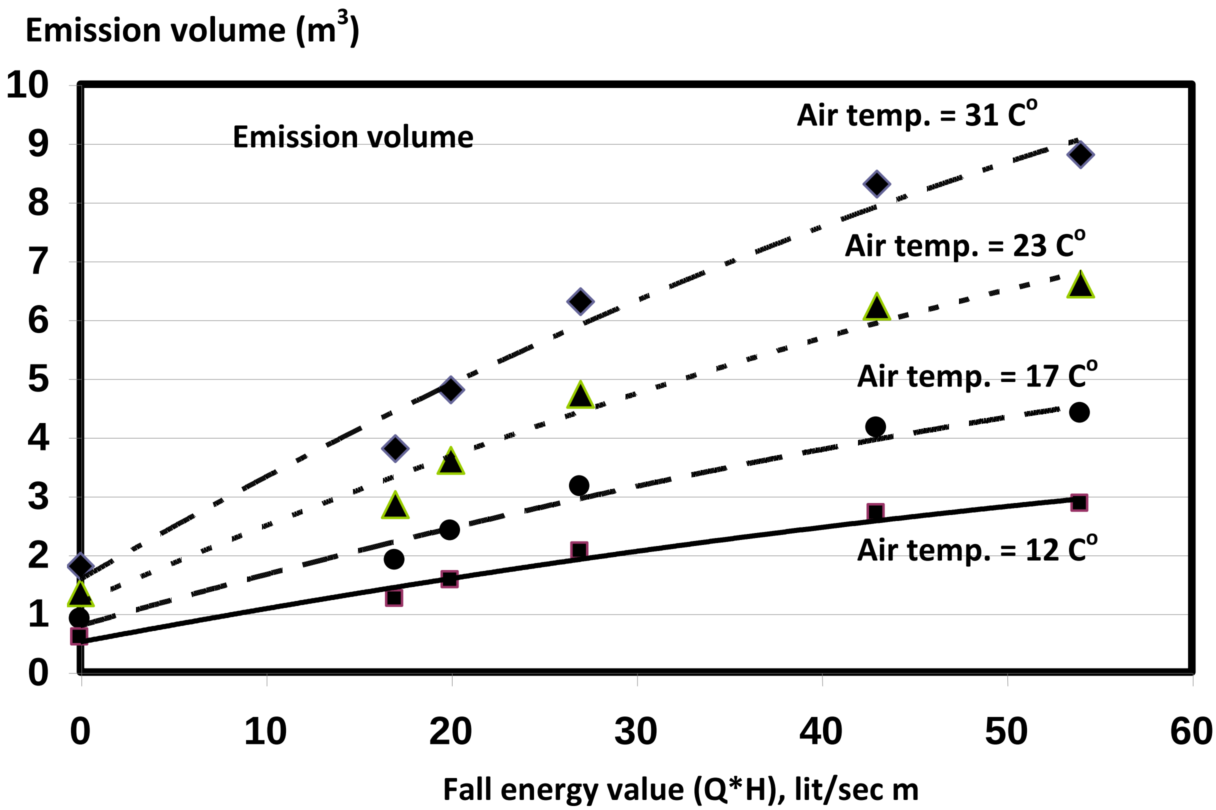

Figure 4.illustrates maximum gases volume inside manholes after two months against the fall energy value (Q*H),

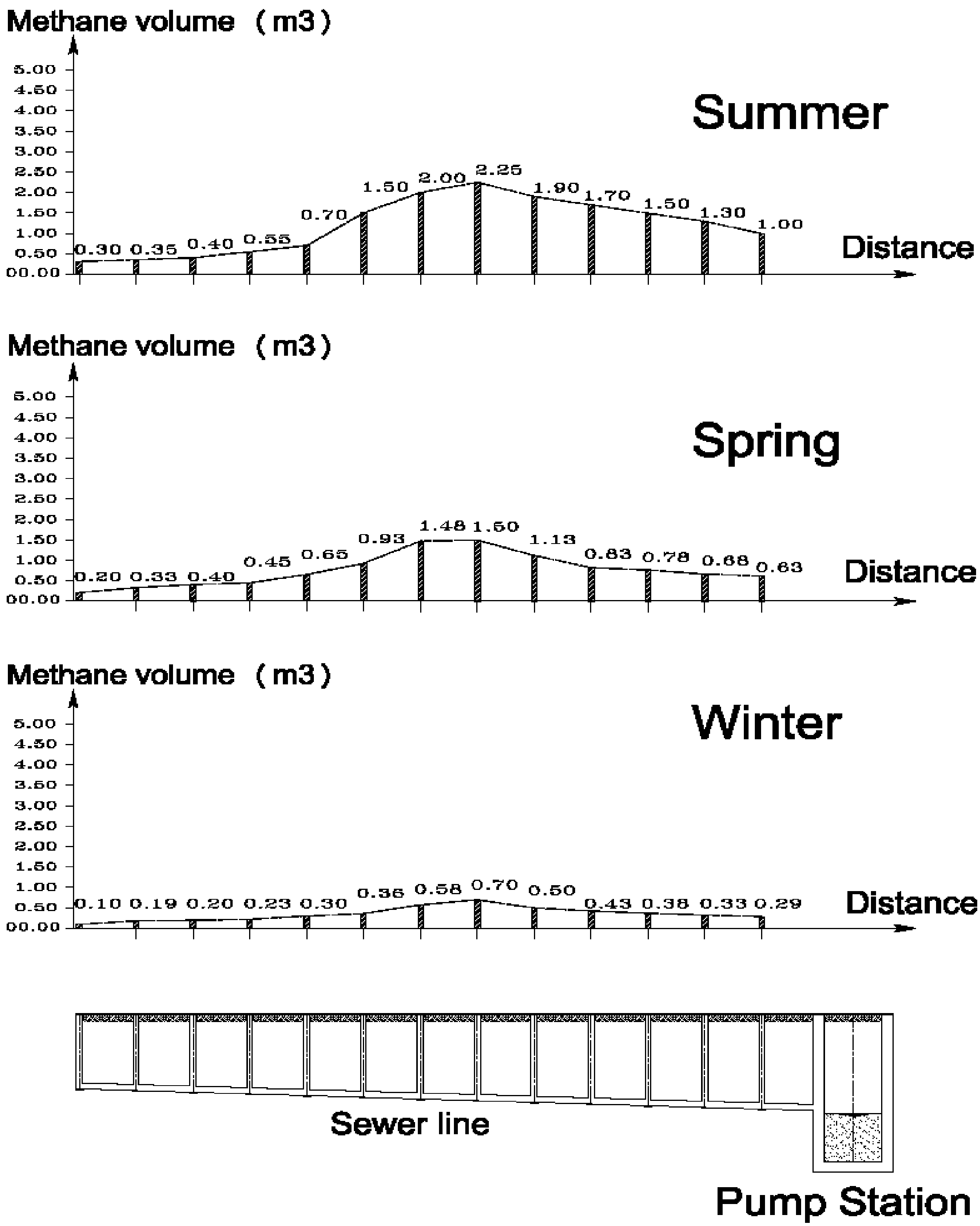

Figure 5. illustrates maximum gases volume inside manholes after two months during summer manholes without water fall

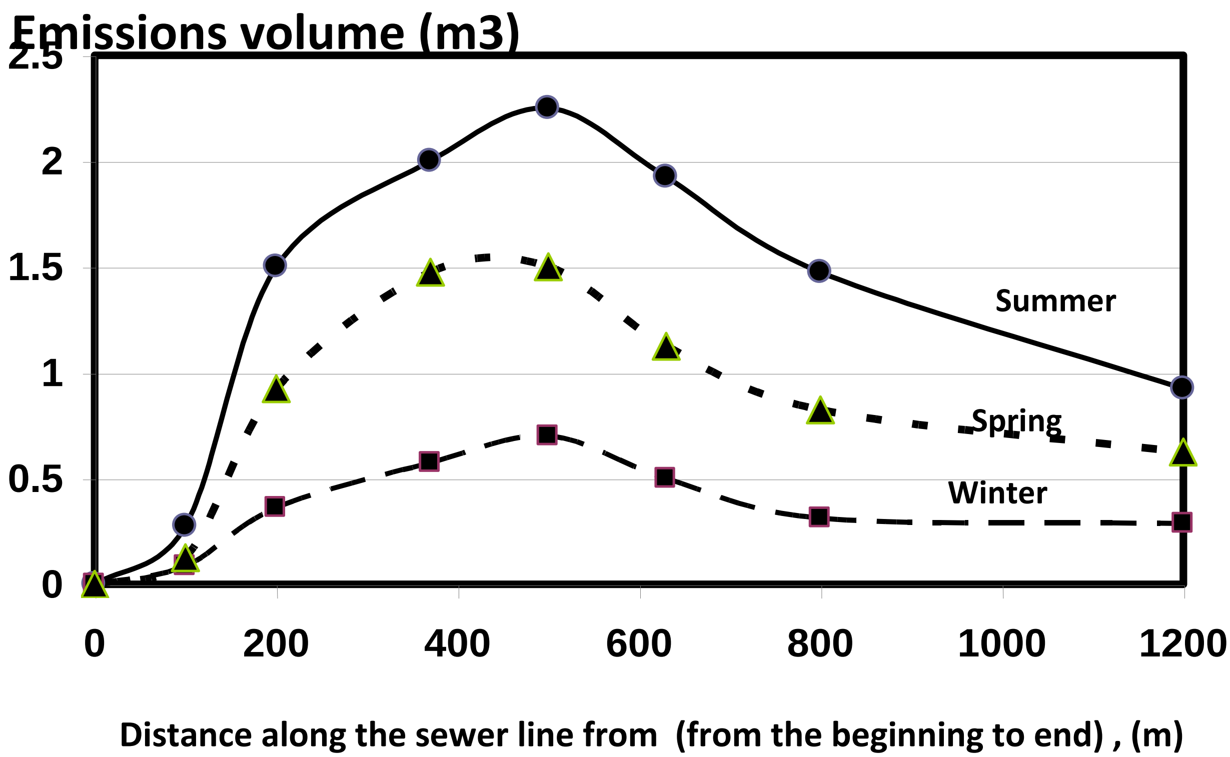

Figure 6 . illustrates maximum emissions volume inside manholes after two months every season against distance along the sewer line

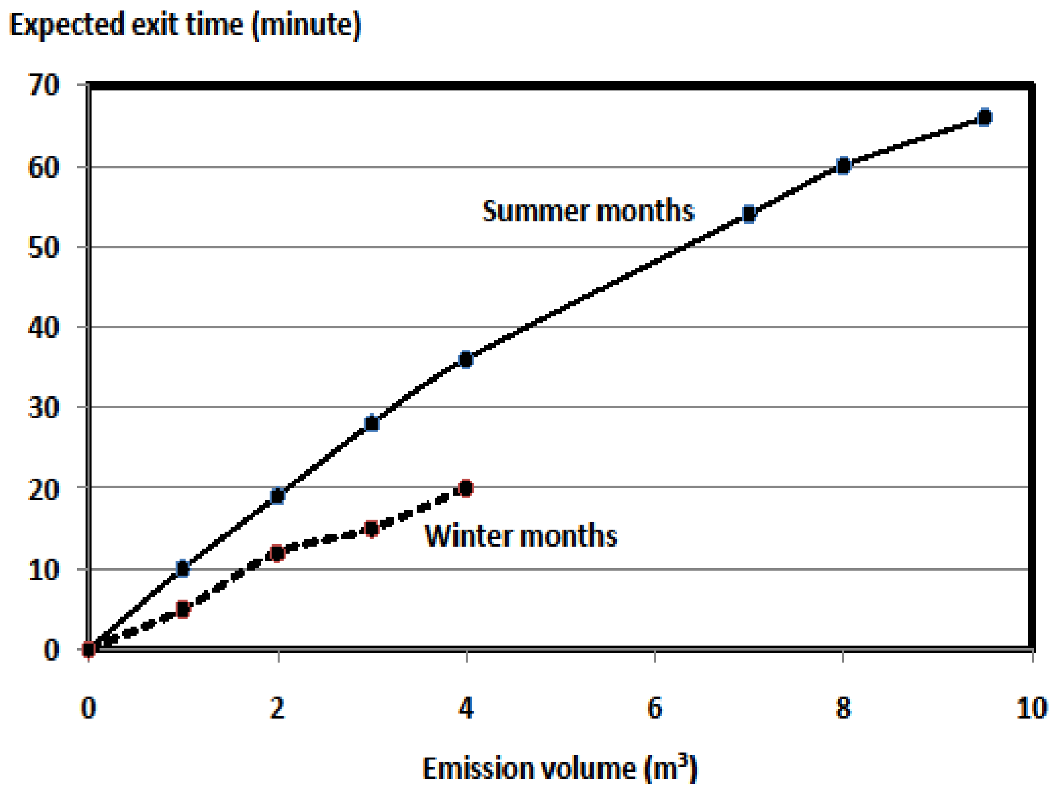

Figure 7. illustrates the relation between emission volume against expected exit time

4. CONCLUSIONS

- In addition to maintenance sewer lines, some manholes act as biological reactors for ammonia and gases stripping from sewage according to the fall energy of the wastewater inside these manholes.
- The most serious manholes in the sewage network in terms of emissions generation are those manholes, which contain the largest fall energy for wastewater.
- The emissions accumulation inside the serious manholes is directly proportional to fall energy for wastewater and the ambient air temperature outside the manholes, so maximum and minimum accumulation were observed at summer and winter respectively.
- The emissions exit rate from the serious manholes is inversely proportional to ambient air temperature outside the manholes.
- In winter, emissions accumulation inside manholes is limited, and its exit rate is fast, so the emissions are released quickly when the manholes are opened, thus suffocation and death are unlikely.
- In summer, the accumulation of emissions are increased within the manholes, in addition, emissions go out at slow rate when the manholes are opened, thus suffocation and death are expected.
- In Egypt, through the last thirteen years(2013-2016), the maximum and minimum deaths due to the exposure to emissions from sewer lines were recorded at July and January respectively.

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