Urban Environmental Pollution
17-20 June 2012 • Amsterdam, The Netherlands
CREATING HEALTHY, LIVEABLE CITIES
UEP 2012

METHANE EMISSIONS FROM URBAN LIGHT DUTY VEHICLES

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Introduction

Compared with CO_2, methane (CH_4) has a much lower concentration in the atmosphere. However, it is a greenhouse gas with much higher infrared absorption capacity. It has already been established that vehicle emission contains CH_4 (Lipman and DeLucchi 2002), whose formation is strongly dependent on the type of emission control system used. In the transportation sector, the methane emission can contributes significantly to the total GHG emissions, considering the lifecycle of the fuel used. The modern vehicles equipped with three-way catalysts, are more efficient in removing CH_4 from the exhaust gases, so it is probable that, with more restricted pollutants emissions limits, automatically the CH_4 emissions will have a tendency to reduce (NESCCAF 2004). A possible exception to that tendency could be the emissions from compressed natural gas (CNG) powered vehicles, although to make that contribution a great environmental impact, it has to have a substantial piece of the fleet powered by CNG.

Materials and methods

Number and characteristics of vehicles tested:

The sample of vehicles tested represents a similar proportion found in the current fleet:
21 light duty vehicles tested (35 tests), including vehicles running with gasohol (gasoline plus 22% of ethanol), ethanol and CNG (compressed natural gas)

Exhaust Emission measurement

For the determination of emissions from exhaust gas, vehicles were tested by the method described in standard ABNT NBR 6601 (ABNT 2005), similar to the procedure used by the EPA (Code of Federal Regulation (CFR), 40 CFR part 86), through the use of the driving cycle FTP-75 - Federal Test Procedure, in the Vehicle Emission Laboratory of CETESB (Figure 1).

Figure 1. Vehicle exhaust emission test

The regulated pollutants were measured by a Horiba analyzer bench series 200 and the analytical methods used were: flame ionization detector (FID) for total hydrocarbons (THC), chromatography equipped with FID for methane, chemiluminescence for nitrogen oxides NOx) and non dispersive infrared (NDIR) detector for carbon dioxide (CO_2). Non-methane hydrocarbons (NMHC) were calculated by subtracting the methane from THC.

Fugitive emissions of methane:

For the measurement of the fugitive methane emission the CNG vehicles remained for an hour inside the evaporation chamber before the dynamometer test and one hour after this test. It was measured the methane emissions from the vehicle inside the chamber during the two periods (Figure 2).

Figure 2. Fugitive emission test

Results

The average percentage standard deviation for the results from the replicate tests was 7.6% for ethanol vehicles and 20.7% for gasohol vehicles. Replicate tests were not performed for the CNG vehicles. The methane exhaust emissions by fuel type are shown in Table 1, and the methane fugitive emissions are shown in Table 2.

Fuel	CH_4 emissions		
	$mg.km^{-1}$	$mg.L^{-1}$	$mg.kg^{-1}$
Gasohol	50	396	489
Ethanol	51	586	781
CNG	590	6,281 [a]	8,001

a: expressed in mg.m-3

Table 1 - Average fuel based emissions for CH_4 measured in exhaust gas

Test	Emission (g)			
	cold fase	warm fase	total	uncertainty
15	0.1087	0.0024	0.1111	0.0360
16	0.0040	0.0274	0.0314	0.0160
19	0.0419	0.0627	0.1046	0.0330
average	0.0515	0.0309	0.0824	0.0283
s.d.[a]	0.0530	0.0303	0.0443	-

Table 2 – Fugitive emissions of methane a: standard deviation

It can be seen that fugitive emission represents approximately 4% of the emission coming from the exhaust gas.

Emission ratios

It is usual to establish ratios between the regulated pollutants and greenhouse gases so that the latter can be estimated from the available data of the former. The ratios for the experiment resulted in the following equations:

Gasohol vehicles: $CH_4 = 0.253 \times THC$
Ethanol vehicles: $CH_4 = 0.217 \times THC$
CNG vehicles: $CH_4 = 0.758 \times THC$

Conclusions

The results show that CH_4 emission can be significant and therefore it can not be neglected in terms of the greenhouse effect, especially considering the largest global warming potential of methane compared to CO_2.
The largest CH_4 emission was observed in CNG vehicles, because of its large methane content. Although the greenhouse gas emissions from vehicles are only a fraction of total global emissions, the increase in world fleet of vehicles could make such emission to increase significantly.

References

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Acknowledgements

The authors would like to acknowledge all the staff of CETESB, especially the workers of the Vehicle Emission Laboratory, for their efforts in performing the tests and analyses, for providing vehicles for this study and for all the their good ideas.