

Brief Research Report

VOLATILE ORGANIC COMPOUNDS IN STREET AIR *

David G. Saliba and Alfred J. Vella[†]

Department of Chemistry, University of Malta, Msida, Malta.

Volatile Organic Compounds (VOCs) are organic compounds which are released to the atmosphere by various industrial sources or through vaporization of oil products. VOCs are chemically reactive and are involved in the chemistry of tropospheric ozone production.

VOCs derived from gasoline combustion and evaporation have deleterious effects on human health [1]. This paper presents the results from a quantitative study on street air pollution from specific VOC compounds, namely benzene, toluene, ethylbenzene, ortho- meta- para-xylenes, methyl tert-butyl ether, tert- amyl methyl ether (TAME), ethyl tert- butyl methyl ether (ETBE), 2-methylpentane, 3-methyl pentane and isooctane as found in street air in Malta in the months of January to April 2001 and, in particular, how the street air pollution was affected by the activities of fuel service stations (FSS).

VOCs in air were adsorbed onto charcoal sorbents which were then extracted with carbon disulphide. The resulting solution was analysed by gas chromatography/flame ionisation detection (GC/FID).

Ambient air levels of benzene and toluene away from FSS ranged from $10.5 \mu\text{g m}^{-3}$ to $57.2 \mu\text{g m}^{-3}$ and $6.3 \mu\text{g m}^{-3}$ to $30.1 \mu\text{g m}^{-3}$ respectively. The risk criterion proposed by the World Health Organisation, which considers as “socially acceptable” the risk of 22 to 37 additional cases of leukaemia every million people, is equivalent to a concentration of $5 \mu\text{g m}^{-3}$ benzene, and as a consequence was set as the limit concentration for urban air [2].

Active air samples were taken from Hamrun, Paola, Mosta and Msida. These locations represent densely populated urban zones with main arterial roads that are not in the vicinity of FSS. Passive air samples were taken from Hamrun, Birkirkara and Qormi. These represent areas having FSS amidst densely populated urban zones.



Figure 1: A map of Malta showing the Sampling Locations

This study found a strong correlation between wind speed and VOC concentration in Hamrun ($r^2 = 0.9329$) and Paola ($r^2 = 0.8542$) while no such correlation was found in Mosta ($r^2 = 0.2816$) and Msida ($r^2 = 0.3129$).

This study also found a clear diminishing trend of pollutant air concentration with distance from FSS (benzene: $140.3 \mu\text{g m}^{-3}$ at the forecourt of the Qormi service station, decreasing to $15.8 \mu\text{g m}^{-3}$ 130 m down the road).

A sharp shift in the ambient air benzene/toluene (B/T) ratio from 0.25 in Sliema and 0.32 in Msida in 1999 [3] to 1.80 at both sites as measured in this study was observed. The main reason for this observation is likely to be the increased quantity of benzene found in premium gasoline introduced to the market during the period of this study (the B/T ratio in liquid gasoline increased from 0.170 (1999) to 0.896 (2001)).

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[†] Corresponding Author. Tel. +356 2340 2275 e-mail: alfred.j.vella@um.edu.mt

The values of the mole fraction of ethylbenzene (ϕ_E) expressed in terms of the isomeric mixture of compounds (ethylbenzene and xylenes) for air samples in the vicinity of the Qormi fuel service station range from 0.22-0.30 (Mean 0.28; CV 8.8%) and this compares well with a value of 0.29 for headspace gas above liquid gasoline. This strongly suggests gasoline evaporative emissions as the main source of VOC pollution in the vicinity of the FSS.

The value of (ϕ_E) for air samples away from FSS ranged from 0.14 – 0.27 (Mean 0.18; CV 17%). This strongly suggests a separate source of VOC pollution away from FSS, probably vehicular, tailpipe emissions.

References:

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- [3] Zammit M. *Influence of Service stations on Air Quality*, B.Sc. (Hons) Dissertation, University of Malta (1999)