Assessing the impact of petrol stations on their immediate surroundings

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Article history:
Received 11 January 2010
Received in revised form 9 July 2010
Accepted 7 August 2010
Keywords: Petrol stations; Volatile organic compounds; Aromatic/aliphatic concentration ratio

Abstract

This paper describes a novel methodology for evaluating the extent to which petrol stations affect their surroundings. The method is based on the fact that the ratio of the concentrations of aliphatic and aromatic hydrocarbon pollutants in the air of the petrol stations and their surroundings (basically determined by vapor emissions from unburned gasoline) differs from the ratio found in urban air, which is mainly in À X H Q F H G E \ W U D I ¿ F H P L V V L R Q V

2. Experimental section

2.1. Location

The study was carried out in the city of Murcia, located in the south-east of the Iberian Peninsula, which is characterized by very low annual rainfall (around 375 l/m²), annual average temperature of 18C and extreme temperatures of 40-45 C in summer and 20C in winter. The air of the urban surface of the city, around 465 hm², was the subject of the study with regard to VOC concen

active charcoal in the passive samplers was carried out XVLQJ FDUERQ GLVXOILGH) regarding solvent desorption can be found in González Ferradás et al., 2010. A gas chromatograph (HP 6890, Agilent Technologies, Inc., Santa Clara, California (US)) equipped ZLWK D ÀDPH LRQL]DWLRQ GHWHFWRU DQG D VHPL-FDSLOODU\ FROXPQ - : 6FLHQWL¿F lo QJ DQG PP L G ¿OP Agilent Technologies, Inc., Santa Clara, California (US)) was used for quantitation. The oven temperature was programmed from 50C (0 min) at 10C/min to 80C (10 min) and at 10C/min to 200C (10 min). The injector and detector temperatures were 250 and 350C, respectively, and the ÀRZ UDWH RI WKH FDU (N2) was 40 ml/min. Operational procedures (sampler set up and recovery, desorption and analysis of VOCs) were developed in order to assure comparable results.

Once the mass of each hydrocarbon was known, mi, the concentration

The next step was to draw the isoconcentration curves of the two hydrocarbons with the highest relative difference in ratios, radiating from the petrol station by means of suitable software, in this case SURFER 8.0 (Golden Software Inc., Golden, Colorado (US)), and using as inputs the concentration data of the passive samplers located inside (3 points) and around the petrol station (12 points). It was also necessary to include some background concentrations taken from the urban monitors. These graphs permit us to obtain the concentration values of each selected pollutant at different distances from the petrol station in each primary direction (N, S, E and W). The extent of the influence of the petrol station is taken as the point along each direction where the ratio becomes equal to the urban background ratio.

4. Results and discussion

4.1. Meteorological data

The average temperature during each campaign was 19.7C and 23C, respectively. With regard to wind speed, the average value

the ratio but they can proportionally affect the concentration changes of both compounds in

in the petrol station, where the air was mainly characterized by unburned gasoline vapours. These findings were corroborated by their autoignition temperatures, being 498, 260 and 240C for benzene, cyclohexane and n-hexane, respectively (INSHT, 2003).

Selected pollutant (n-hexane and benzene) isoconcentration curves for each campaign were obtained by means of SURFER 8.0, selecting a multiquadric interpolation (Figs. 3 and 4, respectively), using as inputs the concentration data of the 15 passive samplers located inside and in the vicinity of the petrol station. Only one point representative of the petrol station was used, obtained from the average concentration of the three passive samplers located inside the station. It was also important to use as input several concentration values typical of the urban air to set the

Table 3
0D[LPXP VSDWLDO LQÀXHQFH GLVWDQFH E\ RQ ³LQ)LHOG´ PHDVXUHPHQWV WKURXJK
two sampling campaigns.

Direction	1st Campaign	2nd Campaign
North	60	75
South	36	49
East	60	67
West	25	39
Average	45	58

Finally, we should remember that it is necessary to aim at avoiding the impact of any type of major pollution source on the population. As has been shown before, in the W direction, the LQÀXHQFH RI WKH SHWURO VWDWLRQ was lower because a different pollution source was even more important than the one coming from the petrol station with the subsequent harmful effects of that source on the population. Minimization of concentrations of chemicals of concern, regardless of their sources, is indispensable for effective health protection.

5. Conclusions

In this work, we present a methodology for estimating the spaWLDO LQÀXHQFH RI SHW on their surroundings based on the fact that the concentration ratio of n-hexane and benzene found in the air of the petrol stations is different from that found in city air (mainly determined by motor vehicle exhaust). The ¿UVW point in each geographical direction moving away from the petrol station where the ratio becomes equal to the urban background ratio

Acknowledgements

7KLV ZRUN ZDV FDUULHG RXW ZLWK WKH ¿QDQFLDO VXSSRUW RI WKH Council of Murcia and the technical help of the volunteers who collaborated in the setting and collection of the diffusive samplers. We would also like to acknowledge the contributions of the anonymous reviewers which have GH¿QLWHO\ LPSURYHG WKH TXDOLW\ RI this article.

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