Organic Compounds and Elemental Carbon in PM of Milan (Italy): effect of a Low Emission Zone

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The problem of air pollution is particularly evident in heavily populated areas. Since traffic is considered the main source of pollution in urban areas (Perrone *et al*., 2012), many cities have introduced Low Emission Zones (LEZ) in order to reduce traffic and limit the circulation of the most polluting vehicles. The city of Milan, starting from January 2012, established a system of road pricing to the central area of the city named "Area C".

Total Suspended Particulate (TSP) has been sampled at two sites in Milan. They are representative of the urban atmosphere of the city,, one internal to Area C (Via San Vittore, IN) and one external to it (Torre Breda, OUT). The concentration of Polycyclic Aromatic Hydrocarbons (PAHs), n-alkanes (ALKs), organic and elemental carbon (OC, EC) was determined in order to assess the effect of the introduction of the low emission zone on these compounds.

PAHs are an important class of compounds because of their high toxic potential. Their origin is mainly anthropogenic and they are almost exclusively emitted from combustion processes. Linear alkanes are issued by both anthropogenic (combustion processes) and natural sources (biogenic emissions). EC is emitted only from combustion sources and it is a marker of traffic source.

The sampling campaign was carried out during autumn 2013 (2-15 October 2013) and a total of 20 samples were collected (10 per site) using a gravimetric high volume sampler (200 l min^{-1}, on 11.0 cm Ø quartz fiber filters). TSP samples were extracted in dichloromethane by a ultrasonic bath and analyzed by GC-MS for PAHs (20 PAHs, 3 to 6 aromatic rings) and ALKs (15 ALKs from C20 to C32). A spot of each filter was analysed by thermal-optical transmittance technique for EC and OC.

TSP concentrations were rather similar in the two sampling sites; the average TSP concentration was 55 (± 19) µg m^{-3}, with a minimum and maximum value of 15 and 80 µg m^{-3} respectively.

The average PAH concentration (sum of 20 PAHs) was 3.37 (±2.19) ng m^{-3}. There was a good correlation (R^2=0.86) as regards the concentration of PAHs in the two sites, with a decrease moving from the site external to the LEZ toward the internal site (mean reduction of 25%). The distribution pattern of PAHs was the same at the two sites: the most abundant turned out to be benzo(b)fluoranthene + benzo(j)fluoranthene (20%), pyrene (15%) and benzo(g,h,i) perylene (12%),

Linear alkanes were present in concentrations ranging from a minimum of 20 ng m^{-3} to a maximum of 70 ng m^{-3} (sum of C20 to C32). The most abundant were C29, with an abundance of 15% of the total number of alkanes analyzed, followed by C27 (11%), C31 (11%) and C25 (9%). The trend followed by alkanes was not very clear and definite: the concentrations were similar in the two sampling and there wasn't a substantial reduction within the LEZ.

The average OC and EC concentration was 8.2 (±0.9) µg m^{-3} and 2.1 (±0.4) µg m^{-3} respectively. While the OC concentrations did not vary significantly between the two sites, a significant reduction of EC concentration in the Area C was measured (mean reduction of 36%).

Table 1. Average concentration, standard deviation and percentage ratio between IN (inside LEZ) and OUT (outside LEZ) concentrations

	average conc. (ng m3)	**St. Dev**	**IN/OUT%**
PAHs	2,56	1,64	75
ALKs	46	16,8	84
OC	$8{,}2*10^3$	2,7	85
EC	$2{,}1*10^3$	1	64

The concentrations of PAHs and EC within Area C show higher reductions than alkanes and OC. This is due to the fact that both PAHs and EC are emitted from combustion processes and from the traffic source (Perrone *et al*, 2014). This highlights the fact that LEZ can effectively reduce the concentrations of PM components (PAHs and EC), which are recognized hazardous for their negative effects on health.

Perrone M.G., et al., (2012), Science of the Total Environment **414**, 343-355

Perrone M.G., et al., (2014), Atmospheric Environment, **82**, 391-400.