European Commission

Science for Environment Policy

Subway stations with platform sliding doors and good ventilation reduce passengers' exposure to $PM_{2.5}$

Underground trains are among the most widely used public transport systems in cities worldwide. A study investigating the chemical composition and source of particles in Barcelona subway stations found that a new station design, with sliding doors that separate the platform from the tunnel and good ventilation, reduced the concentration of fine particulate matter ($PM_{2.5}$) by over 50% compared with older station designs.

People who commute using subways may be exposed to harmful air pollutants, such as particulate matter (PM), which has been linked to health problems including heart and respiratory diseases. In subways, potential sources of PM include the wear of brakes, wheels and rails, as well as outdoor air that enters subway stations through ventilation systems and entrances.

This study, partly supported by two EU-funded projects[1,2], investigated the air quality in subway stations in Barcelona, Spain. The researchers identified the concentration, chemical composition and sources of fine particulate matter ($PM_{2.5}$).

During two seasonal periods (warm – April to July 2013, and cold – October 2013 to March 2014), high volume samplers were used to collect $PM_{2.5}$ on the platforms of four stations, representing different designs. Three stations were older, designed with one or two rail tracks (with or without a dividing wall between tracks). The fourth station was new and had sliding screen doors across the platform, separating it from the tunnel. They also measured $PM_{2.5}$ in outdoor air at an urban station in Barcelona for comparison.

Analysis of the samples revealed variable $PM_{2.5}$ concentrations at the different stations and during the two seasons. At all stations, $PM_{2.5}$ concentrations were higher in the colder period than in the warmer period, likely due to increased ventilation in the warmer period, which increases dispersion of $PM_{2.5}$.

$PM_{2.5}$ concentrations were over 50% lower in the new station, on average, compared with the older stations. This, the researchers say, is likely due to the sliding door, which keeps the tunnel air separate from the platform. Better ventilation in the new station and (in this case) fewer trains running through the station likely also contributed to the lower $PM_{2.5}$ concentration. However, $PM_{2.5}$ concentrations were 1.4 to 5.4 times higher in all subways compared with outdoor air.

The researchers also analysed the chemical composition of the samples, which they used to identify the sources of the $PM_{2.5}$. Around 76–98% of the $PM_{2.5}$ was made up of iron-containing compounds (mainly in the haematite oxidised form), carbon-containing aerosols, dust particles, ions, sea salt and trace elements.

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1. HEXACOMM (*Human exposure to aerosol contaminants in modern microenvironments)* is funded under the European Commission's Seventh Framework Programme. http://hexacomm.nilu.no/

2. IMPROVE (Implementing methodologies and practices to reduce air pollution of the subway environment) is funded by the European Commission's Life+ Environment Policy and Governance Programme. http://improve-life.eu/

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(continued)

The largest component of $PM_{2.5}$ (28–65% of the total) was haematite, generated mainly from the abrasion of rail tracks, wheels and brake pads. The concentration of haematite was approximately 60% lower in the new station than in the older stations, where the tunnel was not separated from the platform. Based on this finding, the researchers suggest that haematite detected on the subway platform originated in tunnels.

Concentrations of some trace metals, particularly barium, copper, manganese and zinc, were higher in subways than in outdoor air. They were also higher in the colder period compared with the warmer period (again likely due to stronger ventilation in the warmer months). The lowest trace metal concentrations were found in the new station. Differences in trace metal concentrations between stations also reflected different types of materials used in wheels, brake pads and rail lines, for example.

Stronger ventilation and reducing the metal content of rail tracks and trains could reduce metal exposure in subways. Overall, the researchers say their findings show that better control of station ventilation, improved subway station design and careful choice of materials can improve air quality in subway stations.

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