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Impact of vehicular exhaust on ambient air quality of Rohtak city, India

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Abstract: *In the present study, ambient air quality of Rohtak city (Haryana) was monitored by High Volume Sampler .The selected parameters to judge the quality of air were Sulphur dioxide (SO_2), Nitrogen dioxide NO_2), Ozone (O_3) and Suspended particulate matters (SPM) which give a fair idea of pollution load carried by the air. The monitoring data were collected from six sites randomly selected in Rohtak city. Sulphur dioxide was found below the permissible limits of National Ambient Avo Quality Standards (NAAQS) at all the sites. Higher concentration of SO_2 was observed during winter in comparison to summer and monsoon seasons. Nitrogen dioxide concentration was found to be above the prescribed standards of NAAQS at four sites in winter season. Ozone concentration was found below the prescribed standards (NAAQS), but its concentration was higher in summer season as compared to winter. Suspended particulate matter concentration was observed above the safety limits at all the sites in all three seasons.*

Key words: *SPM, Sulphur dioxide, Nitrogen dioxide, Ozone*
PDF of full length paper is available online

Introduction

Environmental pollution is a common problem in both developing and developed countries. Every year large quantities of toxic wastes are discharged into the environment from the ever increasing production of goods and from the burning of fossil fuels to generate the energy needed to sustain industrial and domestic activities. Sulphur dioxide, nitrogen dioxide and suspended particulate matter (SPM) are regarded as major air pollutants in India (Agrawal and Singh, 2000). In the developing countries, air quality crisis in cities is attributed to vehicular emission which contributes to 40-80% of total air pollution (Ghose *et al*., 2005). The urban population is mainly exposed to high levels of air pollution including metals because of motor vehicle emissions, which is also the main source of fine and ultrafine particles (Sharma *et al*., 2006), which influence the air quality. These particles can penetrate deep into the respiratory system, and studies indicate that the smaller the particle, more severe the health impacts (Pope *et al*., 1995). The impact of vehicular pollution on human health in urban areas is at peak level as vehicle emissions are near the ground level where people live and work. Atmospheric pollutants exist in both gaseous and pollutants forms. Diesel exhaust, in addition to generating pollutants like hydrocarbons, oxides of nitrogen and carbon is a major contributor to particulate matter in most places of the world. Symptoms like chronic cough, wheezing and breathlessness have been reported on exposure to these pollutants (Chabra *et al*., 2001).

India has 23 major cities of over 1 million people and ambient air pollution exceeds the WHO Standards in many of them. (Gupta *et al.*, 2002.) Suspended particulate matter in ambient air is a complex, multiphase system consisting of particle sizes ranging from <0.01μm to >100μm (Wan- Kuen *et al.*, 2005,2006). Nanoparticles (Particles <0.1 μm) in mass median aerodynamic diameter have been postulated to affect cardiopulmonary system (Nel, 2005). Urban areas exhibit both the highest level of pollution and largest target of impact on human health (Goyal and Sidhartha, 2003). Diesel and Petroleum exhaust contain various substances, which are harmful to human beings (Gurjar *et al.*, 2004; Boralkar *et al.*, 1992).

The reasons for faster urbanisation of Rohtak may be due to its being very near to Delhi. Rohtak has seen tremendous increase of vehicles with uncontrolled exhaust. Air pollution in Rohtak city is increasing day by day due to vehicular exhausts. Hence ambient air quality of the city has been monitored in the present study.

Materials and Methods

Six sampling sites were selected in Rahtak city located at 70 kms from Delhi (a metropolitan city) towards North having an area of 441100 ha on the basis of vehicular density and population *i.e.*:
University campus (low traffic density, thin populated);
Delhi bye pass (High traffic density, low populated);
Medical mor. (City centre, moderate traffic, thickly populated);
New bus stand (High traffic density and thickly populated);
Bhiwani stand (High traffic density and thickly populated);
Hissar road (High traffic density and moderate populated).

Sampling and procedure: In the present study ambient air quality was monitored using 'High Volume Sampler' (Envirotech APM 415-

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411) eight hr daily for suspended particulate matter (SPM) and four hr daily for gaseous pollutants in winter, summer and monsoon seasons with a frequency of once in a week. For Suspended particulate matter, the ambient air was filtered through glass microfibre filter paper GF/A (20.3 x 25.4 cm). The SPM present in the air thus got deposited on the surface of filter paper. The filter paper was reweighed after sampling, which gives the amount of SPM in the air during that time period and this concentration of the particulate matter in ambient air was then computed on the net mass collected, divided by the volume of air sampled.

For gaseous pollutants (SO_2 and NO_2), sampling was done at an interval of four hr in a day. SO_2 concentration was analyzed by modified West and Gaeke (1956) pararosaniline method. In this method SO_2 was absorbed in absorbing solution of potassium tetrachloromercurate solution and formed a complex of dichlorosulphitomercurate. The complex was made to react with pararosaniline and formaldehyde to form intensely coloured pararosaniline methylsulphonic acid. The absorbance of the solution was measured at wavelength of 560 nm. NO_2 concentration in the ambient air was monitored by sodium arsenite method (Margeson, 1977). NO_2 was absorbed in absorbing solution of sodium hydroxide and sodium arsenite to form a stable solution of sodium nitrite and was determined at a wavelength of 540 nm by reacting the exposed absorbing reagent with phosphoric acid, sulphanilamide and N (1-napthyl) ethylenediamine dihydrochloride. Ozone present in the ambient air was determined by buffered potassium iodide method (Byers and Saltzman, 1958).Ozone liberated iodine with this method in a 1% solution of potassium iodine at pH 6.8. Iodine was determined spectrophotometrically by measuring the absorption of triiodide ion at 352 nm.

Air quality index (AQI): The air quality index is a tool used by EPA (2000) and other agencies to provide the public with timely and easy-to-understand information on local air quality and whether air pollution levels pose a health concern. The higher value (above 125) of an index refers to a great level of air pollution (Severly polluted).

The air quality index (AQI) was calculated by the following formula:

$$AQI = 100 \times \frac{\text{Observed mean concentration of a pollutant}}{\text{Standard for the respective pollutant}}$$

Results and Discussion

The study has shown variation in the pollutant levels during winter, summer and monsoon season in the city ambient air quality.

Sulphur dioxide (SO_2): The mean value of SO_2 at University campus, Hissar road, Medical mor, New bus stand, Delhi bye pass and Bhiwani stand was 14.00, 38.52, 24.68, 22.13, 29.35 and 38.38 µg m^{-3} in winter; 12.97, 32.03, 20.08, 22.68, 18.43 and 28.59 µg m^{-3} in summer and 9.25, 29.39, 17.62, 21.38, 18.41 and 27.21 µg m^{-3} in monsoon seasons respectively (Fig. 1).

The average level of SO_2 was below the permissible limit (80 µg m^{-3}) as prescribed by NAAQS at all sites in all the three seasons. SO_2 was found to be maximum in winter season at Hissar road and minimum at University campus in monsoon season.

Nitrogen dioxide (NO_2): The mean value of NO_2 at University campus, Hissar road, Medical mor, New bus stand, Delhi bye pass and Bhiwani stand was 42.59, 117.90, 79.99, 81.54, 86.26 and 118.35 µg m^{-3} in winter, 40.02, 113.73, 79.13, 75.41, 84.36 and 105.14 µg m^{-3} in summer and 37.59, 93.75, 54.04, 70.24, 63.53 and 89.90 µg m^{-3} in monsoon seasons respectively (Fig. 2).

NO_2 mean level exceeds the prescribed NAAQS (80 µg m^{-3}) at New bus stand, Delhi bye pass, Bhiwani stand and Hissar road in winter, at Delhi bye pass, Bhiwani stand and Hissar road in summer and at Bhiwani stand and Hissar road in monsoon season. NO_2 level remains within safety limit (Gupta *et al*., 2002) at Medical mor and University campus in all the three seasons. The mean NO_2 concentration was observed maximum at Bhiwani stand in winter season and minimum at University campus in monsoon season.

Ozone (O_3): The mean value of O_3 at University campus, Hissar road, Medical mor, New bus stand, Delhi bye pass and Bhiwani stand was 4.38, 53.81, 6.82, 20.50, 18.82 and 51.62 µg m^{-3} in winter; 6.94, 81.95, 12.93, 22.27, 19.60 and 68.26 µg m^{-3} in summer and 2.95, 36.01, 7.12, 19.19, 12.35 and 27.24 µg m^{-3} in monsoon seasons respectively (Fig. 3).

O_3 peak level was found to be higher in summer season in comparison to winter and monsoon seasons. The mean level of O_3 remains within safety limit (Gupta *et al*., 2002) at all the sites. O_3 was found to be maximum in summer season at Hissar road and minimum at University campus in monsoon season.

Suspended particulate matter (SPM): The mean value of SPM at University campus, Hissar road, Medical mor, New bus stand, Delhi bye pass and Bhiwani stand was 404.54, 1310.76, 757.22, 756.87, 771.44 and 1146.13 µg m^{-3} in winter; 354.93, 1216.37, 704.56, 686.86, 678.70 and 1025.39 µg m^{-3} in summer and 245.14, 915.91, 593.86, 607.12, 414.72 and 785.74 µg m^{-3} in monsoon seasons respectively (Fig. 4).

SPM was found to be highest at Hissar road in winter season and lowest at University campus in monsoon season. The level of SPM was observed above the safety limit (Gupta *et al*., 2002) at all the sites in all the three seasons, except University campus in monsoon season.

The AQI at different sites reveled that University campus was fairly clean, Delhi bye pass, New bus stand, Medical mor were moderately polluted, Bhiwani stand was heavily polluted sites and Hissar road was severely polluted site (Table 1).

The major causes of increased emission of pollutants in urban area include the use of poor quality fuel, traffic congestion and badly maintained motor vehicles. Impact of vehicular pollution

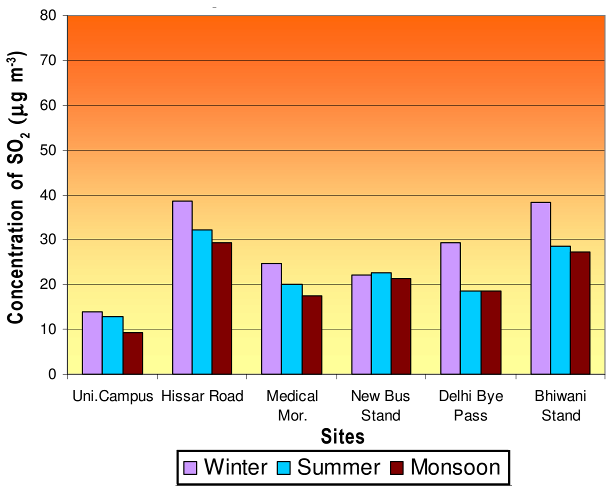

Fig. 1: Concentration (µg m^{-3}) of SO_2 at different sites of Rohtak city

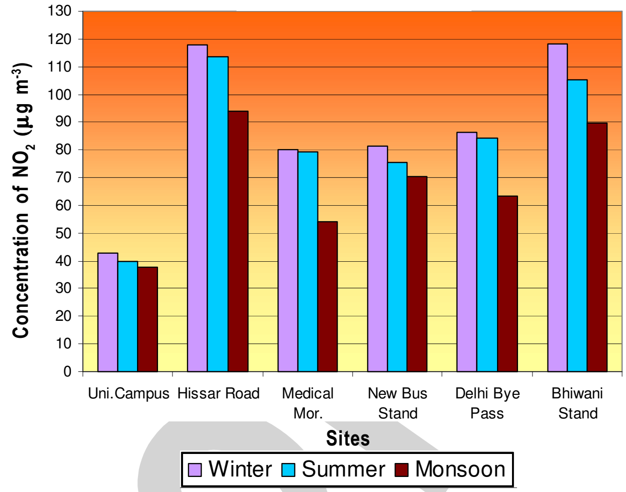

Fig. 2: Concentration of NO_2 (µg m^{-3}) at different sites of Rohtak city

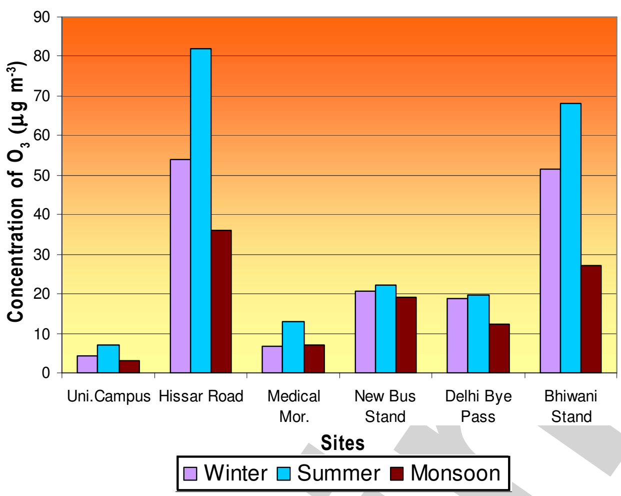

Fig. 3: Concentration of O_3 (µg m^{-3}) at different sites of Rohtak city

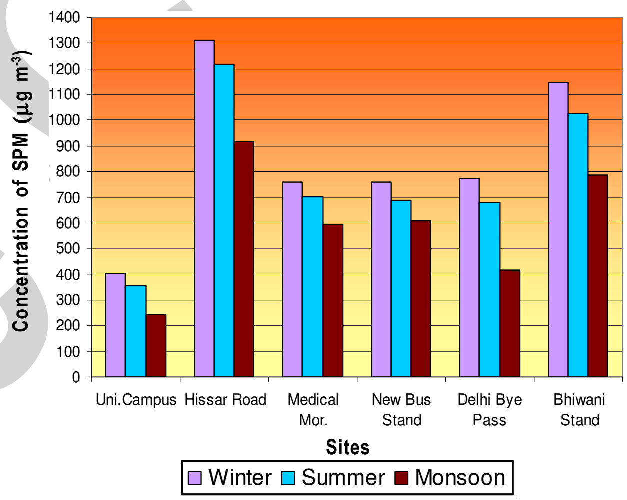

Fig. 4: Concentration of SPM (µg m^{-3}) at different sites of Rohtak city

on human health in urban areas is at peak level as vehicle emissions are near the ground level where people live and work. Meteorological factors play an important role in air pollution (Backer *et al*., 2005).

In the above study, the concentrations of SPM, NO_2 and SO_2 were observed maximum in winter season in comparison to summer and monsoon season. During winter season there is increased atmospheric stability, which in turn allows for less general circulation and thus more stagnant air masses. It prevents an upward movement of air, hence atmospheric mixing is retarded and pollutants are trapped near the ground. Secondly, cold starts in winter lead to longer period of incomplete combustion and longer warm up times for catalytic converter, which generate more pollution (Faiz *et al*., 1995). Agarwal *et al.* (2006) study focuses on assessing the status of respiratory morbidity in Delhi over a four years period from 2000-2003. The study showed that winter months had greater exposure risk as pollutants often get trapped in the lower layers of atmosphere resulting in high concentrations. The concentrations of Ozone were observed maximum in summer in comparison to winter and monsoon season. In the lower (troposphere) layer, ground-level ozone is formed by the reaction of VOCs and NOx with ambient oxygen in the presence of sunlight and high temperatures. Ground-level ozone concentrations depend on the absolute and relative concentrations of its precursors and the intensity of solar radiation, which exhibits diurnal and seasonal variations (Faiz *et al*., 1995). Thermal inversions increase ground-level ozone concentrations (World Bank, 1996). The monsoon results in large amount of precipitation and increased humidity, while rain became responsible for the 'washing off' of ambient air pollutants.

The Hisar road was severely polluted site among all the selected sites. University campus was fairly clean sits. Pollution level of the two sites revealed a fact that there was a lot of difference between them. SPM was the biggest concern for the city and for the residents the situation is alarming. The mean concentration of

SPM, SO_2, NO_2 pollutants were observed maximum in winter season.

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