# IMMENSE INDUSTRIALIZATION AND THEIR AIR PROMINENT POLLUTANTS EFFECT ON URBAN AIR QUALITY INDEX

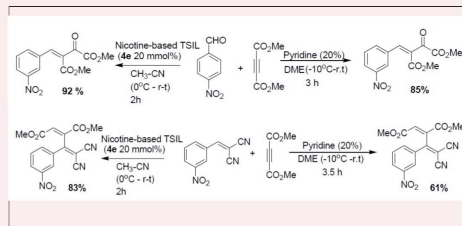# Immense industrialization and their air Prominent Pollutants Effect on Urban air Quality index

Rooh Ullah*, Waqar Uddin, Naeemullah, Saif Ullah, Muhammad Haroon, Shafiq Ur Rahman, Nasir Khan, Abdul Haseeb, Shahbano Ali Kashani, Ubang Jerome Etim, Fazle Subhan

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### Abstract

On the basis of the reported air quality index (API) and air pollutant monitoring data obtained at the Peshawar city over the last seven years, the characteristics of air quality prominent pollutants and variation of the average annual concentrations of $SO_2$, $NO_2$ total suspended particulate (TSP) fine particulates ($PM_{10}$) CO and dust fall in Peshawar were analyzed. Results showed that $SO_2$ and $NO_2$ were the prominent pollutants in the ambient air environment of Peshawar. Of the prominent pollutants TSP accounted for nearly 63 % $SO_2$, 32.8 ppb $NO_2$, 147 ppb of $CH_4$, 13.8 ppb of CO, 94.5 $\mu g/m^3$ of MC and 0.60 ppb of $O_3$ respectively in 2013. $NO_2$ to $SO_2$ comparison ratio initially declined to 39.3 in 2009 and then starts to increase to 42.5 in 2010 while in 2013 reached upto 44.8 and $O_3$ to $SO_2$ ratio in the last year of observation, the ratio drop to 0.01830 $\mu g/m^3$. Concentrations of air pollutants have shown a upward trend in recent years but they are generally worse than ambient air quality standards for EPA-USA, Pakistan and EU. $SO_2$ and NO$x$ pollution were still serious impling that waste gas pollution from all kinds of vehicles had become a significant problem for environmental protection in Peshawar. The possible causes of worsening air quality were also discussed in this paper.

**Keywords:** PM10, Air Pollution, Health Effect, Air Quality Index

# INTRODUCTION

Air pollution in urban areas remains a considerable issue in all time. Along with detrimental impact on well-beings, pollution also causes damage to ecosystems, materials and the visibility. Peshawar, capital city of Khyber Pakhtunkhwa, the ambient air quality is constantly deteriorating due to anthropogenic activities [Qadir, 2002]. As a result Peshawar is one of the most polluted cities [Ghauri et al, 2007] in Pakistan.

One cannot neglect the effort of government to implement different policies and devise different programs especially for those sectors which are more vulnerable to cause environmental pollution such as energy production particularly from fossil fuels, inception of heavy traffic load to meet the current need and many other harmful residues. Different international organization such as EPA (Environmental Protection Agency) [Khan, 2012] , World Bank, WHO (World Health Organization) [Technology et al, 1984], the European Union Air Quality Frame work and Daughter Directives, put their utmost attempt to establish and promote their own standards for this objective. Different Monitoring bodies play vital role in observing effectiveness of air quality control regulations and ensuring the implementation of air quality standards. Even this organization has the right to enforce local community to engineer the pollution control policies if ambient air quality unlikely meet certain standard.

Since 75 % of entire populations in developed countries are accommodated in urban air, their financial conditions make them capable of effective pollution prevention and control against pollutant [Kleveman, 2003]. In recent times, environment of developing countries are taken under serious condition in term of pollution prevention and its control. Still many cities of developing world are most vulnerable to have exposure to impure environment.

Many factors are responsible for formation of substandard environment in developing world [Manahan, 2013]. One of the major factors is uncontrolled increase in population; consequently, it

leads to poor urbanization. Second principal aspect is of unplanned industrialization without consideration of local meteorological and topographical conditions. However, recently, almost 35 % of entire population resides in urban area in emerging nations, and this figure is twofold as five decades ago. In order to provide equal comfort and ease to increasing population, it disturb natural balance and in most serious condition cause natural calamities and catastrophe for instance consequences of deforestation. Other pollution sources are heavy vehicle traffic, dwelling heating, power generation, commercial and trade centers, and, many more, unavoidably root cause in increasing emission of air pollutant in cities [Rehman et al, 2017]. It seems challengeable to control and prevent emission under stricter world figures and regulation with scarce resources.

Once air pollutant [Stein et al, 2000; Golinski, 1999] evolved from variant sources, are force to undergo mixing, transportation, dispersion and complex chemical reaction and physical transformation in urban atmosphere. For instance, reaction between emitted nitrogen oxides and volatile organic compound leads to synthesis of ground level ozone. Secondary particulates formation and acid deposition [Schwartz, 1989] occur in urban air when primary and secondary pollutants combine with emitted Sulphur compounds.

It has been reported that one of the main air quality parameter, $SO_2$ depict downward trend with certain exception of Central American and Asian cities. However, nitrogen dioxide level chases WHO standard but in Kiev, Beijing and Guangzhou, the $NO_2$ is almost threefold than WHO standard. Currently, Particulate matter is serious issue in Asian continent with concentration of more than $300\mu$ g/m$^3$ in many urban areas. Ground level ozone ($O_3$) concentration value is above WHO, USEPA and EU standard criteria which demonstrate that it is global issue.

Poor urbanization and improper industrialization strategies have considerable contribution to air pollution in Peshawar as it has been noticed in developing world. Moreover, air quality become worse due to certain factors such as consumption of substandard fossil fuels, ill-mannered combustion techniques and drastic increase in traffic load. EPA [Salles et al, 2018] is the only main body in Pakistan whose responsibility cannot be neglected. Almost no reliable air quality assessment has been reported in Pakistan particularly in Peshawar.

Air quality parameters [Golinski, 1999; Nurnberg,

1984] such as $SO_2$, PM, $NO_x$, $O_3$, MC, CO and $CH_4$ are continuously monitored in Peshawar for 24 hours and depict real picture of ambient air quality with recently established continuous air monitoring station placed on roof of EPA building. The collected data were taken for average of 3 hour, 8 hour and 24 hour. Annual average concentration of $NO_x$, MC, $SO_2$ CO, $O_3$, $CH_4$ [Mirza et al, 2008] and particulate matter are shown in table 3 and 5. The result shows that all of the air pollutants in Peshawar air space were mainly caused due to combustion of bad quality fuel, heavy traffic load, brick kilns, industries, poor solid waste disposal and lake of town planning while other sources include road sweeping, burning of solid, wood, air traffic and commercial activities such as frying meat in oil and roasting on charcoal fire are minor contributors.

Geographically Peshawar lies between 33$^{\circ}$ 44 and 34$^{\circ}$ 15 North latitude and 71$^{\circ}$ 22, and 71$^{\circ}$ 42 east longitude. It is approximately 1173 feet above sea level. The climate of Peshawar is extreme. The summer season is hot, the mean maximum and minimum temperature is 40 $^{\circ}$C and 25 $^{\circ}$C in summer while the mean maximum and minimum temperature in winter is recorded as 18 $^{\circ}$C and 4 $^{\circ}$C respectively. In Peshawar mean annual wind speed in winter is 1.9 Knots (1 knot = 1.152 miles/hour or 1.85 km/hour) while in summer wind speed is 2.9 knots. Wind flows north-easterly during summer while south-easterly in winter. Summers are hot with temperature range 42-48 $^{\circ}$C. It has a distinct winter season which brings daytime's temperatures to 16 $^{\circ}$C or low. The annual rainfall is 13 inches. Most rain falls during the summer season from July to September. Peshawar also experiences a moderate winter rainy season as well.

Main objective of this study is to obtain a realistic picture of ambient air quality and generates a base line data in Peshawar city, to increase the public awareness, and to identify air pollution source in the city and also for the formulation of air quality standard. From the above discussion it can safely be concluded that the study about ambient air quality in Peshawar in past was not reliable. In this paper we have focus to collect reliable data and to measure the concentration of pollutants by using more advance technology.

## RESULTS AND DISCUSSION

The above chart depicts a clear picture of air quality parameter variation in atmosphere during 2007 to 2013

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in Peshawar-Capital city of Khyber Pakhtunkhwa, Pakistan. Furthermore, all the readings were taken on 1st July of each year. Figure 1, NOx is reported to be 24.8 ppb in 2007.However, it starts to increase either abruptly or gradually depend upon the measures which were taken by regulatory body. NOx amount in air is 26.3PPb in 2008 and further it is followed by 28.5 ppb in 2010 by passing through 27 ppb in previous year. Last but peak is touched in 2013 when its concentration reached upto 32.8 ppb.
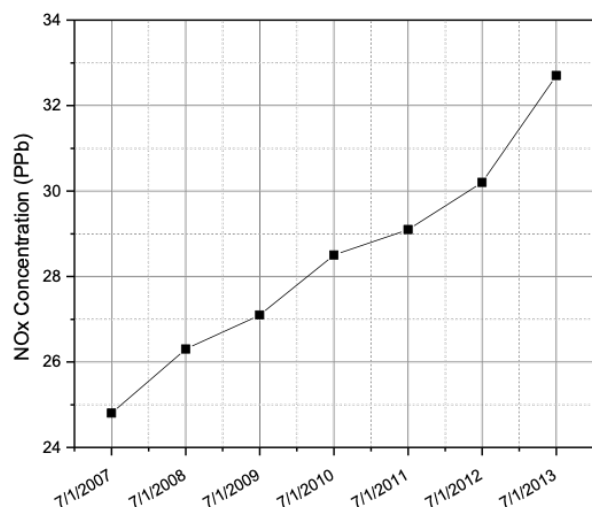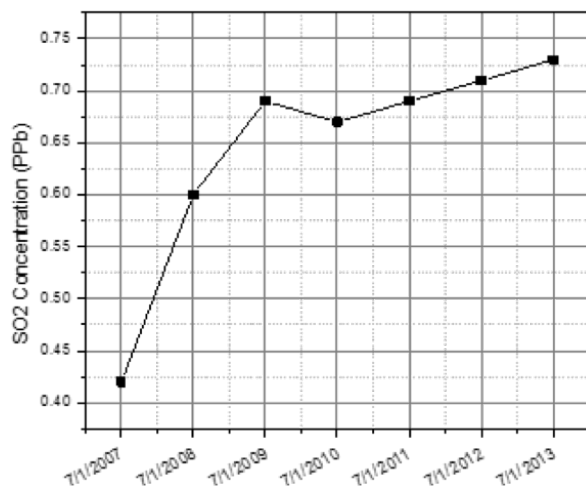


**Figure 1**. $NO_x$ is reported to be 24.8PPb in 2007



**Figure 2**. $SO_2$ concentration factor at different time scales

Figure 2, One striking factor is notable in above chart that is overall $SO_2$ concentration climb up during observation span of time except in 2010.Sharp inclination has been observed during 1st year of observation and furthermore it is followed by little bit less inclination and reached to 0.6875 ppb.This increase is almost 63 % of 2007 concentration. Drop in

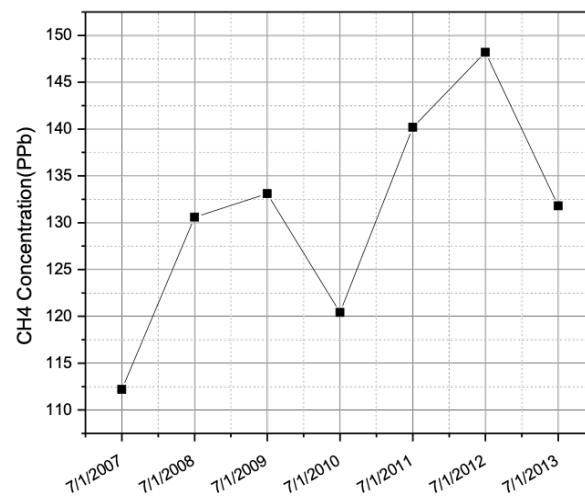$SO_2$ is noted in 2010 and then it is followed by linear increase and reached to 0.725 ppb.



**Figure 3**. $CH_4$ concentration factor at different time scales

Figure 3, $CH_4$ concentration stands at 112 ppb in 2007 but its value climb up almost 16 % per annum and reach to 130 ppb in 2008. Due to implication of different Air quality control projects by different government and non-government organization, the $CH_4$ quantity remain 132 in 2009 by increasing only 1.5 % of the last year. Since, recovering of Air quality is slow and steady process.



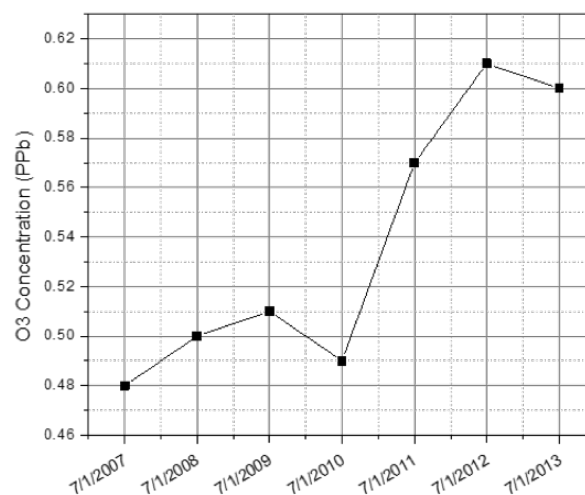**Figure 4**. $O_3$ concentration and their effect

The last year's regulation of different regulatory authorities' measures show drastic decline in $CH_4$ value and decrease upto 9.0% in July, 2010. However, $CH_4$ concentration touch a peak of 147 ppb in 2012 by following 140 ppb in 2011.This peak is caused by different pollution sources such as frequent bomb

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blasts and exponential growth in vehicles. In 2013, again considering decrease is reported and $CH_4$ concentration remain the same as in 2009.

Figure 4, It's noteworthy that $O_3$ concentration varies irregular from 2007 to 2013. Firstly, It starts from 0.48 ppb and reached upto 0.51 ppb in 2009. However, In following year, it drops abruptly to 0.49 ppb.Once again, striking climb up has been observed from 2010 to 2011 and touch concentration of 0.57 ppb.Almost same inclination is followed by $O_3$ trend. Lastly, it declines to 0.60 ppb in 2013.

Figure 5, CO concentration starts from 3.5 ppb in 2007 and grows up sharply to 7.8 ppb by increasing almost 120 % in 2008.This drastic increment is due to installation of different industries which produce significant amount of pollutants such as CO and SOx. Furthermore, CO amount in air remains plateau from 2009 to 2010.This plateau is followed by abrupt increase in CO amount in 2012 and reached upto 12.8 ppb by escalation of 14 % of last years. Lastly, it touches a peak of 13.8 ppb in 2013
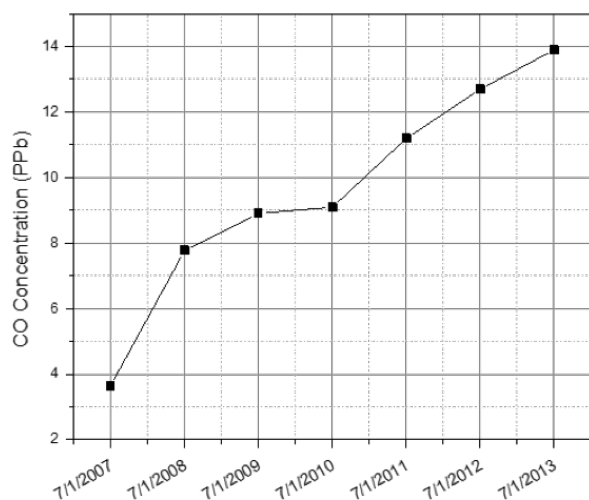


**Figure 6**. MC concentration from 2007 to 2013

Figure 7, Below chart shows the ratio of $NO_2$ to $SO_2$ first decline to 39.3 in 2009 and then starts to increase to 42.5 in 2010. Again said trend decrease but slightly to 42.1in 2011. However, in 2012, the trend gradually goes up to 42.5 and remain the same as in 2010. But 2013 shows drastic increase and reached upto 44.8.



**Figure 5**. CO concentration at urban area
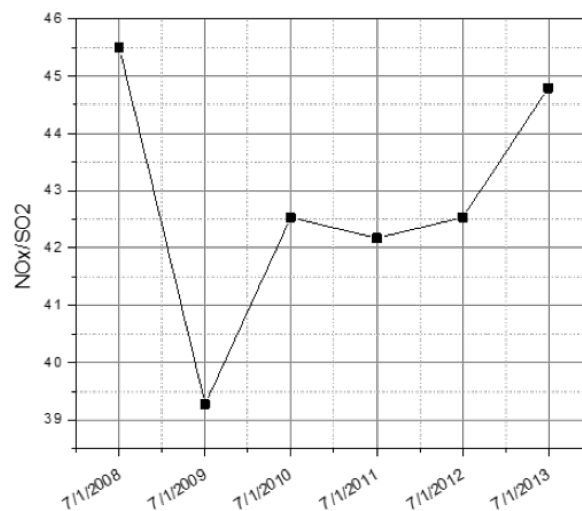


**Figure 7**. The ratio of $NO_2$ to $SO_2$

Figure 6, the below chart clear illustrate MC concentration from 2007 to 2013. All measurement was carried out on 1st July. Overall MC concentration trend increase except in 2010. Firstly, it increase to 81.5 $\mu g/m^3$ in 2008 followed by 87.9 $\mu g/m^3$ in 2009. However, gradual decrease has been reported in 2010 and it drop to 85.5 $\mu g/m^3$. After that, It followed almost a linear trend till 2013 by achieving 94.5 $\mu g/m^3$ .

Figure 8, the below chart shows $O_3$ to $SO_2$ ratio from 2008 to 2013. Although, There is no such regular increase or decrease but the trend first goes up to 0.01875 in 2009. However, drastic decline observed in 2010. It's value stand at 0.01680. One can't neglect the peak of 0.02025 in 2012 just after 0.01960 in 2011. In last year of observation, the ratio drop to 0.01830.

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**Figure 8**. The $O_3$ to $SO_2$ ratio from 2008 to 2013

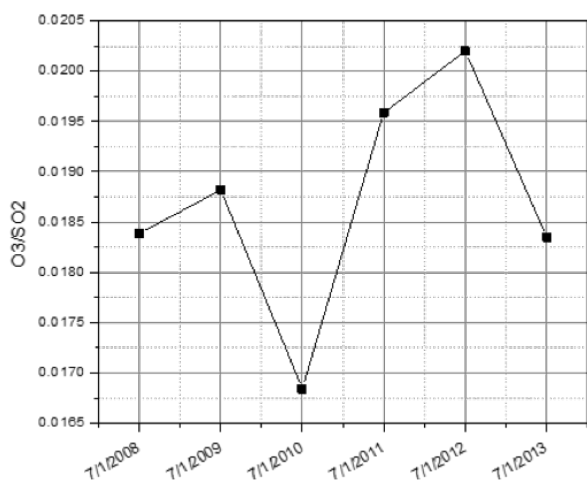The chart given in Figure 9 illustrates bomb blast in KPK from 2000 to 2012. The objective of this trend is to relate environmental pollution especially air pollution caused by bomb blast. Although, there was counted number of blast upto 2005 but 2006 saw sharp increase and reached upto 200. This figure play vital role in air pollution. However, their effect may not appear instantly, but with passage of time, Blast's product may react with other element or compound in atmosphere and lead to produce most harmful substance. Furthermore, Explosions were not stopped at that level. In 2008, it touched the peak of 235. In 2009, decline in blasts were reported followed by further decrease to 130 in 2010. Again in 2011, number of blast were 198. Since it contain elemental sulfur and Tri Nitro Toluene (TNT) but after blast it react with oxygen to form Sulfur and nitrogen oxides.
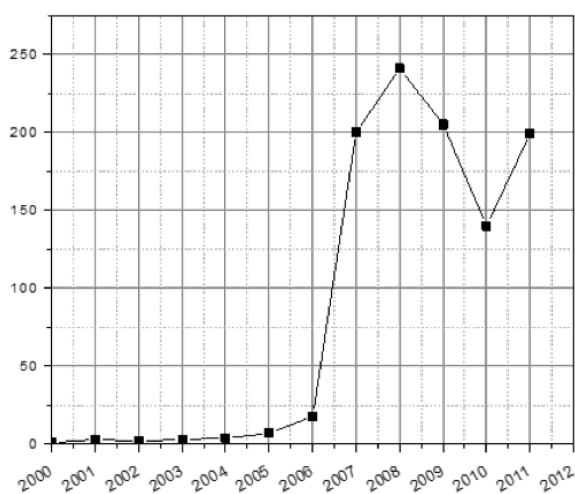


**Figure 9**. bomb blast in KPK from 2000 to 2012

The below bar chart (Fig. 10) depicts daily

concentration of $NO_2$ in month of July, 2007. Since the analyzer was installed on Khyber Road. This aforementioned road is considered to be one of the busiest roads. In mid of the month, the concentration leveled off at 24 ppb.It is noteworthy that on either on Friday or Monday, Peaks were reported mostly due to heavy traffic and these peaks were of same level. Highest peak was observed on 25 of July. This sudden and distinguished peak is due to some terrorism activities which cause drastic increase.
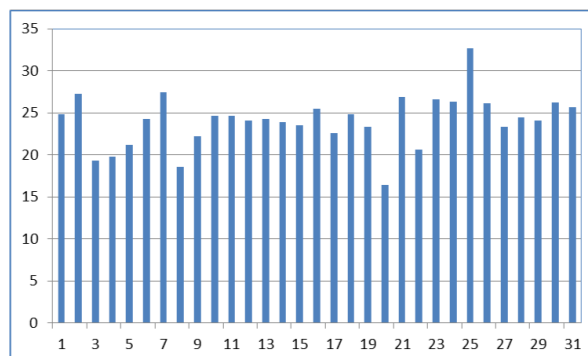


**Figure 10**. Concentration of $NO_2$ in month of July, 2007

Second major factor of air pollution is solid waste produced by principal hospitals, situated in Peshawar. Name and amount of waste generated by corresponding hospital are tabulated in above table. Tertiary hospital such as Lady Reading Hospital, Khyber Teaching Hospital and Hayatabad Medical Complex produce 300, 300 and 250 Kilogram (Table 1) per day of solid waste respectively. Since most of hospital have either no incinerator or faulty incinerator. Due to improper disposition of this waste lead to both water and air pollution. Overall, 965 Kg of solid waste per day cause tremendous destruction to environment in term of air and water. Although, Rehman Medical Institute and Hayatabad Medical complex generate significant figure of waste but they are incinerated properly and it cause comparatively less detrimental to air.

**Table 1**. Various hospitables and their generated wastes

| S. No | Name of Hospital | Solid Waste Generated (Kg/day) | Status/Incinerator |
|---|---|---|---|
| 1 | Lady Reading Hospital | 300 | Non functional |
| 2 | Khyber Teaching Hospital | 300 | Non functional |
| 3 | Naseer Teaching Hospital | 50 | No incinerator |
| 4 | Aman Hospital | 60 | No incinerator |
| 5 | Nasir Mehmmond Hospital | 15 | No incinerator |
| 6 | North West Hospital | 120 | Non functional |
| 7 | DHQ Charsadda | 80 | Non functional |
| 8 | City General | 20 | No incinerator |
| 9 | Doctors Hospital | 20 | No incinerator |
| 10 | Rehman Medical Institute | 120 | Functional |
| 11 | Hayatabad Medical Complex | 250 | Functional |

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Table 2 compare and contrast Peshawar with other metropolitan cities of Khyber Pakhtunkhwa such as Mingora and D.I. Khan. Daily waste solid generation is high in Peshawar with value of 602 ton per day in comparison with other two cities. Although, The Population density in Peshawar is more due to which the Per capita per day solid waste is equal to other two districts. Solid waste per capita per day for all three cities is 0.5.

Table 3 also depict amount of solid waste which was recovered and disposed properly. In this column, Peshawar also stands first with value of 398 Ton per day while rest of solid waste are either dumped or incinerated in open atmosphere. Although, efficiency of Peshawar and D.I khan are almost same.

**Table 2**. Solid waste produced by principal hospitals in KPK

| Main Cities | Solid Waste generated (tons / day) | Capita per day (kg) | Solid waste collected (tons / day) | Efficiency (%) |
|---|---|---|---|---|
| Peshawar | 602 | 0.5 | 398 | 66 |
| Mingora | 450 | 0.5 | 221 | 49 |
| D.I. Khan | 510 | 0.5 | 332 | 65 |

**Table 3**. Pollutants caused by burning of various fuel in 500 Brick Kiln units

| Sr.No | Fuel Consumed/Year Type | Wt. /Kiln (tons) | Total (Tons) | Particulates Unit Tons | Particulates Total Kg/T | Carbon Monoxide Unit Tons | Carbon Monoxide Total Kg/T | Hydrocarbons Unit Tons | Hydrocarbons Total Kg/T | Nitrogen Oxides Unit Tons | Nitrogen Oxides Total Kg/T | Sulphur Oxides Unit Tons | Sulphur Oxides Total Tons |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Coal | 1100 | 550,000 | 19 | 10,450 | 30 | 16,500 | 1.6 | 880 | 0.7 | 385 | 18 | 9,900 |
| 2. | Rubber | 10 | 5,000 | 69 | 345 | - | - | - | - | - | - | - | - |
| 3. | Saw Dust | 270 | 135,000 | 15 | 2,025 | 15.5 | 2,092.5 | 18 | 2,430 | 5 | 675 | 0.75 | 101.25 |
| 4. | Used Engine Oil | 40 | 20,000 | 0.31 | 6.2 | 0.63 | 12.6 | 0.12 | 2.4 | 2.3 | 46 | 5.1 | 102 |
| | Total | | | | 12,826.2 | | 18,605.1 | | 3,312.4 | | 1,106 | | 10,103.25 |

The below table clearly show different amount of pollutants caused by burning of various fuel in 500 Brick Kiln units in Peshawar. Different fuels such as Coal, Rubber, Saw dust and Used Engine Oil were used for baking of Brick. Although, variant amount of above mentioned fuels were utilized in brick kilns with maximum of 1,100 Ton of coal for one unit. Substances vulnerable to cause air pollution are discussed one by one. Rubber has maximum particulates content with value of 69Kg/Ton but maximum particulates were produced by coal due to consumption of highest amount of coal (550,000 Ton).Similarly, supreme quantity of Carbon monoxide exist in Coal and coal stood first in CO production followed by Saw dust and then Used Engine oil. Their values are 16,500, 2092.5 and 12.6 Tons respectively.

Other important factor is Hydrocarbon, Saw dust has more hydrocarbons. As a result, maximum amount of hydrocarbon are generated by saw dust whose value is 2,430 Tons. Last but vital pollutants are Nitrogen Oxides and Sulphur oxides, 2.3Kg/T of Nitrogen Oxide contain in Used Engine oil but the maximum NOx is produced by Saw dust which is 675Tons per annum. As far as Sox is concern, 9,900 tons are generated by burning of coal for 500 Brick Kilns. To sum up, 12,826.2, 18,605.1, 3,312.4, 1,106 and 10,103.2 tons are annually generated quantity of Particulates, Carbon monoxide, Hydrocarbon, Nitrogen Oxides and sulphur oxides respectively.

## EXPERIMENTAL

The ambient air quality was carried out by using automatic fixed air monitoring station (Horiba, Japan), surrounded by air masses reach polluted area. The analyzers used in this study are NO, $NO_2$, $SO_2$, $O_3$ $CH_4$ and particulate matter, which were regularly calibrated using zero and respective span gases. Data received and averagely analyzed for 3, 8 and 24 hours. During the measurements, metrological data were collected for wind speed, wind direction, humidity, temperature and solar flux. Table 4 show different analyzer used for this study with function and ranges.

**Table 4**. Analyzers used with their function and ranges

| Ambient air Monitor | Functions | Range |
|---|---|---|
| CO APMA-370 | CO in ambient air | 0-100 ppm |
| SO2 APSA-370 | SO2 in ambient air | 0-10 ppm |
| $NO_x$ APNA-370 | $NO_2$, NO and $NO_x$ in ambient air | 0-10 ppm |
| THC APHA-370 | THC, NMHC, and $CH_4$ in ambient air | 0-100 ppm |
| $O_3$ APOA-370 | $O_3$ in ambient air | 0-10 ppm |

### SO₂ Analyzer

The pararrosaniline method used for the determination of sulfur dioxide concentration in ambient air. This method is based on fluorescent light measurement given off by certain molecules. $SO_2$ in sample react with potassium tetrachloro mercurate solution TCM ($K_2HgCl_4$) and form stable monochloro-sulfonatemercurate complex which resist air oxidation even stable in the presence of powerful oxidizing agents such as ozone ($O_3$) and nitrous oxides (NOx). Complex then reacts with pararrosaniline and formaldehyde to form intense colored pararrosaniline methyl sulfonic acid, while optical density of this

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compound were measured on spectrophotometer.

## NOx Analyzer

Nitrogen oxides were measure in ambient air through gaseous phase chemiluminescence's technique [Gupta et al, 2003]. Nitrogen dioxide (NO$_2$) measured indirectly, by photometric determination of light intensity at wavelengths greater than 600 nm, resulting from the chemiluminiscent reaction of nitrous oxide (NO) and ozone (O$_3$). NO$_2$ is quantitatively reduced to NO by a converter. The NO normally present in the air along with the NOx pass through the converter unchanged, causing a resulting total concentration of nitrous oxides (NOx) equal to NO + NO$_2$. A sample of incoming air (NOx) were measured, bypass the converter and subtracted from the first (NO + NO$_2$) to give the final measurement of NOx. Chemiluminescence's analyzers for NO/NO$_2$/NOx are also sensitive to other nitrogenated compounds, such as peroxyacetyl nitrate (PAN), which may be reduced to NO in the thermal converter.

## CO Analyzer

Non-dispersive photometer method was used for determination of carbon monoxide concentration in ambient air, by infrared absorption process. This method based on the absorption of certain wavelength in IR regions by the carbon dioxide. A beam of infrared energy is passed through a cell containing the air sample to be analyzed by NDP.

## O$_3$ Analyzer

ChemiIuminiscence method was used for determining the concentration of ozone in the ambient air. This process based [Foyer et al, 1994] on the capacity of ozone to emit light when it reacts with ethylene. Mixture of air and ethylene were used in this method, ozone present in the air reacts with the ethylene and emits light, which is detected using a photo-multiplier tube. The resulting photo-current is amplified and may be read directly or shown on a gage, in accordance with the kinetics of the (corresponding) reaction.

## CH$_4$ Analyzer

Methane hydrocarbons were determined in voltage by combustion method. Hydrocarbon molecules with hydrogen pass through jet nozzle tip ionizer which receives high temperature energy by applying a direct current voltage between two electrodes. Flame generator produces a minute ion current, proportional to the carbon of the ionized hydrocarbon. The total

hydrocarbon can be measured by passing this ion current through high resistant to convert it to voltage.

## The Study Area and Sampling Sites

Area meteorology and topography greatly influence the dispersion pattern of air emission. Meteorological parameters such as wind speed, wind direction, humidity and temperature differences that exist within in air mass, are the major governing factors. The most important is wind speed which affects the horizontal dispersion efficiency wind direction determine the area affected by emission while vertical temperature variation, determine the upward dispersion efficiency. The topography of large cities also influences the manner in which pollutants are transported and dispersed. Peshawar has plain topography [Gupta et al, 2003]. The Degree and type of air pollution is not only depend on the source, but also on the climate, weather, wind speed, wind direction, temperature, humidity can transfer the pollution hazard from one area to another. Similarly Inversion of temperature and sunshine can produce deadly results in heavily polluted areas.

Geographically Peshawar district lies between 33$^\circ$, 44 and 34$^\circ$ 15 north latitudes and 71$^\circ$ 22 and 71$^\circ$ 42$^\circ$ east longitude. It is bounded on the north by Charssadda district, on the east by Nowshera, on the south by tribal areas adjoining Peshawar and Kohat and on the west by Mohmand and Khyber agency. The total area of the district is 1,259 square kilometer. The district is almost a fertile plain [Ahmad et al, 2008]. There are no proper forests in the district. It is approximately 1173 feet above sea level. The terrestrial climate of Peshawar city is extreme. The summer season is hot, the mean maximum and minimum temperature is 40 $^\circ$C and 25 $^\circ$C in summer while the mean maximum and minimum temperature in winter is recorded as 18 $^\circ$C and 4 $^\circ$C respectively. In Peshawar Mean annual wind speed in winter is 1.9 Knots, while summer wind speed is 2.9 knots. Wind flows are north –Easterly during summer while south – easterly in winter Humidity in August, July is 63.8 % May, June 44.4 % Mean monthly winter rain fall is 16.5 cm while summer mean rain fall is 19.1cm shown in table 5. Mean monthly winter sun shine 6.7 hr. / day while summer 8.8 hr/ day. An important element for accelerating to heavy air pollution in Peshawar city is its location inside the land. Besides Peshawar have not enough wind speed which will take away air pollutants from the city [HomerDixon, 1994]. In addition it has not enough rain falls to prevent scattering of pollutant from emission source.

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**Table 5**. Mean monthly temperature, precipitation and relative humidity recorded at Peshawar station, Peshawar district

| Month | Mean Temperature ($^{o}$C) | | Precipitation (Millimeters) | Relative Humidity (%) |
|---|---|---|---|---|
| | Maximum | Minimum | | |
| January | 18.5 | 4.00 | 26.00 | 58.60 |
| February | 19.46 | 6.34 | 42.67 | 57.50 |
| March | 23.74 | 11.16 | 78.41 | 58.43 |
| April | 29.98 | 16.40 | 48.87 | 51.72 |
| May | 35.94 | 21.30 | 26.98 | 37.35 |
| June | 40.42 | 25.68 | 7.72 | 36.16 |
| July | 37.73 | 26.59 | 42.31 | 55.03 |
| August | 35.72 | 25.74 | 67.68 | 64.58 |
| September | 35.02 | 22.69 | 17.90 | 58.68 |
| October | 31.23 | 16.09 | 9.66 | 54.88 |
| November | 25.62 | 9.56 | 12.34 | 60.11 |
| December | 20.12 | 4.92 | 23.29 | 63.72 |
| Annual | 29.44 | 15.87 | 403.83 | 54.73 |

According to 2013 Census the present (2013) population of the city is estimated to be over 3,307,798 (Density 2,600/km$^2$ (6,800/sq mi) increasing at a growth rate of 3.3 percent per annum (Table 6). The growth rate of population in Peshawar has been very high and no sign of decline has been noticed yet, in spite of government's efforts in this connection. With this much population and limited resources available no improvement in the situation is expected. Larger population, it may be urban [Qadir, 2002] or rural [Luken, 2000], spoils the environment through human activity including irrational use of chemicals. Peshawar population is growing at a high rate, widening the gap between consumption and resource availability and causing congestion in many areas. Out of total population 46.52 % are migrants, from other parts of Khyber pakhtunkhwa and other provinces. Besides there are approximately 400000 afghan refugees in Peshawar. The available recourses of Peshawar to support the increasing population are not encouraging and no improvement in the situation is expected. Larger population spoils the environment through human activity. Such tremendous population has resulted in huge load on Peshawar and has enhanced pollution problems manifold [Sawyer et al, 2000].

**Table 6**. Population of the Peshawar city

| Division/ District | Area in Sq. K.M | Population | | %age Change in 1998 over 1981 | Population Density per Sq. K.M | | Growth Rate 1981-1998 (Percent) |
|---|---|---|---|---|---|---|---|
| | | 1981 | 1998 | | 1981 | 1998 | |
| Peshawar | 1257 | 1113303 | 2019118 | 81 | 886 | 1606 | 3.56 |

# CONCLUSION

Major problem come from automobile exhaust emissions, industrial emissions, especially from brick kilns factories, domestic burning and wind-blown dust arising from unpaved roads. Urban air pollution in Peshawar is attributable to many sources, the most prominent are vehicular pollution, dust particles, emission from the large number of small scale brick kilns and stone crushers. The rickshaws, a traditional means of public transport, emit noise and smoke, increasing pollution in the Peshawar city. Therefore is needed to establish and enforce ambient air quality standard in Pakistan on priority basis. The main source of air pollutant (NOx) in the Peshawar air space is motor vehicles. Measures should be adopted for strick enforcement of NEQS. Efforts should be made by Government of Khyber Pakhtunkhwa to increase the number of environmental tribunals. To minimize air pollution in Peshawar, measure should be adopted to improve traffic flow, upgrade public transport system. In brick kilns rubber and tyres are added which increase the emission of $SO_2$ so there should be a ban on use of rubber and tyres.

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