Polluted Air Quality Component Analysis from Stack Emission and its Hazardous Consequences on Human Health.

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Abstract

The health impacts of air pollution have received more attention and have recently been subject to extensive study. Exposures to air pollutants have been linked to lung and cardiovascular disease and increases in both hospital admissions and mortality.

The present research work was designed to monitor and estimate the Nitrogen Oxides (NOx) Sulphur oxides (SOx), CO and Particulate Matter that correlates with climate parameters and check its hazards effect on human health. The research work was executed at Department of Chemistry with the collaboration of Environmental Laboratories Sheikhupura by Dragger tube which is fast and reliable method, with some classical absorption method. Pollutant concentration at source emission was measured. The questionnaires about the health of employees were also asked to check the hazardous effect on human health. The obtained results were compared with the guidelines of Environment Protection Department which are known as National Environmental Quality Standard (NEQS). Out of twenty, fifteen were found exceeding the NEQS limits. Employees who are working in the highly polluted industries were mostly suffering from lungs diseases. Overall, only five industries emissions were found safe according to Punjab environment protection department guidelines.

Key Words: Air pollution from industries, Air pollution control, Environment and Health Aspects.

Introduction

Air is the most vital component, without which the question of our survival does not exist beyond a few minutes. A human being of normal height and health respires 22,000 time a day and the air consume in course of such respiration is about 20 times more than the quantity of food consumed by human being. (Yadav 2008).Air pollution is composed of a complex mixture of substances that have well characterized adverse effects on human health. One of the well known examples of air pollution increasing morbidity and mortality is the 1952 London Smog (Laumbach., 2010).Weather conditions at that time caused a sharp increase in ambient air pollution levels and over the passing few days, greater than three times as many people died as would otherwise have been expected. A great deal has modified since that incident with guidelines and legislation restricting pollution levels in many regions of the world to well below the levels in the 1950's (WHO 2006).Despite that, major concerns over more long term effects of pollution remain. A number of health science studies have shown that air pollution can account for 1–2 years of life shortening in those exposed to higher concentrations (Brunekreef and Holgate 2002).

Component of Air Pollutions

When considering which component of Air pollution is responsible for these adverse health effects, it is important to recognize that this is a heterogeneous mixture of substances commonly composed of gases, volatile organic compounds (e.g., Benzene), and particulate matter (Vargas et al 2011 and Chen 2008).Particulate matter itself is a mixture of components and contains, among others, microbial particles (bacteria, spores), pollen, organic carbon, inorganic sulfates, nitrates, polycyclic aromatic hydrocarbons, and heavy metals particles (WHO., 2000).

Effect on Air pollution in Human

Human respiratory system has a number of mechanisms for protection from air pollution. Bigger particle (>10 μm) can be trapped by the hair and sticky mucus in the lining of nose. Smaller particle can reach traceobronchial system and there get reached in mucus. They are pulled back to throat by beating of hair like form of cilia from where they can be removed by spitting or swallowing. Sulphur

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dioxide causes damage of respiratory passage and can cause bronchitis like conditions. In the attachment of suspended particulates, SO2 can form acid sulphate particles which can go deep into the lungs and affect them severely. Oxide of nitrogen especially NO2 can irritate the lungs and cause condition like chronic bronchitis and emphysema. Carbon monoxide reaches the lungs and combine with hemoglobin of blood to form carboxyhaemoglobin.CO has affinity for hemoglobin 210 times more than oxygen. Hemoglobin's therefore, unable to transport oxygen to various part of body and this cause suffocation. Long exposure to CO may cause wooziness, unconsciousness and can cause to death. Suspended particulate can cause damage to lung tissue and can cause asthma, bronchitis and cancer especially when they bring with them cancer causing or toxic pollutant attached on their surface (Kaushik, 2008). A large fraction of pollutants that are inhaled will be ingested and rapidly enter the intestine. Gaseous pollutants also relate with serious inflammation, which may further impact on the intestine (Martinez et al 2007).

Pollution and Intestine Problems

This is the fact that the oral route accounts for much exposure to air pollutants as the pollutants contaminate both the food and water supply in significant amounts (ECSC., 2002).Additionally, human health studies have shown that all larger particles (N6 μm) are quickly cleared from the lungs and transported to the intestinal tract by mucociliary clearance (Kreyling et al., 2004 & Moller et al., 2004).In this way, a large amount of pollutants that are inhaled will be ingested and rapidly enter the intestine. Gaseous pollutants also relate with serious inflammation, which may further cause serious effect on the intestine (Vidgren et al., 1995). A small number of health studies have found an association between air pollution and a number of different aspects of intestinal disease for example, a few studies have linked exposure to air pollutants to digestive tract cancers. (Gaeciduenas et al., 2007).The experts suggest an explanation for this association by referring to the increase in tumor necrosis factor (TNF)-α caused by inhalation of diesel exhaust particles (DEPs) and, because appendicitis is an serious inflammatory condition, this develop in pro-inflammatory cytokines could trigger appendicitis. An Italian pediatric research study used a similar case– crossover design to investigate an association between pollution and emergency room visits for wheezing and episodes of diarrhea and vomiting in 6 centers. Carbon monoxide exposure and its effects in the winter was modestly associated with enteric disease in approximately 25,000 cases were reported (3.8% increase; 95% CI 1.0–6.8 per 1.1 μg/m3 increase in carbon monoxide) but other pollutants did not reach significance; (Mills et al., 1995).Interestingly, no link was found between intestinal disorders and a number of indices of air pollution in research study of adults (Orazzo., 2009).The discovery of genes linked to susceptibility to IBD has been a major breakthrough over the last decade, however, this only explains 20% of the hereditary variance and suggests that environmental factors likely contribute more than genes to disease pathogenesis (Lipset., 2004).

Affect of Pollutants Chemistry on Environment

NOx are transparent to most wavelengths of light (although NO2 has a brownish color and the rare N2O3 is black), they allow the vast majority of photons to pass through and therefore, have a lifetime of at least several days. Because NO2 is recycled from NO by the photo reaction of volatile organic compound (VOC) to make more ozone, NO2 seems to have an even longer lifetime and is capable of traveling considerable distances before creating ozone. Weather systems usually travel over the earth's surface and allow the atmospheric effects to move downwind for several hundred miles. Differences in the distance estimates between the emission of NOx and the generation of ozone may be related to differences in plume transport (wind) speeds as well as other meteorological and air quality factors. At high temperature combustion can convert sulfur in fuel to SO2 and SO3. While SO2 is toxic and forms sulfurous acid when dissolved in water, SO3 is both toxic and hygroscopic (moisture absorbing) and forms sulfuric acid by combining with moisture in the atmosphere. SO2 and SO3 form sulfites and sulfates when their acids are neutralized. Both of these acids can form solid particles by reacting with ammonia in air. SO2 and SO3 also contribute to pH (acidity) changes in water, which can adversely affect both land and aquatic life. Therefore, both NOx and SOx from combustion can kill plants and animals (Hirano et al., 1999).

Prohibition on Certain Discharges or Emissions

According to Punjab Environment Protection Act of Sc-11

- No one is permission to emit or discharge emission of any waste material like air pollution and liquid and solid effluents.
- Parameters of effluents does not exceed the NEQS limit the standards established under sub-clause (I) of clause (g) of sub-section (1) of section 6
- Government can levy a pollution penalty to a person or company or industry who fails to comply with the provision of this act. (PEPA 1997)

Disposal of Waste and Effluents

According to the Sc-14 of factories act:

- (1) Effective arrangement shall be made in every factory for the disposal of wastes and effluents due to the manufacturing process carried on there.
- (2) The Provincial Government may make rules prescribing the arrangements to be made under sub-section (1) or requiring that the arrangements made in accordance with that sub-section shall be subject to the approval of such authority as may be prescribed (Factory Act 1934).

National Environmental Quality Standards

These rules are made and enforced by the provision of PEPA 1997. According to NEQS Rules, priority and important parameters mean those parameters of National Environmental Quality Standard which has been selected for purposes of submission environmental monitoring reports to provincial agency by an industrial operation unit. (NEQS. 2001).As shown in the below Table 1.

Table 1: National Environmental Quality Standards for Industrial Gaseous Emissions (mg/Nm3)

S.No.	Parameter	Source of emission	Standards
1.	Smoke	Smoke opacity not to exceed:-	40% or 2 (Ringlemann Scale).
2.	Particulate matter.1	Boilers and furnaces:	
		(I) Using Oil.	300
		(ii) Using Coal.	500
		(iii) Cement Kilns.	200
		Grinding, crushing, clinker coolers and related processes, metallurgical processes, convertors, blast furnaces and cupolas.	500
3.	Sulphur Oxides	Sulfuric Acid Plants.	400
		Others.	400
4.	Carbon Monoxide	Any.	800
5.	Oxides of Nitrogen (NOx)	(i) Any Nitric Acid manufacturing unit.	400
		(Ii) other sources	400

Materials & Methods

Case Study Sampling Site

In order to study the magnitude of air pollution by different pollutant component, a site was selected in the city of Lahore –Sheikhupura Road (31.71° North latitude, 73.98° East longitude) in Pakistan. This site has access to maximum levels of pollution that an urban population can be exposed. The selected site was located at the Lahore-sheikhupura industrial zone. The sampling was carried out in each industry with the help of EPA. The major pollutant analyzed there and health issues were also discussed with employees which were directly affected from their gaseous emission. For determination of NOx, SOx and CO with its surrounding air was monitored with Different concentration type of dragger tube with some classical absorption methods. Flue gas analyzer was also used for some support to measure emission component from atmosphere of industry.

Method-1 for NOx Determination

Scale tube –reddish brown oxidation layer, and its Chemical reagents present in the tube are Chromium (VI) compound (any NO which may be present in NOx is oxidize to NO2) white indicating layer is N, N-diphenyle-benzidine. After the chemical reaction color change to reddish brown.

$$NO+Cr\ (VI)compound \rightarrow NO2$$

$$NO2+O\text{-}diansidine \rightarrow Reddish\ brown\ reaction\ product$$

Measurement

$$ppm\ (NO + NO2) = \frac{Scale\ value\ read - off \times 5}{number\ of\ stroke}$$

The number of stroke can be increase up to 200

Method-2 for NOx Determination

Setup apparatus as shown in Figure 1. Took 300~400ml absorbing solution (5 %- H2O2) in 500ml bubbler. Passed adequate amount (50~100L) of gas sample through solution while keeping the flow rate 1L/minute. Noted temperature and atmospheric pressure at the time of sample collection. Transferred absorbed solution from bubbler in 500ml volumetric flask & make the volume to 500ml with distilled water. Took 50ml sample from step above solution and neutralize it to pH 7~8 with NaOH solution. Evaporate the sample to dryness then make volume& determine Nitrate (NO3).

Calculation

$$NOx\ as\ NO_3\ (mg/Nm^3) = \frac{ppm\ NO_3 \times 500 \times 1000 \times 2}{1000 \times Gas\ passed\ at\ NTP}$$

Method-1 for SOx Determination

Scale tube –brownish yellow in which iodine is used as a indicating layer reagent. After the chemical reaction color change to white.

SOx Chemical Reaction

$$SO2+I2+H2O \rightarrow H2SO4+2HI\ (Color\ change\ to\ white)$$

Method-2 for SOx Determination

The sulphur dioxide present in gas is trapped in a washing bottle comprise a dilute solution of H2O2. Sulfuric acid formed was titrated with standard NaOH solution.

Determination

Transferred about 75 mili litre absorbing solution in the gas washing bottle and added 3 pearls of mixed indicator solution. Titrate absorbing solution against 0.002 N-NaOH solution till red colour disappear & green fluorescence show up. Purged the sample line and connect the washing bottle of gas in such a way that the gas passes through the washing bottle and then

through the wet test gas meter. After passing known a volume of gas disconnect the washing bottle and titrate the absorbing solution against 0.002N-NaOH solution until the appearance of green fluorescence. Pass 15-20 liters of gas. Record the volume of gas and mls. of NaOH solution used.

Calculation

$$\text{Gram Moles of sulphur dioxide} = \frac{ml\ of\ NaOH\ \times Normality \times 0.332}{32}$$

$$\text{Gram moles of sample} = \frac{V}{22.4} \times \frac{\text{P} - \text{PW}}{P} \times \frac{273}{273 + t} \times \frac{P}{760}$$

$$\text{ppm Sulphur dioxide (mole} - \text{basis)} = \frac{\text{Gram} - \text{moles of SO2}}{\text{Gram mole of sample}} \times 10^6$$

$$\text{Sulphur dioxide percent} = \frac{\text{Gram} - \text{moles of SO2}}{\text{Gram mole of sample}} \times 100$$

Method for Carbon Monoxide Determination

Description

Scale tube –orange precleanse layer, Chemical reagents present in the tube is Chromium (VI) compound,while indicating layer reagent is Iodine pentoxide, selenium dioxide with fuming sulphuric acid. After the chemical reaction color change to brownish green.

$$CO + I_2O_5 \xrightarrow{SeO2 + H2S2O7} I_2 + 5CO_2 \text{ (Color change to brownish green)}$$

Cross- sensitivity:

Acetylene react in the same way as carbon as carbon monoxide. Other interfering gases like petroleum distillate, Benzene and Hydrogen Sulphide are retained in the precleanse layer. With fairly high concentrations of hydrocarbon, the capacity of the precleanse layer may not be sufficient for quantitative absorption of the hydrocarbon. In order to remove this error there should be a pretube of activated charcoal which absorb the hydrocarbons.

Measurement:

$$\text{ppm CO} = \frac{10\ \times numerical\ value\ (10 - stroke\ scale)}{number\ of\ stroke}$$

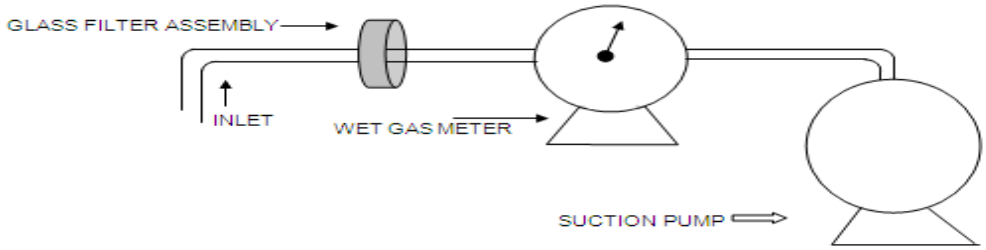
The number of stroke can also be increase to n= 200, if the moisture content of the air or gas sample does not exceed 6 mg H2O per liter.

Method for PM determination

Kept filter paper in oven at 105 oC for 30 minutes. Cool it in desiccators. Weigh out the filter paper Note weight of filter paper as "W" Fit the filter paper in assembly. Set the assembly where the dust is to be monitored. Adjust flow rate as 600 to 700 liter per hour. After four hours stop flow and detach assembly.

Calculation

$$\text{PM mg/m}^3 = \frac{C \times 1000 \times 1000}{Total\ gas\ passed}$$



Results and Discussion

Respiratory diseases are in the set of indicators for air quality (WHO, 1999).A long-term energy crisis has resulted in increased combustion of biomass fuel in industrial and household sectors in Pakistan. Pakistan produces about 19,500MW of electric power; WAPDA provides about 11,363MW, or 58% of this. The remaining power is supplied by the KESC and IPPs. There is currently load shedding of up to 7000MW a day (Ali & Shah., 2012). About half of the overall Pakistan's population has no access to electricity and per capita consumption is one of the lowest in the world. The country is facing serious energy crisis due to shortage of electricity and gas supply. About two-third of the total electricity is generated from fossil fuels. Pakistan heavily depends on imported energy due to limited indigenous reserves and production of oil. The persistent shortage of electricity in the country has adversely affected the national economy. Industrial production has been severely hit; and also triggered social unrest which sometimes turns violent thus, creating law and order problems in many urban centers in the country. According to one estimate power shortages have resulted in an annual loss of about 2 percent of GDP (Abbasi, 2011). Another recent study reports total industrial output loss in the range of 12 percent to 37 percent due to power outages (Siddiqui, 2011).The production, transportation, transformation and consumption of fossil fuels also adversely affect the quality of the environment due to indiscriminate release of toxic substances. The key notion is that a healthy work environment and a healthy work organization deliver the employees with chances for safety, social interface and the ability to control and forecast features of their working situation, opportunities which in turn are thought to be useful to employee health and well-being in the organizational background (Seeman, 2000). Many large countries around the world harbor massive air pollutants, which demand steady monitoring of these pollutants in order to make better policies for their control. These issues have turned to attention owing to their adverse effects on human health and ecological systems. Occupation health diseases can be defined as any disorder arising from work place contacts which compromises worker's physical, mental and social welfare. Generally, the introduction of Occupational health in industries and other occupations can advantage everybody especially the management, the employers and the employees. When the employees are healthy physically, emotionally and mentally the atmosphere within the occupational setting becomes inspiring, calm and attractive. The efficiency increases, the company stands better chance of development (Achalu, 2000).Cardiovascular diseases (CVD) are major cause contributors to mortality and morbidity in South Asia. Chronic exposure to air pollution is necessary risk factor for cardiovascular diseases, although the majority of studies to date have been conducted in developed countries. Many of these autoimmune diseases are associated with industrialization and urban development, as reflected in the hygiene hypothesis (Bach, 2002). Industries which violate the air pollution rules and regulation, can create serious health problems which are often ignored. Problems from the noise comprise poor hearing, loss of attentiveness, frustration, fatigue, restlessness and in serious cases loss of hearing. Noise is a stress that not only harms hearing but also raises heart rate and disturbs other physiological limitations that decrease physical performance (Horino, 1977). Environmentalists say that PM 2.5 is a complex mixture of extremely small particles and liquid droplets and made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. The size of particles is directly linked to their potential for causing health problems. Once inhaled, these particles can affect heart and lungs (Raza, 2010). The present research represent the atmosphere of industry and health of employees. It is also shown in Table 2.

Table 2: Data Analysis

Unit. Names	NOx mg/Nm^3	SOx mg/Nm^3	CO mg/Nm^3	Particulate Matter mg/Nm^3
Unit#1	130	210	610	250
Unit#2	163	194	616	284
Unit#3	140	212	657	315
Unit#4	175	196	552	210
Unit#5	217	255	582	223

Unit#6	250	380	778	322
Unit#7	228	448	813	357
Unit#8	190	416	540	189
Unit#9	182	392	668	252
Unit#10	160	377	772	328
Unit#11	350	422	824	354
Unit#12	255	455	866	419
Unit#13	420	513	924	375
Unit#14	435	450	814	523
Unit#15	487	394	807	445
Unit#16	512	352	793	362
Unit#17	430	543	886	438
Unit#18	392	432	773	390
Unit#19	540	448	856	554
Unit#20	460	592	762	413

Nitrogen Oxides:

In the twenty sample, it was checked that out of twenty only the eleven samples for Nitrogen oxides (NOx) were under the limit of national environmental quality standards and remaining were above the NEQS level and need treatment for reduction. The sample which has the high concentration is 540 mg/Nm3 and lowest concentration sample is 130 mg/Nm3. NOx has been shown graphically in Figure 1

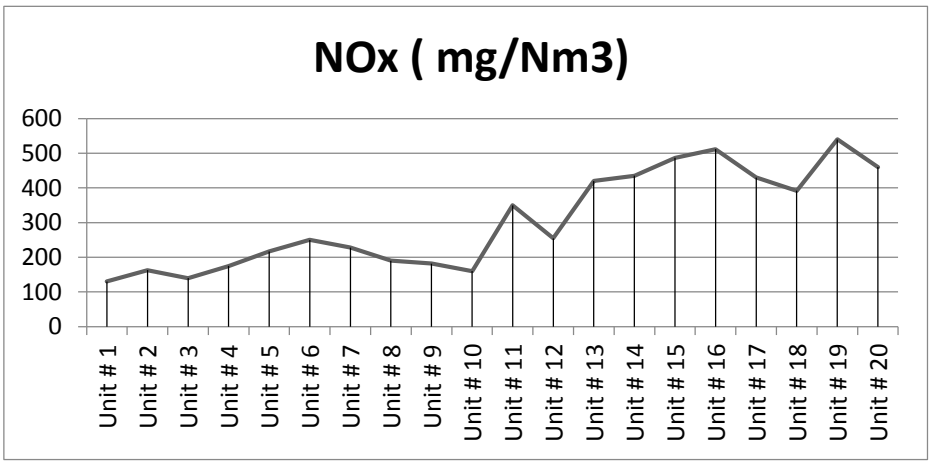


Figure 1: NOx in gas emission samples

Sulphur-Oxides

In the twenty sample, it was found that out of twenty only the ten samples for sulphur oxides (SOx) were under the limit of national environmental quality standards and remaining were above the NEQS level and need treatment for reduction. The sample which has the highest concentration is 592 mg/Nm3 and lowest concentration sample is 194 mg/Nm3. So the range of SOx is from 194-592. It is shown in Figure 2.

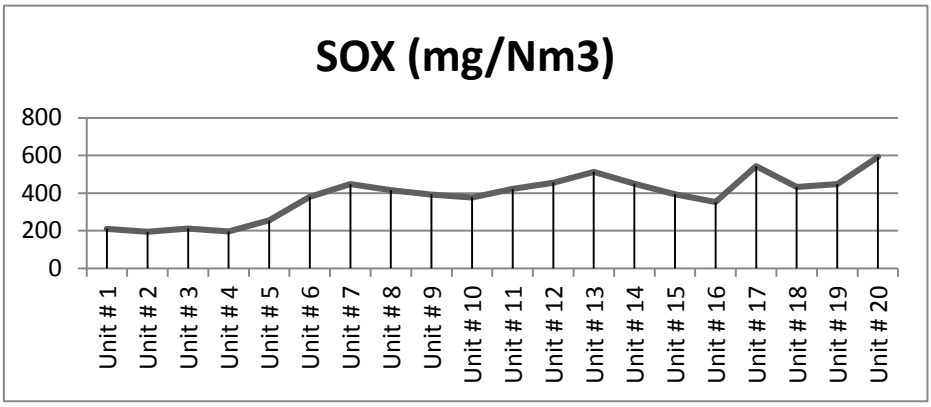


Figure 2: SOx in gas emission samples.

Carbon-Monoxides

In the twenty sample, it was checked that out of twenty only the nine samples for Carbon monoxides (CO) were under the limit of national environmental quality standards and remaining were above the NEQS level. The range of CO in the samples were from 610-886 mg/Nm3. The flue gases from furnace oil contain more CO than gas bas boiler. The trend of CO emission is shown in Figure 3

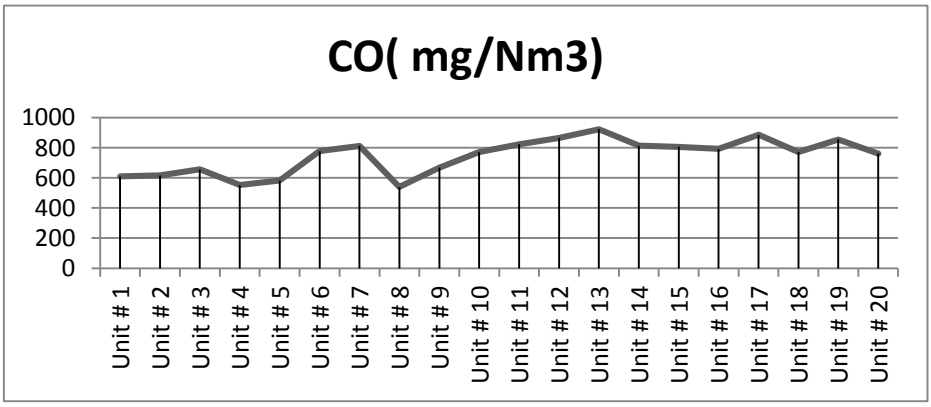


Figure 3: CO in gas emission samples

Particulate Matter:

In the twenty sample, it was checked that out of twenty only the four samples for particulate matter (PM) were under the limit of national environmental quality standards and remaining were above the NEQS level and need treatment for reduction. The range of PM is from 189-554mg/Nm3.. It is shown in Figure 4.

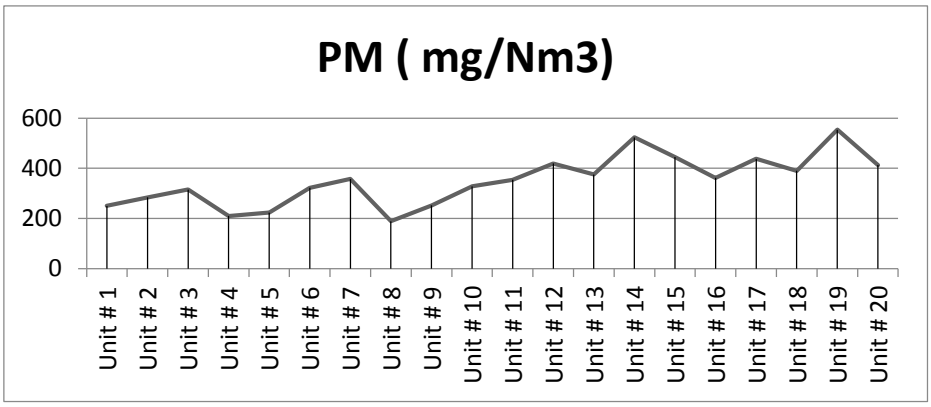


Figure 4: PM in gas emission sample

Table 3: Heath And Safety Check List

Sr #	Questions	Yes	No
1	Are you aware of your emission and its effects?	80	20
2	Are you aware of Pakistan Environmental Protection Act?	60	40
3	Do you have a registration of Pakistan SMART/Green Industry Program?	30	70
4	Are you aware of NEQS under PEPA?	30	70
5	Are you aware of SOx hazard on health?	80	20
6	Does the organization has ISO 14001 certification?	20	80
7	Is there an Environmental Policy that shows your commitment to save Environment?	30	70
8	Is there any medical checkup periodically?	20	80
9	Does the organization has OSHA 18001 certification?	10	90
10	Does NOx are measured with any defined period?	30	70
11	Does any type of environment tests are performed in your laboratory?	60	40
12	Are your emissions and effluents under the strict limitations of NEQS?	60	40
13	Is there any training program in your industry according to environmental impact or awareness?	40	60
14	Does the priority is given to rectify the environment issue or not, in case of any serious environmental issue?	70	30
15	If some other person like us want to deliver lecture about awareness of environmental laws, Would you or your management allow him?	80	20

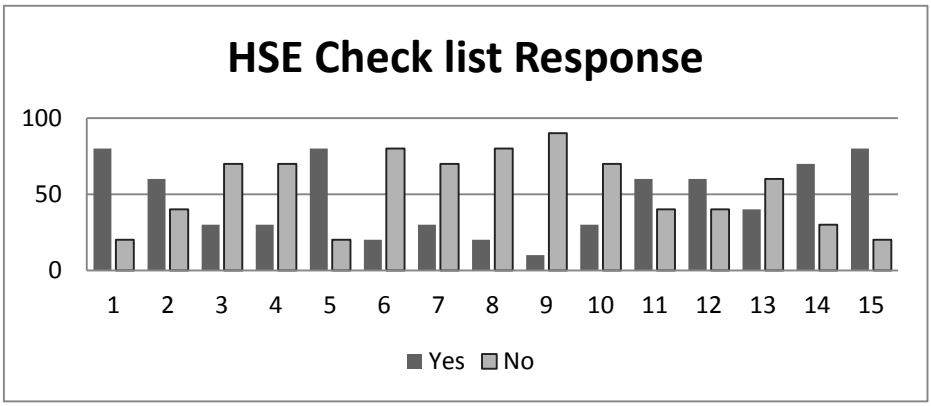


Figure 5: Response of HSE checklist.

Conclusion & Recommendations

We reviewed current knowledge of the effect of climate change on air quality with focus on 21st-century projections for NOx, SOx, CO and particulate matter (PM). We examined results from various approaches to the problem including observed correlations of NOx, SOx, CO and PM with meteorological variables. Ambient air pollution is a health hazard. It is a global challenge, as evidence shows that adverse effects still exist even at relatively low air pollutant concentrations, Cardiovascular diseases are caused by several factors such as age, family history, physical inactivity, overweight, smoking, high cholesterol level, high blood pressure, and unhealthy diets. Air pollution is the other important cause that can aggravate chronic heart and lung diseases. The comparative analyses of the climate, air pollution and respiratory diseases data sets shows significant characteristics of interaction and correlation between climatic zones, air pollution and respiratory diseases occurrences in different parts of big cities. According to the results obtained in this study, PM10 is the most important

component of local air pollution. Prevention is possible by intervening the risk factors in cardiovascular diseases such as identification of some elements in the environment and finding the place of their distribution, avoiding the use of air pollutants or using them as little as possible, proper use of technology, changing diets, behaviors, physical habits, reducing anxieties and mental stresses and other environmental diseases. The research also concludes that physical environment of industry is badly affecting the health of workers. Physical factors like chemical pollution, noise pollution, air pollution, poor working condition, extreme heat, night shift work, extended working hours and physical work load are associated with the health of workers and are main causes of diseases. Result shows that excessive heat badly effect health of workers and become causes of diseases.

- There should be training program for awareness of occupational work and safety and their data should be continuous monitored and checked
- There should be continuous monitoring system according to safety and environment
- There should be availability of PPEs in every industry by regulatory requirement.
- Concerned department should provide technical assistance to control air pollution and there should be annual medical examination of all employees, mission to treat in case of any disease, not to make them un-employed.

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