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Estimation of NO_x,SO_x,CO and Particulate Matter from stack emission and its hazardous effect 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 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 using the standard methods. During this pollution assessment and health impacted research work, 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 working in the highly polluted industries were mostly suffering from lungs diseases. Overall, only five industries emission were found safe according to Punjab environment protection department guidelines.

Keywords: 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 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 him [1]. Air pollution is composed of a complex mixture of substances that have well characterized adverse effects on health. Perhaps one of the well known examples of air pollution increasing morbidity and mortality is the 1952 London Smog [2]. Weather conditions at the 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 [3]. 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 [4].

Component of Air pollutions: When considering which component of air pollution is responsible for these 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 [5,6]. Particulate matter itself is a mixture of components and contains, among others, microbial particles (bacteria, spores), pollen, organic carbon, inorganic sulfates, nitrates, polycyclic aromatic hydro carbons, and heavy metals particles [7].

Effect on Air pollution in Human: Human respiratory system has a number of mechanism for protection from air pollution. Bigger particle (>10 um) can be trapped by the hair and sticky mucus in the lining of nose. Smaller particle can reach trace obronchial 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 dioxide causes damage of respiratory passage and can cause bronchitis like conditions. In the attachment of suspended particulates, SO_2 can form acid sulphate particles which can go deep into the lungs and affect them severely. Oxide of nitrogen especially NO_2 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 is, therefore, unable to transport oxygen to various parts 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 [8]. 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 [9].

Systematic Effects of Air Pollution in Humans: On a population basis, large-scale case studies have shown increased hospitalizations and mortality during and immediately following increased air pollution levels [reviewed in Ref. 10]. Notably, increased levels of air pollution cause decreased lung function in healthy individuals [11], impaired lung function growth in exposed children[12]and exacerbations of existing lung diseases (e.g., chronic obstructive pulmonary disease, asthma). [13].Health and environment studies have also shown that one component of air pollution, particulate matter (PM), is consistently associated with increased cardiovascular mortality [14].

Pollution and Intestine problems: This is despite the fact that the oral route accounts for much of the exposure to air pollutants as the pollutants contaminate both the food and water supply in significant amounts [15]. 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 [16-17]. 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 [18]. 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 [19-22].

The authors 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 $m^{3\ -1}$ increase in carbon monoxide) but other pollutants did not reach significance [23]; interestingly, no link was found between intestinal disorders and a number of indices of air pollution in research study of adults [24].

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 [25].

Prohibition on certain discharges or emissions: According to Punjab Environment Protection Act

- 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. [26]

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" [27].

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 [28] as shown in the table I.

Table 1. National Environmental Quality Standards for Industrial Gaseous Emissions (mg Nm^{3-1})

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. Others.	400 400
4.	Carbon Monoxide	Any.	800
5.	Oxides of Nitrogen (NOx)	(i) Any Nitric Acid manufacturing unit. (Ii) other sources	400 400

MATERIALS AND METHODS

Case study sampling site: In order to study the magnitude of air pollution by different pollutant component,we selected a site in the city of Lahore –Shekhupua Road in Pakistan Such site allows access to maximum levels of pollution that an urban population can be exposed. The selected site where measures were carried out was located at the Lahore-shekhupua industrial zone. The sampling was carried out in each industry with the help of EPA from stack emission. The major pollutant we analyzed there and health issues were also discussed with employees which were directly affected from their stack emission.

Prerequisite Preparation: Before experiment following activity was performed

- Instruments were calibrated to check the efficiency with standards
- Solutions were standardized
- Analytical grade chemicals were used for the preparation of reagent

Sampling mode:

- For NOx and CO, Flue gas analyzer was used, its probe was enter in to stack and reading was noted.
- For Particulate matter, Iso kinetic method was used and 200 liters was gas passed.
- For SOx sample was collected in high volume sampler.

Sampler Precaution: Samplers were evacuated before collecting the gas sample either by vacuum pump or by air ejector.

- For each and every sample a separate sampler, properly labeled (source of sample) was used.
- The sample line was purged for 30-60 seconds and the sample valve was closed to an extent that a slight positive pressure of gas remained in the sample line.
- The evacuated rubber balloon was connected to the sample point. The pinch cock of the balloon was slowly opened and the gas is allowed to enter the balloon; desired flow of gas into the balloon was established by opening the sample valve.
- After collecting 1.5 to 2.5 liters of gas the pinch cock was closed and balloon was removed from the sampling point; and the sampling point was closed.

Equipment

- Flue gas Analyzers
- UV/Visible spectrophotometer
- Wet test meter
- Vacuum pump

RESULTS AND DISCUSSION

A long-term energy crisis has resulted in increased combustion of biomass fuel in industrial and household sectors in Pakistan[29]. About half of the over all 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 production, transportation, transformation and consumption of fossil fuels also adversely affect the quality of the environment due to indiscriminate release of toxic substances [30]. 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. 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. Both indoor and outdoor pollution of air are growing problems in developing countries in South Asia yet the impact on rising rates of CVD in these regions has largely been ignored. Our research will help to assess the evidence available regarding air pollution effects on CVD and CVD risk factors in lower income countries in South Asia. The present research represent the atmosphere of industry and health of employees. It is also shown in table 2.

Table 2: Estimation of NOx, SOx, CO and matter particulate from stack emission on the basis of fuel and its hazardous effect on human health.

Unit. Names	NOx mg/Nm^3	Sox (mg/Nm^3)	CO mg/Nm^3	Matter Particulate 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 $Nm3^{-1}$. It is shown in fig 1.

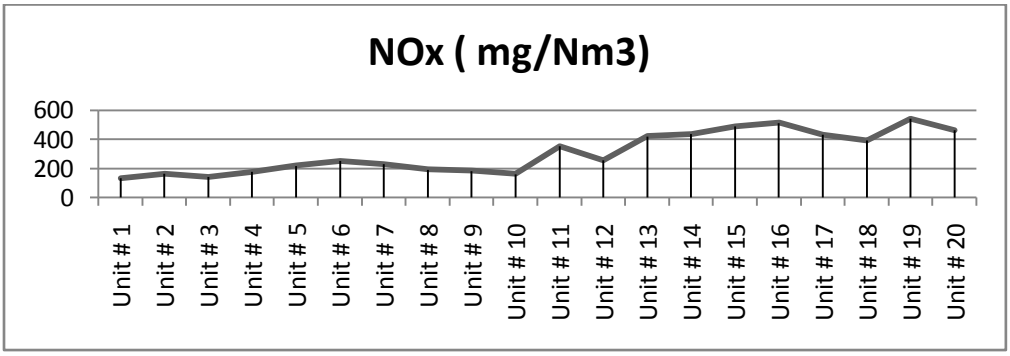

Fig.1 NOx in stack emission samples

Sulphur-Oxides: In the twenty sample, it was checked 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 high concentration is 592 mg/Nm3 and lowest concentration sample is 194 mg $Nm3^{-1}$. So the range of SOx is from 194-592. It is shown in fig 2.

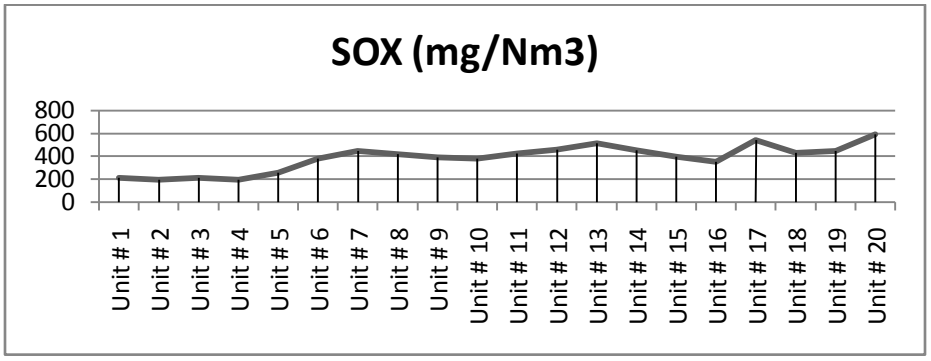

Fig.2. SOx in stack emission samples

Carbon-monoxides: In the twenty samples, 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 was from 610-886 mg $Nm3^{-1}$. The flue gases from furnace oil contain more CO than gas bas boiler. The trend of CO emission is shown in fig-3.

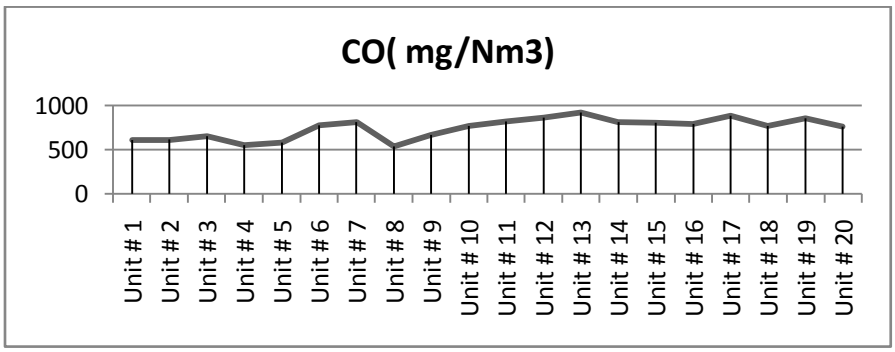

Fig. 3

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 $Nm3^{-1}$. It is shown in fig. 4.

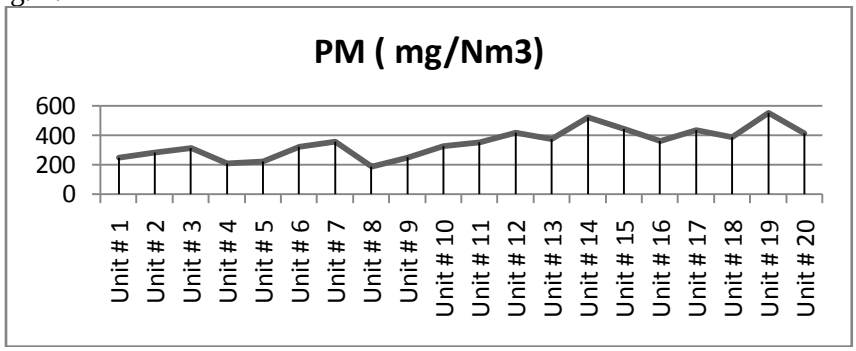

Fig.4 PM in stack emission sample

APPLICATIONS

This research work is applicable to all industries to continue monitor their emission and examine the medical check up for good health of their employees.

CONCLUSIONS

Air pollution can be minimized by the following methods.

- Sitting of industries after proper environmental assessment studies.
- By the dilution of emission. This can be done by increasing the stack of height (though up to permission able height), beyond the inversion layer. Wind currents will disperse the pollutants.
- Removing of sulphur from gas, furnace oil and coal
- Removing NOx during the combustion process and controlling the flow of air and fuel in industrial boilers.
- Control CO by proper burning.

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