# 148. Impact of Air Pollution from the Industries S.I.T.E Area Kotri

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## Abstract

Environmental pollution has become a serious problem in the world since last few decades and causing dangerous and harmful effects in the biosphere, where human beings are living and are responsible for introducing pollutants in it. This paper mainly deals with the air pollution, which is the main reason of harm to the life of human beings. The air pollution produced from Sindh Industrial Trading Estate (SITE) area Kotri is one of the major problems being faced by the locality. In this project the air pollution at SITE area Kotri were measured by latest equipment to check the level of ambient air quality in its vicinity area. The results concluded that majority of industries have air pollution values above standard fixed by the Environmental Protection Agency (EPA), World Health Organization (WHO) and National Environmental Quality Standards (NEQS). It is suggested that the existing position of air pollution need for quick action to tackle to reduced air pollution. Also, it is compulsory to implement ambient air quality standards, development of continuous monitoring sites is essential.



***Keywords:*** Air Pollution, S.I.T.E Area Kotri, Industrial Area of Kotri, Air Pollution Standards

## 1. Introduction

Today, air pollution, climate change and energy security are broadly considered as three challenging issues. Some of the under developed countries of world has reached substantial economic development in last few decades, but they also considered as the world's largest producer for environmental pollution, source of greenhouse gas emissions (GHGs) and energy consumers, [1]. Environmental pollution and global climate change are very close to each other, for environmental pollution ($SO_2$, NOX, PM, VOCs, etc.) while for GHGs ($CO_2$, $CH_4$, $N_2O$, HFCs, etc.) are emitted from the combustion of fossil fuels [2], [3]. The increased requirement for energy

is fulfilled by the combustion of fuels i.e. petroleum products & coal in the industries & power generation and in transport. At the same time the scientists are engaged to safeguard the world from such environmental pollution gases emitted from industries, refineries, and transport and power generation [4]. In order to design and execute any industry with all other environmental considerations are also modifying at the time of design to protect the human beings [5].

Industries, in general, 50% of $CO_2$, 90% of $SO_2$ and nearly all of its toxic chemicals of the world while consuming only 37% of the world's energy [6]. Lately, however; the high cost of remediation and strictness of some of the local impacts of the industries is becoming highly sensitive and uncontrollable problem in Pakistan. The stationary sources of air pollution emitted from industries such as petrochemical plants, power generation, petroleum industries, fertilizer, cement, iron and steel industries are increasing with alarming condition in Pakistan. Also, these industries are expanding their work in industrial cities such as Karachi, Lahore, Hyderabad, Kotri and many other industrial cities of the Pakistan which also turns to worsen the air pollutants level [7]. Although the extra energy services related to economic growth can be consumed through an installation of air pollution control devices, so that the air pollution reduction targets may achieve over there [8].

Through the literature review, the major sources of air pollution in Sindh are: Industrial pollutants ($SO_2$, $CO_2$, CO, Hydrogen Sulphide, particulate matters (PM) etc.), Automobile exhaust pollutants (carbon monoxide, Radiation - nitrogen oxides), Domestic Pollutants (fossil fuel burnt by humans) and other miscellaneous sources are from textile, pharmaceutical, ceramics and fertilizer industries [9].

Geologically, the Kotri city is a flat-topped, typical of arid topography. The climate of city is subtropical, semi-desert type; characterized by low and highly erratic rainfall, low relative humidity and high rate of temperature. The Industrial zone of Kotri (SITE Kotri) was chose for this study and is located on the right bank of the Indus River (in, Sindh Pakistan). The SITE Kotri ranks third in Sindh province and seventh in the national level. It lies in latitude 25º.3739´ north and longitude 68º.3013s´ east. The major industries in S.I.T.E Area Kotri are textile in nature, cotton, power plants, pharmaceutical, and general industries. There are more than 120 industries in Kotri industrial zone but most of them are the textile industries and major productions are cotton, cloths, medicines, piping, power production, and general products. There are many colonies, village's education system in the vicinity of S.I.T.E Area Kotri such as: Bihar Colony, Khursheed Colony, Khuda Ki Basti, Yousaf Baloch Goth, Labor Colony, Degree College Kotri, Government Girls College, Government Boys & Girls High School and Taluka Hospital Kotri with population of around 0.2 Million.

## 2. Nuisance of Air Pollution

Exposure to air pollution cause increasing in respiratory and cardio vascular morbidity and mortality [10], [11] and [12], including lung cancer [13] and [14]. Such effects are also observed among children, both for respiratory [15] and cardiovascular morbidity [16]. Also, the adverse pregnancy and birth out comes has been observed due to air pollution [17], in particular birth weight [18], [19] and [20]. For short-term effects of air pollution on mortality, no threshold of exposure below which the effects cease to exist has been identified [21]. The issue of environmental justice, or socio-economic status facing air pollution, has become a public health main concern.

**Table 1: USA National Ambient Air Quality Standards (NAQS)**

| Pollutant [links to historical tables of NAAQS reviews] | | Primary / Secondary | Average Time | Level | Form |
|---|---|---|---|---|---|
| Carbon Monoxide (CO) | | Primary | 8 hours<br>1 hour | 9 ppm<br>35 ppm | Not to be exceeded more than once per year |
| Lead (Pb) | | Primary & Secondary | Rolling 3 month period | 0.15 µg / $m^3$ (1) | Not to be exceeded |
| Nitrogen Dioxide ($NO_2$) | | Primary | 1 hour | 100 ppb | 98th Percentile of 1- hour daily maximum concentration, averaged over 3 years |
| | | Primary & Secondary | 1 Year | 53 ppb (2) | Annual Mean |
| Ozone ($O_3$) | | Primary & Secondary | 8 hours | 0.070 ppm (3) | Annual fourth heights daily maximum 8 hours concentration, averaged over 3 years |
| Particle Pollution (PM) | PM 2.5 | Primary | 1 Year | 12.0 µg / $m^3$ | Annual Mean, averaged over 3 years |
| | | Secondary | 1 Year | 15.0 µg / $m^3$ | Annual Mean, averaged over 3 years |
| | | Primary & Secondary | 24 hours | 35 µg / $m^3$ | 98th Percentile, averaged over 3 years |
| | PM 10 | Primary & Secondary | 24 hours | 15.0 µg / $m^3$ | Not to be exceeded more than once per year on average over 3 years |
| Sulfur Dioxide ($SO_2$) | | Primary | 1 hour | 75 ppb (4) | 98th Percentile of 1- hour daily maximum concentration, averaged over 3 years |
| | | Secondary | 3 hours | 0.5 ppm | Not to be exceeded more than once per year |

Chemical reactions regarding with air pollutants can resulted acidic compounds which could destruction to buildings, vegetation and our atmosphere. Sometimes, when an air pollutant, such as sulfuric acid combined with the water droplets that produced clouds, the water droplets become acidic and forming acid rain. Also, these chemical reactions with air pollutant resulted a poisonous gas ozone (O3) [22], and affect people's health and can damage planet and some animal life too. Air pollutants in the form of PM and depend on the length of exposure time, type and concentration can be very dangerous to our health. The adverse effects can be short-term effects (bronchitis & pneumonia, irritation to the eyes, nose and throat) and can worsen the medical conditions of individuals with asthma and emphysema. Long-term

health effects (chronic respiratory disease, lung cancer, heart disease, and even damage to the brain, nerves, liver, or kidneys) and continual exposure to air pollution affects the lungs of growing children and may complicate medical conditions in the elderly [23].

## 3. USA National Ambient Air Quality Standards (NAAQS)

The Clean Air Act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards (40 CFR part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of national ambient air quality standards [24].

## 4. National Environmental Quality Standards (NEQS)

The Pakistan Environmental Protection Agency (PEPA) drafted NEQS for ambient air. In pursuance of the statutory requirements under clause (e) of sub section (1) of section (6) of the Pakistan Environmental Protection Agency Act 1997 are as follow: [25].

**Table 2: National Environmental Quality Standards (NEQS)**

| ` | Time-weighted average | Concentration in ambient air | |
|---|---|---|---|
| | | Effective from 1st January 2009 | Effective from 1st January 2012 |
| Sulfur Dioxide (SO2) | Annual Average* | 80 µg / m3 | 80 µg / m3 |
| | 24 hours** | 120 µg / m3 | 120 µg / m3 |
| Oxides of Nitrogen | Annual Average* | 40 µg / m3 | 40 µg/ m3 |
| | 24 hours** | 80 µg / m3 | 80 µg / m3 |
| $O_3$ | 1 hour | 180 µg / m3 | 130 µg / m3 |
| Suspended Particle Pollution (SPM) | Annual Average* | 400 µg / m3 | 360 µg / m3 |
| | 24 hours** | 550 µg / m3 | 500 µg / m3 |
| Repirable Particle Pollution (PM10) | Annual Average* | 200 µg / m3 | 120 µg / m3 |
| | 24 hours** | 250 µg / m3 | 150 µg / m3 |
| Repirable Particle Pollution (PM2.5) | Annual Average* | 25 µg / m3 | 15 µg / m3 |
| | 24 hours** | 40 µg / m3 | 35 µg / m3 |
| | 1 hour | 25 µg / m3 | 15 µg / m3 |
| Lead (Pb) | Annual Average* | 1.5 µg / m3 | 1 µg / m3 |
| | 24 hours** | 2 µg / m3 | 1.5 µg / m3 |
| Carbon Monoxide (CO) | 8 hours** | 5 µg / m3 | 5 µg / m3 |
| | 1 hour | 10 µg / m3 | 10 µg / m3 |

*Annual Arithmetic mean of minimum 104 measurement in a year taken twice a week 24 hourly at uniform interval
**24 hourly / 8 hourly values should be met 98% of the in a year. 2% in a time, it may exceed but not on two consecutive days

## 5. Pollution Measuring Equipment

The Digital Sound Level Meter is used during this project. The detail features of equipment were: Large clear digital display, FAST / SLOW Time weightings, MAX hold function, AC / DC output, Sound level: 30 -130 dB, Accuracy: ±1.5dB (under reference conditions), Ranges: 30 - 80dB, 50 - 100dB , 60 - 110dB, 80 - 130dB, Display: 5-digit LCD display, Resolution: 0.1dB, Bar Graph: 50dB scale with 1dB steps, linearity range: 50dB, Warning: 'OVER' & 'UNDER' indicating when value is out of level range, Frequency Weighting: A / C, Frequency Range: 31.5 - 8.5K Hz, Time Weighting: FAST / SLOW, Power Life: Approx. 30 hours from alkaline batteries, Size: 265 x 75 x 35mm and Weight: 300g including batteries and was calibrated from the PCSIR Laboratories, the Digital Sound Level Meter is shown in figure 1

**Fig. 1: Gas Monitor for SOx & NOx**

## 6. Results and Discussion

The latest and calibrated equipment was used at different dates, timing and locations were selected for data collection in the Kotri SITE Area. Also different working hours were also selected for finding out the data for the air pollution. From Figure 2 to Figure 8 are the SOx data for different categories of industries at S.I.T.E Area Kotri.

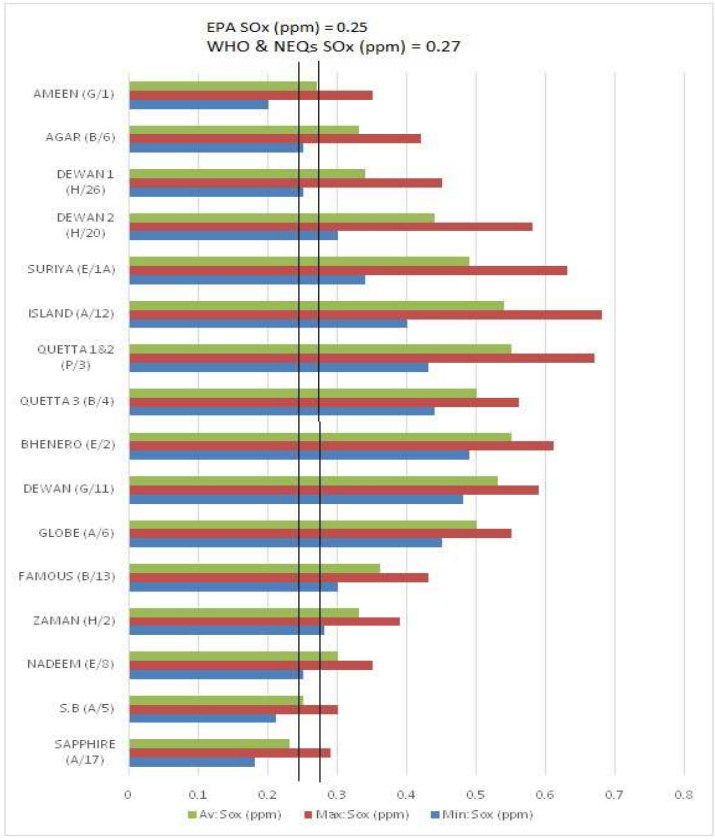


**Fig. 2: Comparison of SOx Emission from Textile Industries of Kotri SITE with one hour Standard of EPA, NEQS & WHO**

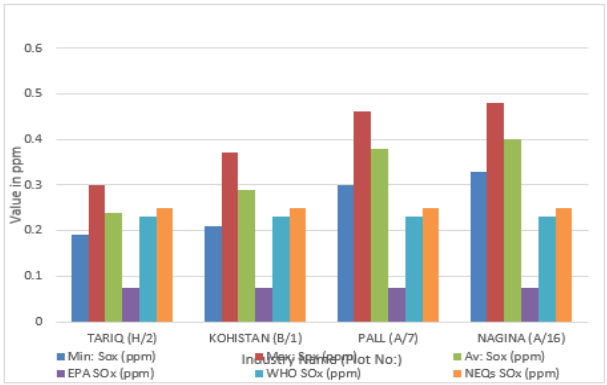


**Fig. 3: Comparison of SOx Emission from Cotton Industries of SITE Kotri with One Hour Standard of EPA, NEQs & WHO**

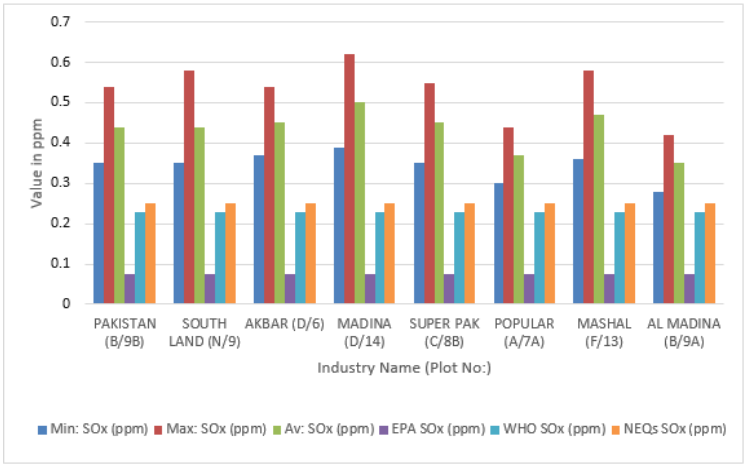


**Fig. 4: Comparison of SOx Emission of Flour Mills Industries of SITE Kotri with One Hour Standard of EPA, NEQs & WHO**

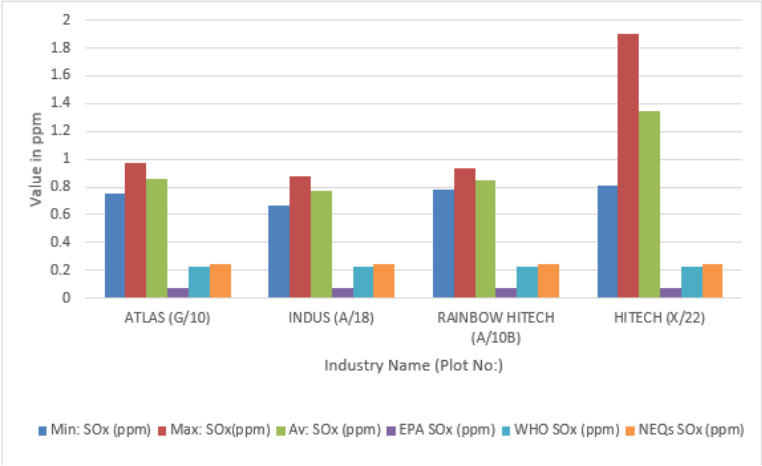


**Fig. 5: Comparison of SOx Emission of Piping Industries of SITE Kotri with One Hour Standard of EPA, NEQs & WHO**

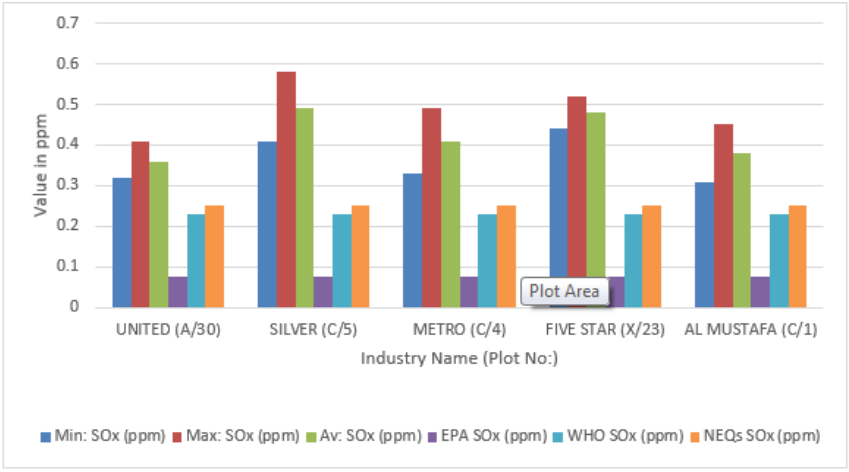


**Fig. 6: Comparison of SOx Emission of Rice Mill of SITE Kotri with One Hour Standard of EPA, NEQs & WHO**

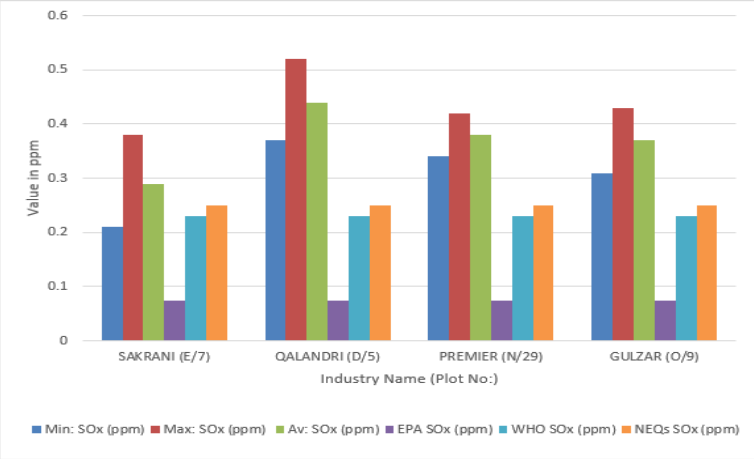


**Fig. 7: Comparison of SOx Emission of Oil Industries of SITE Kotri with One Hour Standard EPA, NEQs & WHO**

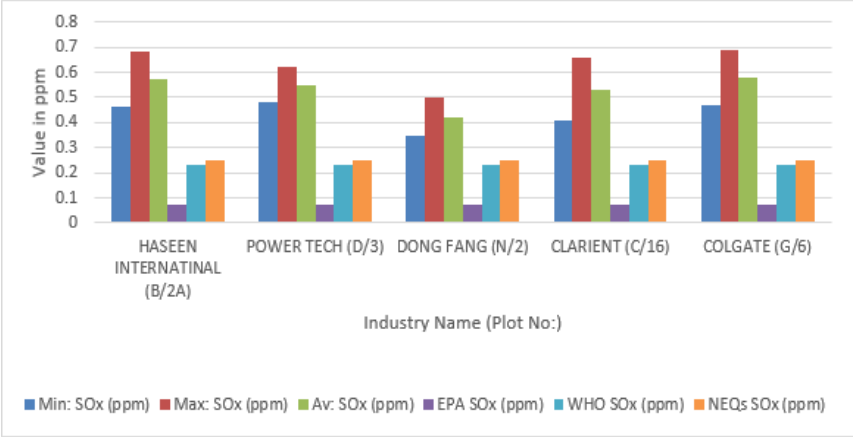


**Fig. 8: Comparison of SOx Emission of Other Industries of SITE Kotri with One Hour Standard EPA, NEQs & WHO**

Figure 2 to Figure 8 shows the SOx (ppm) of the different types of industries of the SITE Kotri and compared with the standard values of EPA, WHO and NEQs. From data it was analyzed that the SOx in the textile, cotton and flour mills was above / high than the EPA, NEQS and WHO standards. It is due to any source at large scale to produce smoke/emission of the air pollutants in SITE Area and it consists of dust in the raw material (cotton) and during processing of the it causes dust not only the inside but also outside of the industry vicinity. Secondly, almost all the textile and cotton industries have their own power generation units running on the natural gas as a fuel which also contribute to produce SOx (ppm) in the atmosphere. The alarming thing to identify here that it was surprisingly observed that these values were too much higher in the winter season stated from month November to April of the year in the SITE area Kotri, this is because some such industries were in operation in this period. Usage of bad quality of raw material for the processing in the industry were major source to produce air pollution in the SITE area Kotri as this was the same case with the flour industries. The major sources of SOx were from the boilers, ovens and storage tanks installed in the industries. During the survey, other significant sources of air pollution emission sources in textile processes included dying, printing, fabric, resin finishing and drying operation were observed. While drying oven and mineral oils in high temperature drying / curing cause to produce hydrocarbons. In general, these textile operations can emit acids, softeners and volatile compounds and formaldehydes in the S.I.T.E area Kotri.

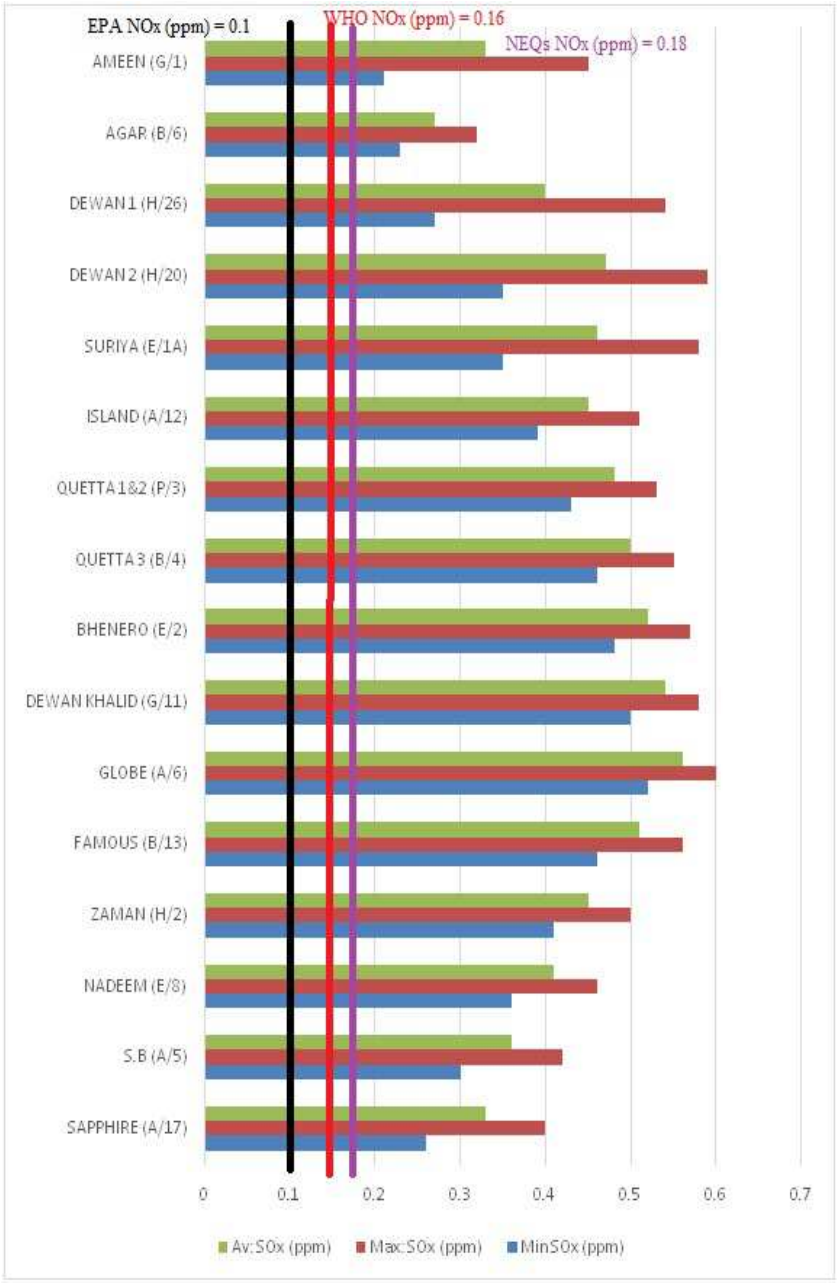


**Fig. 9: Comparison of NOx Emission of Textile Industries of SITE Kotri with One Hour Standard EPA, NEQs & WHO**

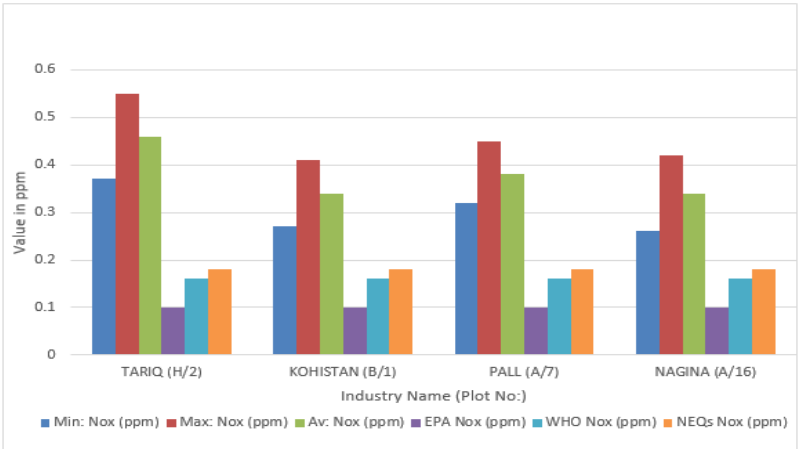

**Fig. 10: Comparison of NOx Emission of Cotton Industries of SITE Kotri with One Hour Standard EPA, NEQs & WHO**

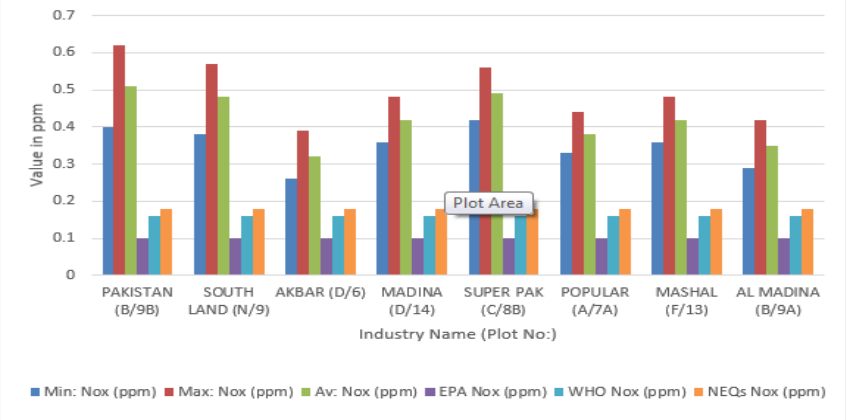


**Fig. 11: Comparison of NOx Emission of Flour Mills Industries of SITE Kotri with One Hour Standard EPA, NEQs & WHO**

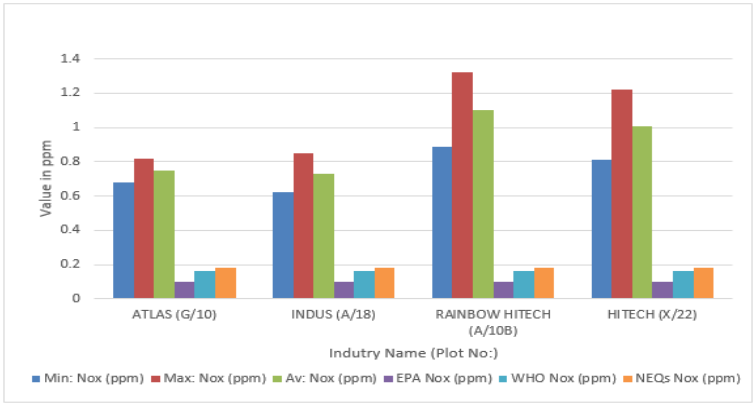


**Fig. 12: Comparison of NOx Emission of Piping Industries of SITE Kotri with One Hour Standard EPA, NEQs & WHO**

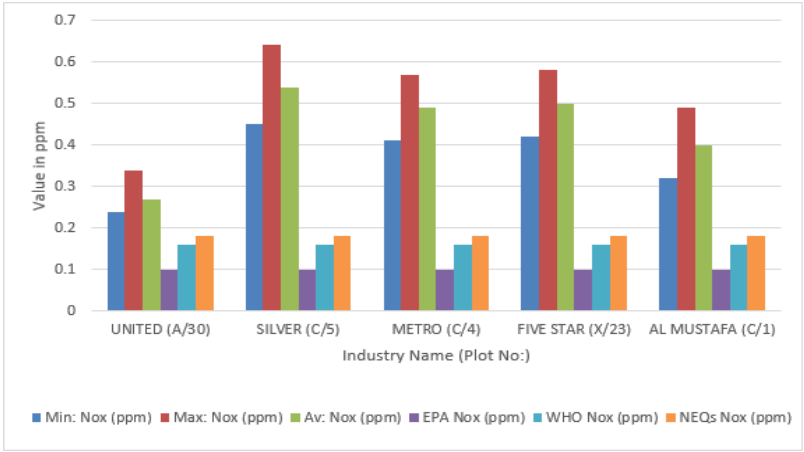


**Fig. 13: Comparison of NOx Emission of Rice Mill of SITE Kotri with One Hour Standard EPA, NEQs & WHO**

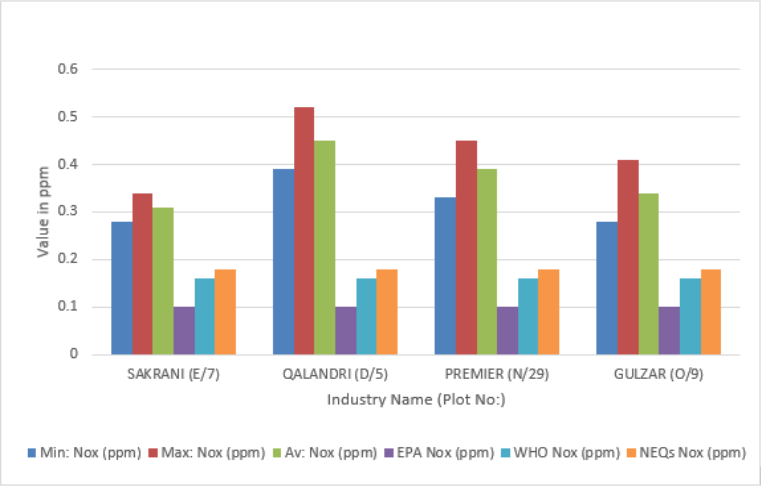


**Fig. 14: Comparison of NOx Emission of Oil Industries of SITE Kotri with One Hour Standard EPA, NEQs & WHO**

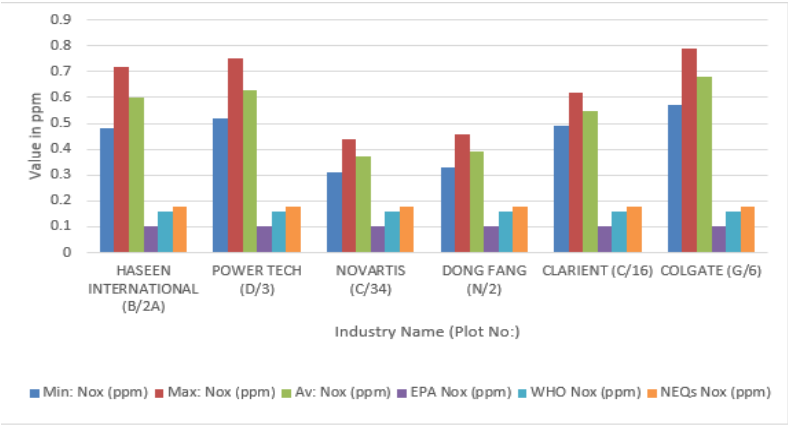


**Fig. 15: Comparison of NOx Emission of Other Industries of SITE Kotri with One Hour Standard EPA, NEQs & WHO**

It is the second major component of air pollution is the NOx and produced mainly the chemical reaction of nitrogen and oxygen mainly due to the combustion of fuel in the air-breathing engine and other thermal application machines (boilers and oven) installed in the different industries in the SITE Area Kotri. Figure 9 to Figure 15 shows the values of NOx (ppm) of the different industries in the SITE Area Kotri and compared with the standard values of the EPA, WHO and NEQs standards. As it was already described that most of the textile, cotton and flour mills have their own power generation units sourced on the natural gas and other thermal application machines used during the processing manufacturing of the products in these industries causes to have much more values of NOx then the standard values of the international standard organizations. Levels are also higher in winter in cold regions of the world than in other seasons because of the increased use of heating fuels.

## 7. Conclusion

Industries contributes various kinds of pollutants to the environment and produced both traditional pollutants such as organic substances, sulfur dioxide, particulates and nutrients etc: and newly classified pollutants such as dioxin and other toxic substances [26]. The rising necessity for environment-friendly products and eco-friendly manufacturing procedures in global and domestic markets suggests that there is an enormous chance for those industries that integrate the concept of pollution prevention, because its advantages have been confirmed to decrease costs, increase efficiency, lessen risk and condense liability [27].

Pakistan, during the past few decades, has gotten an extensive increment in population growth, urbanization, and industrialization, together with a great escalation in motorization and energy use. As a result, a considerable growth has taken place in the types and number of emission sources of various air pollutants [28]. However, due to the deficiency of air quality management proficiencies, the country is

suffering from deterioration of air quality. Indication from several governmental and international organizations has showed that pollutants are substantial danger to the environment, quality of life, and health of the population [29].
This study focused on the air pollution in the SITE area Kotri, the calibrated instruments from the PCSIR Hyderabad were used for data collection at the study area. The collected data was compared with the three different standard agencies at national and international level, from the collected data it may be concluded that all the industries producing the SOx, NOx level more than the standard values given by international & national agencies. All kinds of pollution, witnessed in Sindh, are also common in many parts of Pakistan [30]. Suggestions for remedies for this nuisance are well spread in the international literature. For Hyderabad and Karachi, which are polluted to various degrees of deleterious elements, are of particular interest in both the places, it is pertinent to keep the air clean, devoid of excessive amounts of Respirable particulate matter, and other harmful pollutants. On the basis of this study the authors concluded that whole industries in the SITE area Kotri producing the SOx and NOx pollution specially the textile, cotton and flour mills produced much higher values of SOx and NOx than the other in the vicinity area of the industries.

The current state of air and pollution calls for immediate action to tackle the poor and air quality. The establishment of ambient air quality standards, an extension of the continuous monitoring sites, and the development of emission control strategies are essential.

## 8. Recommendations / Mitigation

1. It is recommended that in order to circumvent some of the environmental concerns, efforts must be made to legislate and implement regulations in this context. However, in adverse conditions, the latest National Standards of Pakistan Environmental Protection Agency should be followed. But, in the absence of specific standards in this regard, the guidelines of World Health Organization, and/or United States Environmental Protection Agency should be consulted for further guidance.
2. It is recommended that industries at SITE area Kotri may installed Scrubber System (Venturi Scrubber, Wet scrubber and Multi-Channel Scrubber etc.) for controlling the Air Pollution
3. It is recommended that industries must properly treat the wastes, discharges and disposals of a pollutants to reduce harmful effects in the vicinity of SITE area Kotri
4. Textile based cottage industries are facing financial problems, in this affection it is suggested that government should funding them by providing loans so that they should switch their old technology into the new and advance technologies, and this help to decrease the pollution concentration but will also upgrade the productivity as well.
5. It is suggested that the management of the textile industries to decrease the working shift to 08 hours period to condense the air pollution and save the damages due to it in the vicinity of SITE area Kotri.
6. It is recommended that plantation of trees, bushes and gardens at the inside and outside of the industries at SITE area Kotri, as plants works as a pollution absorbent.

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**References**

[1] Muhammad Rizwan , Zubair Ahmed, Waqas Arain and Waqas Ali. (2014). Impact of Air and Noise Pollution from the Industries S.I.T.E Area Kotri. Undergraduate Thesis, MUET SZAB Campus Khairpur Mir's.
[2] Johannes Bollen, Bruno Guay, Stéphanie Jamet and Jan Corfee-Morlot. (2009). Co-benefits of Climate Change Mitigation Policies: Literature Review and New Results.
[3] Hari Bansha Dulal and Sameer Akbar. (2013). Greenhouse gas emission reduction options for cities: Finding the "Coincidence of Agendas" between local priorities and climate change mitigation objectives**.** Habitat International Volume 38, April 2013, Pages 100–105.
[4] Shaohui Zhang, Ernst Worrell and Wina Crijns-Graus, (2015). Synergy of air pollutants and greenhouse gas emissions of Chinese industries: A critical assessment of energy models. Energy 93 (2015) 2436-2450.
[5] Jiajia Zheng, Ping Jiang, Wen Qiao, Yun Zhu and Erin Kennedy, (2016). Analysis of air pollution reduction and climate change mitigation in the industry sector of Yangtze River Delta in China. Journal of Cleaner Production 114, 314-322.
[6] K. Priya and Dr.S.Gandhimathi, (2015). Impact of industrial pollution on agricuoture in coimbatore district. Asian Academic Research Journal of Social Science & Humanities Vol 1, Issue 32.

[7] Asadullah Kazi, (2014). Appraisal of Air and Water Pollution in Hyderabad and Karachi, Pakistan. Quaid-e-Awam University Research Journal of Engineering, Science & Technology, Volume 13, No. 1, Jan-Jun.
[8] Worrell E, Ramesohl S, Boyd G. Advances in energy forecasting models based on engineering economics. Annu Rev Environ Resour 2004; 29:345-81.
[9] Farzana Panhwar (2004), Environmental Pollution in Sindh, Pakistan. http://www.eco-web.com/edi/040924.html.
[10] Pope, C.A., Dockery, D.W., 2006.Health effects of fine particulate air pollution: lines that connect. J. Air Waste Manag. Assoc. 56 (6), 709–742.
[11] Kruize, H., Driessen, P. P. J, Glasbergen, P., van Egmond, K. N. D., (2007). Environmental equity and the role of public policy: experiences in the Rijnmond region. Environmental Management. 40 (4), 578–595.
[12] Peters, A., (2011). Ambient particulate matter and the risk for cardio vascular disease. Prog. Cardiovasc. Dis. 53 (5), 327–333.
[13] Lepeule, J., Laden, F., Dockery, D., Schwartz, J, (2012). Chronic exposure to fine particles and mortality: an extended follow up of the Harvard Six Cities study from 974 to 2009. Environ. Health Perspect. 120 (7), 965–970.
[14] Raaschou-Nielsen, O., Andersen, Z. J. ,Beelen, R., Samoli, E., Stafoggia, M., Weinmayr , G., etal., (2013). Air pollution and lung cancer incidence in 17 European cohorts: prospective analyses from the European Study of Cohorts for Air Pollution Effects (ESCAPE). Lancet On col.14 (9), 813–822.
[15] MacIntyre, E. A., Karr, C. J., Koehoorn, M., Demers, P. A., Tamburic, L., Lencar, C., etal., (2011). Residential air pollution and otitis media during the first two years of life. Epidemiology 22 (1), 81–89.
[16] Pieters, N., Koppen, G., Van Poppel, M., De Prins, S., Cox, B., Dons, E., etal., (2015). Blood pressure and same-day exposure to air pollution at school: associations with nano sized to coarse PM in children. Environ. Health Perspect. 123 (7), 737–742.
[17] Shah, P. S., Balkhair, T., (2011). Knowledge synthesis group on determinants of pre-term / L B W births. Air pollution and birth out comes: a systematic review. Environ. Int. 37 (2), 498–516.
[18] Wilhelm, M., Ghosh, J. K., Su, J., Cockburn, M., Jerrett, M., Ritz, B., (2012). Traffic related air toxics and term low birth weight in Los Angeles County, California. Environ. Health Perspect. 120 (1), 132–138.
[19] Dadvand, P., Parker, J., Bell, M. L., Bonzini, M., Brauer, M., Darrow, L. A., etal., (2013). Maternal exposure to particulate air pollution and term birth weight: a multicountry evaluation of effect and heterogeneity. Environ. Health Perspect. 121 (3), 267–373.
[20] Pedersen, M., Giorgis - Allem and, L., Bernard, C., Aguilera, I., Andersen, A.-M.N., Ballester, F., etal., (2013). Ambient air pollution and low birth weight: a European cohort study (ESCAPE). Lancet Respir. Med. 1 (9), 695–704.
[21] World Health Organization, (2013). Review of evidence on health aspects of air pollution REVIHAAP project: final technical report [Internet]. Available from: ⟨http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2013/review-of-evidence-on-health-aspects-of-air-pollutionrevihaap-project-final-technical-report⟩. (cited 24.03.15).
[22] Suseelamma. T and Sujatha, N, (2015). Pollution - A Threat to Human Health. International Journal of Multidisciplinary Advanced Research Trends ISSN: 2349-7408 Volume II, Issue 1(1), 2015.
[23] Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide. (2003). Report on a WHO Working Group Bonn, Germany 13–15 January 2003. http: www.euro.who.int/__data/.../E79097.pdf.
[24] National Ambient Air Quality Standards (NAAQS). US Environmental Protection Agency 1990: (http://www3.epa.gov/ttn/naaqs/criteria.html)
[25] National Environmental Quality Standards (NEQS). Pakistan Environmental Protection Agency (PEPA) 1997.
[26] Valavanidis Athanasios, Thomais Vlachogianni, Spyridon Loridas, Constantinos Fiotakis, (2015). Atmospheric Pollution in Urban Areas of Greece and Economic Crisis Department of Chemistry, University of Athens, University Campus Zografou, 15784 Athens, Greece.
[27] Dong H, Dai H, Dong L, Fujita T, Geng Y, Klimont Z, et al, (2015). Pursuing air pollutant co-benefits of $CO_2$ mitigation in China: a provincial leveled analysis. Appl Energy; 144:165-74.
[28] Moss, L.R., 2008. Local governments reduce costs through pollution prevention. Journal of Cleaner Production 16, 704-708.
[29] Kazi, A. (2014) A review of the assessment and mitigation of Floods in Sindh, Pakistan. Natural Hazards, Vol. 7(1), pp. 839-864.
[30] PEPA (2013) Position Paper for Environmental Quality Standards of Noise in Pakistan. Pakistan Environmental Protection Agency, Islamabad, Pakistan.