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INSTITUTE OF SCIENCE

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CERTIFICATE

This is to certify that Mr./Ms. Name of Student (Enrollment No.) student of M.Sc. in Chemistry has carried out the dissertation under my supervision at Department of Chemistry, Silver Oak Institute of Science (SOIS), Silver Oak University, Gujarat, India.
The dissertation entitled "DISSERTATION TOPIC" is a record of bonafied research work carried out by him/her under my supervision and guidance for partial fulfilment for award of degree of Master of Science (Chemistry).

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DECLARATION

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I hereby declare that this dissertation report entitled "**DISSERTATION TITLE"** was carried out by me (**Ms. /Mr. Name of Student**) for the degree of Master of Science under the guidance and supervision of **Dr. Nitya Chawda,** Assistant professor, Department of Chemistry, Silver Oak Institute of Science (SOIS), Silver Oak University, Gujarat, India. I will not publish this work anywhere without the consent from the supervisor.

Signature:

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CHAPTER 1. INTRODUCTION

1.1 Air Pollution :-

Air pollution is a mixture of various gases such as nitrogen, oxygen, argon, carbon dioxide and small amount of other gases in a fixed proportion . According to WHO, air pollutants is defined as the presence of one or more contaminants in the atmosphere, such as dust, fumes, gases, fog and vapour in quantities or with characteristics and of a duration that may be detrimental to human, animal or plant lift, to property or that interferes with life or property. Air pollution has become a serious issue of concern for many countries across the world.

1.2 source of air pollution :-

In Indian cities, the air pollutants are either emitted from natural source or they can be of anthropogenic origin.

A. Natural source :-

Natural source of air pollution include volcanic activity, dust of storms, forest fires, lightening, soil out gassing, etc..

B. Anthropogenic source :-

Anthropogenic source include stationary point source (eg. Emission from industry.) Mobile source (eg. Vehicular emission, marine vessels, air Planes, waste disposal landfills, open burning, etc.

1.3 Type of air pollutant :-

The substances which are responsible for causing air pollution are called air pollutants.

(1) primary air pollutants :

Those pollutants are harmful chemicals that enter directly into the atmosphere.

(2) secondary air pollutants :

Those are chemicals that form in the atmosphere when primary air pollutants react chemically with one another or with natural components of the atmosphere. for example, gaseous sulfur dioxide reacts with oxygen and water droplets in the air to form sulphuric acid as a secondary particle.

(3) organic air pollutants :

Organic air pollutants are carbon-containing gasses and vapors such as gasoline fumes and solvents.

Example : - carbon dioxide
- carbon monoxide

(4) gaseous air pollutants :

Those pollutants in the form of gas are termed as gaseous air pollutants.

Example : - sulfur oxide
- nitrogen oxides
- ozone

1.4 SOURCE AND EMISSION OF HEAVY METAL :-

Heavy metals to a large extent are dispersed in the environment through industrial pollution, organic wastes, incineration, power generation and transport. The metals emitted naturally in wind blown dusts are often of industrial origin. Some of the prominent sources of atmospheric pollution are : burning fossil fuel to generate energy (Hg, Se) , automobile exhaust (pb), insecticides (as), etc. Lead is the most pervasive environmental pollutant. Metals form industrial sewage constitute a major source of metallic pollution of the hydrosphere. Sources of metal contamination can be divided to five main groups.

(1) metalliferous mining and smelting (As,Cd,Pb,Hg,)

(2) industry (As,Cd,Cr,Co,Cu,Zn,Ni,)

(3) atmospheric deposition (As,Cd,Cr,Cu,Pb,Hg,)

(4) agriculture (As,Cd,Cu,Pb,Si,)

(5) waste disposal (As,Cd,Cr,Cu,Zn,Hg,)

1.5 TOXIC EFFECTS OF HEAVY METAL ON HUMAN HEALTH

Heavy metal toxicity can have several health effects in the body. Heavy metals can damage and alter the functioning of organs such as the brain, kidney, lungs, liver, and blood. Heavy metal toxicity can either be acute or chronic effects. Long-term exposure of the body to heavy metal can progressively lead to muscular, physical and neurological degenerative processes that are similar to diseases such as Parkinson's disease, multiple sclerosis, muscular dystrophy and Alzheimer's disease. Also, chronic long-term exposure of some heavy metals may cause cancer

• **Table 1. Clinical Aspect of Chronic Toxicities**

Metal	**Primary Source**	**Organs**	**Clinical Effects**
Arsenic	Industrial Dusts, Medicinal Uses Of Polluted Water	Pulmonary Nervous System, Skin	Perforation of Nasal Septum, Respiratory Cancer, Peripheral Neuropathy: Dermatomes, Skin, Cancer

Cadmium	Industrial Dust and Fumes and Polluted Water and Food	Renal, Skeletal Pulmonary	Proteniuria, Glucosuria, Osteomalacia, Aminoaciduria,
Chromium	Industrial Dust , Fumes and Polluted Food	Pulmonary	Ulcer, Perforation of Nasal Septum, Respiratory Cancer
Manganese	Dust and Fumes	Nervous System	Central And Peripheral Neuropathies
Lead	Industrial Dust and Fumes and Polluted Food	Nervous System, Hematopoietic System, Renal	Encephalopathy, Peripheral Neuropathy, Central Nervous Disorders, Anemia.
Nickel	Industrial Dust, Aerosols	Pulmonary, Skin	Cancer, Dramatis

1.6 PARTICULATE MATTER (PM) :-

Particulate matter (PM) are mixtures of particals suspended in the air. Their sources include factories,power plants,refuse incinerators, automobile, construction activities,fires and natural windblown dust. major components of PM are metals, organic compounds, materials of biologic origin.ions, and particle carbon core. (5)

PM is subclassified according to particle size into Following.

(a) coarse : PM10 : diameter <10µm

(b) fine : PM2.5 : diameter <2.5µm

(c) ultrafine : PM0.1 : diameter <0.1µm)

Coarse particles derive from numerous natural and industrial sources and generally do not penetrate beyond the upper bronchus. Fine and ultrafine particles are produced through the combustion of fossil fuels and represent a greater threat to health than coarse particles as they penetrate into the small airways and alveoli. While the organic and metal components of particles vary with location, levels of PM2.5 have consistently correlated with negative cardiovascular outcomes regardless of location. (6)

1.7 SOURCE OF PM2.5 :-

PM2.5 is produced by secondary particles, vehicular emission, biomass burning, soil, road dust and solid waste burning. Generally, industrial areas contribute <2% of air pollution.some indoor sources of fine particles are tobacco smoke, cooking, burning candles or oil laps, operating fireplaces, kerosene heaters. The highest concentration of PM2.5 was observed during deep frying cooking. PM2.5 is also produced by common indoor activities. Some indoor sources of fine particles are tobacco smoke, cooking (e.g., frying, sautéing, and broiling), burning candles or oil lamps, and operating fireplaces and fuel-burning space heaters (e.g., kerosene heaters).

1.8 HEALTH EFFECT OF PM :-

PM2.5 being small and light, remains suspended in the air for longer duration thereby increasing the chances of inhalation. Due to their small size they are able to bypass the nose, throat and penetrate deep into the lungs and may even enter the circulatory system. Epidemiological and toxicological studies have shown that PM2.5 does not only induce cardiopulmonary disorders and/or impairments, but also contributes to a variety of other adverse health effects, such as driving the initiation and progression of diabetes mellitus and eliciting adverse birth outcomes. Of note, recent findings have demonstrated that PM2.5 may still pose a hazard to public health even at very low levels (far below national standards) of exposure. The proposed underlying mechanisms whereby PM2.5 causes adverse effects to public health include inducing intracellular oxidative stress, mutagenicity/genotoxicity and inflammatory responses. The present review aims to provide a brief overview of new insights into the molecular mechanisms linking ambient PM2.5 exposure and health effects, which were explored with new technologies in recent years.

1.9 OBJECTIVES :-

Objectives of the present study are following :

A. To estimate the PM2.5 concentration in the industrial area.

B. To determine the heavy metal concentration in PM2.5 .

CHAPTER 2. LITERATURE REVIEW

2. REVIEW OF LITRATURE

Bert Brunekreef *et. al.* (2002) discussed on the adverse effects on health by select air pollutants. These effects have been found in short-term studies, which relate day-to-day variations in air pollution and health, and long-term studies, which have followed cohorts of exposed individuals over time. Effects have been seen at very low levels of exposure, and it is unclear whether a threshold concentration exists for particulate matter and ozone below which no effects on health are likely.

Vasilakos *et. al.* (2003) studied the concentration of various heavy metals in $PM_{2.5}$ aerosol in a suburban site of Athens, Greece. They found concentration of the $PM_{2.5}$ as well as the concentration of heavy metal well within the prescribed limits.

Sriram *et. al.* (2004) carried out sulphur dioxide and suspended particulate matter analysis in the ambient air in the neighbourhood of Naively Thermal Power Corporation.

Mohanraj and Azeez (2004) carried out urban development and particulate air pollution in urban and suburban Coimbatore, Tamil Nadu. The study inferred that in urban areas, metal level were high especially those with frequent vehicular traffic and traffic congestion.

Talebi and Tavakoli-Ghinani (2008) observed high concentrations of heavy metals like lead, cadmium and zinc at the south and west areas with higher traffic densities within the city Isfahan, Iran. Heavy metal concentrations of lead, cadmium and zinc ranged between 79 and 197 ng/m^3, 2.9 and 6.5 ng/m^3, and 220 and 418 ng/m^3, respectively. This range was far higher than those recorded for lead (0.08 - 0.70 ng/m^3), cadmium (0.01 - 0.20 ng/m^3) and zinc (1.79 - 7.34 ng/m^3) in this study. The enrichment factor showed that the well-known toxic heavy metals were mostly released into city atmosphere from anthropogenic sources.

Xie *et. al*. (2009) characterized the ambient particulate pollution in the Taiyuan. Iron rich particles, gypsum, cement particles, silicon sulphide particles, ammonium chloride and potassium sulphate were analyzed in this research. The majority of the particles seemed to originate from coal combustion from the industrial structure in Taiyuan's atmosphere as evidenced by the abundance of the characteristic coal-burning related particles.

Gharaibeh *et. al.* (2010) studied concentrations of various metals and reported that all heavy metals in urban and rural sites reached their maximum concentration during the summer period. The air samples from the urban site had higher concentrations for all measured heavy metals compared to those from the rural site, due to the large number of cars passing through the urban site. In general, aerosols from the rural site had lower concentrations for all the metals compared to those from the urban site.

Leili *et. al.* (2008) analysed concentration of heavy metal content from Total Suspended Particulate (TSP) and Particulate Matter (PM) at Tehran University, Iran. The particulate air pollution has both anthropogenic and natural sources. The emissions from public and industrial transportation are main source of anthropogenic pollution. The TSP and PM average concentration were lower than the Environmental protection Agency standards of Iran.

Bhaskar *et. al*. (2008) studied airborne particulate matter concentration in Madurai, India. The average PM_{10} concentrations varied from 97.2 to152.5 $\mu g/m^3$and were below the Indian air quality standards. The industrial areas had highest concentration of Fe, Zn, Cr and SO_4^{2-}. Traffic areas had the higher concentration of Cd and NO_3.

Shaik Basha *et. al*. (2010) investigated metal concentrations among the seasons. They identified various sources of trace metals in the local atmosphere, industrial activities, vehicular emission, oil combustion, incineration and soil dust.

Prusty (2012) studied the air quality surveillance in Kachchh region with respect to industrial location and mining area. In the study Air Quality Index of Pandhro and mata na-madh were assessed.

Chauasia *et. al*. (2013) analysed ambient air quality of industrial, commercial and residential area of Bhopal. All values of $PM_{2.5}$ and PM_{10} were beyond the permissible limit of CPCB. Value of $PM_{2.5}$ was found in red zone (151-200 $\mu g/m^3$) at all stations which indicated unhealthy air quality for health concern and PM_{10} was found in yellow zone (51-100$\mu g/m^3$) at all stations which indicated moderate air quality. SO_2 and NO_x were found in green zone (0-50$\mu g/m^3$) which is not harmful.

Lamare *et. al.* (2014) studied the concentration of Respirable Suspended Particulate Matter (RSPM), Non-Respirable Suspended Particulate Matter (NRSPM) and Total Suspended Particulate Matter (TSPM) of Shillong, Meghalaya. The concentration of RSPM, NRSPM and TSPM exceeded the permissible limits by CPCB. According to the study, the higher concentration of particulate matter in the ambient air was due to vehicles.

Kamath and Lokeshappa (2014) investigated the air quality and air pollutant concentration at residential, Industrial and sensitive areas of Bangalore. SO_2, NO_x and RSPM were collected over six sites in Bangalore. The concentrations of the pollutants were higher in summer in comparison to the pre-monsoon and post-monsoon. They noticed that the RSPM levels at all selected sites exceeds the prescribed limits. Apart from this SO_2, NO_2, levels in industrial areas were within the prescribed limits of CPCB. It was concluded that at sensitive areas air quality was unhealthy, at residential areas air quality was very unhealthy and at industrial areas air quality was moderate.

Pathak *et. al.* (2014) made a comparative analysis of ambient air quality of Ahmedabad, Gujarat. The study was carried out on the basis of land use pattern and meteorological conditions. During monsoon, the pollutants concentration was minimal due to increased vertical dispersion, washout by monsoon rains and suppressed wind erosion. During winter maximum concentration of all the parameters were observed. The concentration of SPM ranged from 185$\mu g/m^3$to 362$\mu g/m^3$. Maximum concentrations were recorded during January and during the winter mixing height was less. High concentration of pollutants was observed on October due to festival. Minimum concentration of particulates and gases pollutants was found during summer.

Hasan *et. al*. (2016) studied the status of Air Quality and survey of PM pollution in Pabna city, Bangladesh. The concentration of PM had been investigated at five selected locations in Pabna city. Brick kiln emission and long range transports were the major sources of the increase in the PM in Pabna. It was concluded from this study that in Pabna the air pollution problem was severe and it had crossed the AQI standard.

Central Pollution Control Board (2016) determined the air quality for three major pollutants (SO_2, NO_2 and PM) in Delhi. On the basis of annual average concentration of pollutants, air quality trend was observed for 2009-2015 along with the comparison with existing national ambient air quality standards (NAAQS, 2009). Among the three pollutants, the concentrations of NO_2 and PM_{10} exceed the prescribed standards limits of CPCB whereas, the concentration of SO_2 was within the standard limits. However, NO_2 is concerned, concentration continuous rise observed in past 7 years. Moreover, the problem of particulate matter was more critical. Since 2009, approximately 258 - 335% rise had been observed in PM_{10} concentration compared to the standards. Although the concentration had been lowered down since 2011, it was still far above the safe limits.

Dharmendra (2017) made a review and concluded that considerable amount of new scientific information on health effects of particulate matter, ozone and nitrogen dioxide, observed at levels commonly present in India, has been published in the recent years.

Liu *et*. *al*. (2018) investigated various trend of fine particulate matter concentration in Wuhan city, China during 2013 - 2017. Fine particulate matter is directly associated with smog and had become the primary factor that threatens air quality in China. The results showed that $PM_{2.5}$ concentration showed the decreasing trend. January, October and December were the months with relatively high mean $PM_{2.5}$ concentration, while June, July and August reported relatively low mean $PM_{2.5}$ concentration. PM2.5 accounted for a large proportion of the major pollutants and was the main source of air pollution in Wuhan city, with an average proportion as 46%.

Bandpi *et. al.* (2018) studied heavy metal concentration in suspended particles and evaluated the health risk assessment of metals absorbed on suspended particles less than 2.5 µm. The health risk assessment of carcinogen and non-carcinogen of suspended particles were evaluated in three main paths i.e. oral, inhalation and dermal contact. They assessed concentration of Al, Fe, As, Cd, Cr, Mn, Ni, Pb and Zn in various stations, and the order for the heavy metals was urban > traffic > sururban.

CHAPTER 3. MATERIALS & METHODS

CHAPTER 4. RESULTS & DISCUSSION

CHAPTER 5. CONCLUSION

REFERENCES

1. Air pollution in Delhi (2016). ENVIS Centre CPCB on Control of Pollution Water, Air & Noise.
2. Bandpi A.M., Eslami A., Ghaderpoori M., Shahsavani A., Jeihooni A.K., Ghaderpoury A. and Alinejad A. (2018). Health risk assessment of heavy metals on $PM_{2.5}$ in Tehran air, Iran.17:347-355.
3. Basha S., Jhala J., Thorat.R, Goel S., Trivedi R., Shah K., Menon G., Gaur P., Mody K.H, Jha.B, (2010). Assesment of heavy metl content in suspended particulate matter of coastal industrial town, Mithapur, Gujarat, India. Atmospheric Reaserch, 257-265.
4. Bhaskar B.V., Rajasekhar R.V.J., Muthusubramanian P. and Kesarkar A. P.

(2009). Ionic and heavy metal composition of respirable particulate in Madurai, India. Environmental Monitoring and Assessment.

5. Chaurasia S., Dwivedi P., Singh R. And Gupta A.D. (2013). Assessment of ambient air quality stutas and air quality index of Bhopal City (Madhya Pradesh), India, International Journal of Current Science, 9:96-11.

6. Development of Special Economic Zones in India. Volume 1: Policies and issues. Mookkiah Soundarapandian (2012). Concept Publishing Company. 7. Fung Y.S. and Wong L.W.Y. (1995). Apportionment of air pollution sources by receptor models in Hong Kong. Atmospheric Environment, 29(16):2014-2048. 8. Gharaibah A.A., Abdul-Wahab O. El-Rjoob, Harb M.K., (2010). Determination of selected heavy metals in air samples from the Northern part of Jordan. Environmental monitoring and Assessment, 425-429

9. Gharaibah A.A., Abdul-Wahab O. El-Rjoob, Harb M.K., (2010). Determination of selected heavy metals in air samples from the Northern part of Jordan. Environmental monitoring and Assessment, 425-429

10.Gurjar B.R., Molina L.T. and Ojha C. S.P. (2010). Air Pollution Health and Environmental Impacts,CRC Press Taylor & Francis Group. 1-519.

11.Kamath and Lokeshappa (2014). Air quality indexing for selected areas in Bangalore city, Karnataka, India. International journal of Innovative Research in Science, Engineering and Technology, 3(8).

12.Kumar V., Patil R.S and Nambi K.S.V. (2001). Source of apportionment of suspended particulate matter at two traffic junction in Mumbai, India.

Atmospheric Environment, 35:4245-4251.

13.Lamare R.E. and Chaturvedi S.S. (2014). Suspended particulate matter in ambient air of Shillong city, Meghalaya, India. Indian Journal of Science and Technology, 2(6):37-41.

14.Liu D., Deng Q., Zhou Z., Lin Y. and Tao J.(2018), Variation trends of fine particulate matter concentration in Wuhan city from 2013 to 2017. Environmental Research and Public Health.

15.Liu K.K., Shang Q., Wan C., Song P., Chanyuan M. And Cao L., (2017). Characteristics and source of heavy metal in $PM_{2.5}$ during a typical haze episode in rural and urban areas in Taiyuan, China. Atmosphere.

16.Leili M., Naddafi K., Nbizadeh R. and Yunesian M. (2008). The study of TSP and

17. concentration and their heavy metal content in central of Tehran, Iran. Air Quality Atmospheric Health, 1:159-166.

18.Mahurpawar M. (2015). Effect of Heavy Metals on Human Health. International Journal of Research Grnthalya.

19.Mohanraj R., Azeez P.A., Priscilla T. (2004). Heavy Metals in Airborne Particulate Matter of Urban Coimbatore.,Archives Environmental Contamination and Toxicology, 47:162-167.

20.Popoola L. T., Adebanjo S. A. and Adeoye B. K. (2018). Assessment of atmospheric particulate matter and heavy metals. International Journal of Science and Technology, 15:935-948.

21.Prusty B.A.K. (2012). Ambient air quality surveillance and indexing in and around mining clusters in Western Kachchh region, Gujarat, India. Journal of Air Pollution, 1:22-30.

22. Pathak C.Y., Mandaliya H.C., Roy D. and Jadeja R.B. (2015). Comparative study of ambient air quality stutas of Ahmedabad and Gandhinagar city in Gujarat, India. Chemical Science Technology, 4(1):89-94.

23. Particulate Matter (PM) Pollution, Health and Environmental Effects of Particulate Matter, EPA, 2017.

24. Prajapati S.K. (2012).Ecological effect of airborne Particulate matter on Plants. Environmental Skeptics and Critictics, 1(1):12-22.

25. Sharma M. And Maloo S. (2005). Assessment of ambient air PM10 and PM2.5 characterization of PM10 in the city Kanpur, India. Atmospheric Environment, 39:6015-6026.

26. Talebi, S.M., and Tavakoli-Ghinani, T., (2008). Levels of PM_{10} and its Chemical Composition in the Atmosphere of the City of Isfahan. Iranian Journal of Chemical Engineering, Vol. 5, No. 3, 62-67.

27. Vasilakos C., Pateraki S., Veros D., Maggos T., Michopoulos J., Saraga D. and Helmis C.G.(2007). Temporal Determination of heavy metals in $PM_{2.5}$ aerosols in suburban Site of Athens, Greece. Journal of Atmospheric Chemistry, 57:117.

28. World Health Organization (2013). Health Effects of Particulate Matter.