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CONTENTS

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Editorial Note

In the recent times higher education has become more and more interdisciplinary. An educated individual is expected to understand the basic issues of almost all the subjects apart from the main area of his specialization. For instance a trained management graduate is expected to have an orientation of all the functional areas along with his main specialization. Needless to say that he should possess the skills of computer along with mathematical and statistical skills. The decision making capacity of the trained graduates improves with all these newly acquired traits.

The B-schools realizing this emerging trend in the business environment are modifying their curriculum by introducing the new concepts. The educated post-graduate student at all levels is expected to be multi-skilled and ready to work in the new and dynamic environment. Personality development oriented courses are being given as add-on modules for better employability.

Recognizing these trends in the higher education and the requirement in the job market, we have encouraged articles of interdisciplinary nature in the present issue. The articles range from study of exports, accidents, pollution and other related issues. A book review on an important topic of financial management has also been included in this issue. All these articles are applied in nature and demonstrate the use of statistical techniques for writing good research articles. Therefore it is hoped that the research papers published in the present issue will serve as a good reference for researchers in all fields.

Dr. T. V. G. Sarma
Editor

INDUSTRIAL EMISSION –A CASE STUDY

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ABSTRACT: Rapid industrialization is a primary requirement for developing countries in order to enhance living status of its population and contributing to sustainable growth. Industrialization deteriorates the environment. Key atmospheric pollutants are particulate matter, oxides of nitrogen, oxides of sulphur and RSPMs. India ranks fifth globally in overall emissions and is projected to rank higher as the economy grows.

W.H.O defines "air pollution as the presence of materials in the air which are harmful to the living beings when they cross their threshold concentration levels". The Ohio Environmental Protection Agency [EPA] provides the definition of "Air pollutant" or "air contaminant" as particulate matter, dust, fumes, gas, mist, smoke, vapor or odorous substances, or any combination there of. Airborne particles smaller than 10 micrometers, called as particulate matter less than 10 μm [PM10s] cause serious respiratory problems in humans, other pollutants which are harmful are oxides of sulfur and oxides of nitrogen.

Key words: Pollutants, Particulate matter, WHO, EPA, AQI, Environment, Standards.

1.0 INTRODUCTION

Industrialization and urbanization have resulted in a profound deterioration of India's air quality. India's most severe environmental problem, come in several forms, including vehicular emissions and untreated industrial smoke, that change the composition of atmosphere and affect the biotic environment. Urbanization has resulted in the emergence of industrial centers without a corresponding growth in civic amenities and pollution control mechanisms. Various contaminants continuously enter the atmosphere through natural and man-made processes and these contaminants interact with the environment to cause disease, toxicity, environmental decay and are labeled as pollutant and are injurious to human beings other living creatures and the environment. Air pollutants and can be either particles, liquids or gaseous in nature.

Air has a relative constant composition of gases and is utilized by living organisms in respiration to liberate chemical energy for their survival. Air pollution is defined as the addition of various hazardous chemicals, particulate matter, toxic substances and biological organisms into the Earth's atmosphere. There are various factors causing air pollution, but what comes from industries and factories is often considered a prime factor in air pollution. Air pollutant can be defined based on the concentration of chemical present in environment. The composition of clean air (Figure 1) is used as a bench mark. If the concentration of a chemical is above the concentration of chemical present in air, it is then termed as an air pollutant.

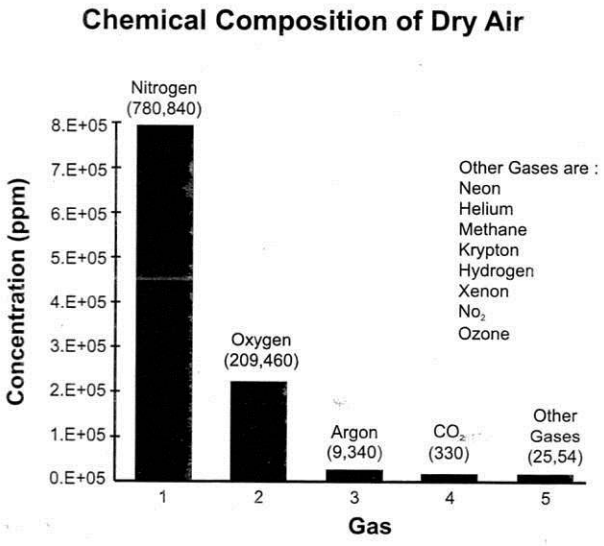


Figure1: Composition of Dry Air

*PPM: Parts Per Million

There are two basic physical forms of air pollutants. The first is gaseous form. For example, sulfur dioxide, ozone and hydro-carbon vapors exist in the form of a gas. The second form of air pollution is particulate matter such as smoke, dust, fly ash and mists. The pollutants are also classified as primary pollutants and secondary pollutants. The primary pollutants remain in the same chemical form as they are released from a source directly into the atmosphere. For example: sulfur dioxide and hydrocarbons. The secondary pollutants are a result of chemical reaction among two or more pollutants, releasing harmful chemicals into the atmosphere. The production of PAN (Peroxyacetyl Nitrate) during photochemical reactions is an example of secondary pollutant. Primary pollutant combines with some component of the atmosphere to produce a secondary pollutant (Naik S., 2005).

Six common pollutants identified are (also known as "criteria" pollutants): Sulfur oxides, Carbon monoxide, Nitrogen dioxide, Ozone, Total suspended particulate matter, and Lead. In this paper the emission levels of various pollutants are measured and compared with the standards provided by the pollution control board to know whether the concerned organisation is polluting the environment were it operates.

2.0 OBJECTIVES OF THE STUDY

The major objectives of the study are as below:

(i) Assessment of emission of SPM, SOX and NO_X at different locations in the paint booth at TATA Marcopolo.

(ii) To know about Air Pollution Index.

(iii) To assess the status of air pollution because of emission of various pollutants.

3.0 TATA MARCOPOLO

The state-of-the-art bus manufacturing facility of Tata Marcopolo Motors at Dharwad (Karnataka) is a 51:49 joint venture of Tata Motors and Marcopolo of Brazil. The Dharwad plant caters to India's growing need for world-class fully built buses for intra-city and inter-city transportation with international standard comfort, quality and safety.

The plant produces a comprehensive range of buses. The range, are marketed under the 'Starbus' and 'Globus' brands, includes 16- to 54-seater standard buses, 18- and 45-seater luxury buses, luxury coaches and low-floor city buses. The plant, spread over about 123 acres, has a capacity to produce 30,000 units a year. The joint venture has already invested about Rs200 crore.

3.1 AIR POLLUTION INDEX

In order to communicate with the public, regulatory agencies in various countries have developed different air pollution indices. The idea is to translate technical information on concentration levels of various pollutants into a simple and easy to understand language for the public.

Environmental Protection Agency in US has developed the pollutant standard index (PSI) for introducing consistency in providing information regarding the air quality throughout the U.S. The system is based on a scale of 0-500. An index below 100 indicates that the air quality is within acceptable range. A value over 100 implies potential health problems. The alerts are issued at 200, 300 and 400 levels. Five pollutants (carbon monoxide, sulfur dioxide, total suspended particulate, ozone and nitrogen dioxide) are included in the index.

Table1: Indian Air Quality Index for Different

S.No	Index	Category	SO_2 (24 hr avg) (ugmlm$_3$)	NO_2 (1-hr avg) (ugmlm$_3$)	SPM (24 hr avg) (ugmlm$_3$)	CO (1-hr avg) (ugmlm$_3$)	CO (8-hr avg) (ugmlm$_3$)	O_3 (1-hr avg) (ugmlm$_3$)	O_3 (24 hr avg) (ugmlm$_3$)	$PM_{2.5}$ (24 hr avg) (ugmlm$_3$)	Pb (24 hr avg) (ugmlm$_3$)	PM_{10} (24 hr avg) (ugmlm$_3$)
1	0-100	Good	0-80	0-80	0-200	0-4	0-2	0-180	0-60	0-400	0-1	0-100
2	101-200	Moderate	81-367	81-180	201-260	4.1-25	2.1-12	180-225	61-90	400-550	1.1-5	101-150
3	201-300	Poor	368-786	181-564	261-400	25.1-35	12.1-17	225-300	61-210	550-700	1.5-2.25	151-350
4	301-400	Very Poor	787-1572	565-1272	401-800	35.1-75	17.1-35	301-800	211-250	700-900	2.25-3.25	351-420
5	401-500	Severe	>1572	>1272	>800	>75	>35	>800	>250	>900	>3.25	>420

To reflect the attainment of National Ambient Air Quality Standards [NAAQS], the AQI is referred to as Good between the ranges 0 - 100. For the second break point(at the standard of United States Environmental Protection Agency [USEPA]), the AQI takes the value of 200 and referred to as Moderate. In absence of any other pollutant of any other pollutant health criteria in India, rest of categorization of Index is based on the USEPAFederal Episode criteria and Significant Harm Level. IND-AQI is primarily a health related index with the following descriptor words: "Good (0 - 100)", "Moderate (101 - 200)", "Poor (201 - 300)", "Very poor (301 - 400)", "Severe (401 - 500)".

3.2.0 DIFFERENCE BETWEEN EMISSIONS AND IMMISSIONS?

Emissions are generally defined as the release of substances or energy from a source into the environment. The Federal Immission Control Act defines emissions as air pollution, noise or odour originating from an installation. Immission relates to the effects of emissions on the environment. With regard to air pollution control, this means the effect of air pollutants on plants, animals, human beings and the atmosphere.

3.2.1 EMISSION INVENTORY

Emission Inventory is a study of the pollutant emission estimates from sources in a given area. The development of emission inventory is important for a company as well as for the pollution control agencies. The inventory allows an environmental scientist to locate pollution sources, to define types and amounts of emission from each source, to define physical characteristics of sources, to determine emission frequency and duration of each pollutant exposure, to determine relative contributions to pollution problem in the area due to individual sources or a group of sources, to determine pollution controls needed to protect public health, and to provide a data base for air quality modeling and risk assessment. Emission Inventory developed may be used for

(i) Identify types of pollutants emitted from specific sources.
(ii) Determining the magnitude or amount of emissions from those sources.
(iii) Developing emission distributions in time and space.
(iv) Calculating emission rates under specific plant operating condition.

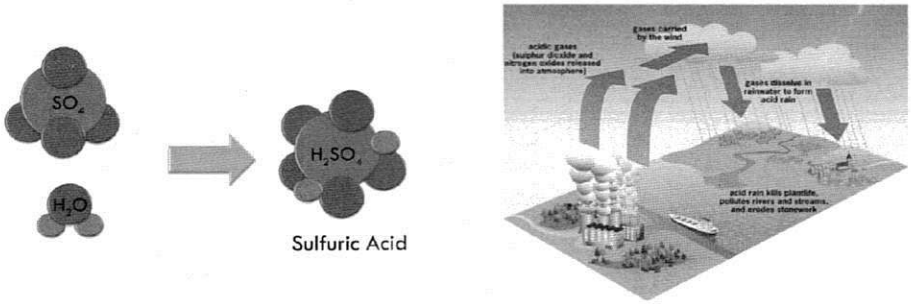
3.2.2 IMPACT OF EMISSION

Some of the effects of air pollution due to industrial emission are:

(i) Global Warming : Global warming is largely considered one of the most hazardous and serious complications associated with air pollution caused by industries and other stationary sources of air pollution. The liberation of certain gases such as methane, or CH4, and carbon dioxide, or CO2, together known as greenhouse gases, is often considered to be prime factor causing global warming. These greenhouse gases often result in an increase in the atmospheric temperature, causing global warming. Global warming has various serious implications both on the ecological balance as well as human health.

(ii) Acid Rain : Industries often emit large amounts of nitrogen and sulphur gases into the Earth's atmosphere. When these gases react with water vapors in the atmosphere, they often change into more aggressive gases, namely nitric acid and sulphuric acid respectively. The rain containing large amounts of these acids is known as acid rain. Acid rain has various health and natural dangers.

Figure1: Effect of Sulphates and Nitrates



(iii) Respiratory Disorders: The emission of various gases such as carbon monoxide, or CO, often results in various respiratory disorders such as bronchitis, asthma, chronic obstructive pulmonary disease, or COPD, in individuals. CO damages air passages in individuals, leading to respiratory disorders. However, if carbon monoxide is present in increased levels in the atmosphere, it can even cause the death of the person, by inhibiting oxygen intake by combining with hemoglobin.

(iv) Ozone Layer Depletion: The ozone layer is a gaseous blanket that helps in supporting and sustaining life on Earth by protecting us from various hazardous radiations such as UV rays. Hence, the addition of some of the above mentioned pollutants often damages the atmosphere, thus causing various health risks in humans such as skin disorders like rashes, irritation and even cancer in severe cases.

4.0 METHODOLOGY OF THE STUDY

The tables given below show the methodology followed to conduct the study and data collected.

Table No. 2 Methodology

Particulars	Details
Monitoring for	Stack Emission Monitoring and Analysis
Sampling Procedure	As per IS/APHA/EPA Guidelines
Sampling Location Stack Attached To:	1. Paint Booth- Primer application booth 1 – vent 1 2. Top coat paint booth 1 paint shop 3. Oven for paint drying in paint shop
Method of measurement	EPA
Instrument	Stack VSS1 Vayubodhan

Table No. 3 Data

Stack Attached To	Paint Booth - Primer application booth -1 vent1	Top coat paint booth 1 Paint shop booth	Oven for paint drying In paint shop
Stack Height [mts]	16.60	16.60	16.60
Stack Shape	Rectangular	Rectangular	Rectangular
Stack Area[mm]	1350x950	1350x950	1350x950
Product	BusBuilding	BusBuilding	BusBuilding
Stack Temperature[k]	303	303	303
Ambient Temperature [k]	301	301	301
Velocity m/sec	6.18	6	6.52
Quantity of Emission [Nm^3/Hr]	1546.97	1501.92	18144.55
Particulate Matter [mg/Nm_3]	64.43	56.18	77.17
Oxidesof Nitrogen NO_x [mg/Nm^3]	13.8	13.3	13.6
Oxides of SulphurSO_x [mg/Nm^3]	12.0	12	12.0
Carbon Monoxide[% Volume]	0.1	0.1	0.2

In thepresent study the AQIis calculatedusing IND-AQI [See table 1 or Annexure1]. The index has beendeveloped based on the dose-responserelationship of various pollutants. Theindex is named as IND-AQI (Indian AirQuality Index). The major air pollutant,which can cause potential harm tohuman health have been included viz. SO2,NO2, SPM, and CO.

$$I_p = \left[\frac{(I_{Hi} - I_{Lo})}{(BP_{Hi} - BP_{Lo})}\right](C_p - BP_{Lo}) + I_{Lo}$$

where IP is the AQI for pollutant "p", CP is the actual ambientconcentration of the pollutant "p", BPHi is the breakpoint in Table 1 [or see annexure1] that is greater than or equal to Cp, BPLo is the breakpoint in Table 1that is less than or equal to Cp, IHi is the sub index valuecorresponding to BPHi, and, ILo is the sub index value correspondingto BPLo.The AQI is determined on the basis of AQI of study pollutantsand the highest among them is declared as the overall AQI. Theformula used here is same as used by USEPA, in which sub-indexand breakpoint concentration depends on Indian **National Ambient Air Quality Standards** [NAAQS].

5.0 RESULTS OF AQI FOR VARIOUS POLLUTANTS

The results of AQI for various pollutants are given in the following tables :

Table 2.1: AQI Calculation for SO_2

Stack Attached to	Sulphur Dioxide (SO_2)	AQI	Category
Paint Booth-Primer application booth -1 vent1	12	15	Good
Top coat paint booth 1 Paint shop booth	12	15	Good
Oven for paint drying In paint shop	12	15	Good

Table 2.2: AQI Calculation for N_2

Stack Attached to	Nitrogen Dioxide (NO_2)	AQI	Category
Paint Booth-Primer application booth -1 vent1	13.8	17.5	Good
Top coat paint booth 1 Paint shop booth	13.3	16.25	Good
Oven for paint drying In paint shop	13.6	17.5	Good

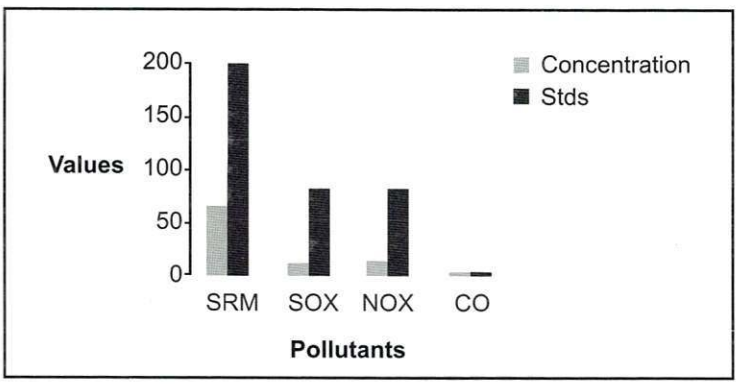
Table 2.3: AQI Calculation for Particulate Matter

Stack Attached to	Particulate Matter	AQI	Category
Paint Booth-Primer application booth -1 vent1	64.43	32.5	Good
Top coat paint booth 1 Paint shop booth	56.18	28	Good
Oven for paint drying In paint shop	77.17	38.5	Good

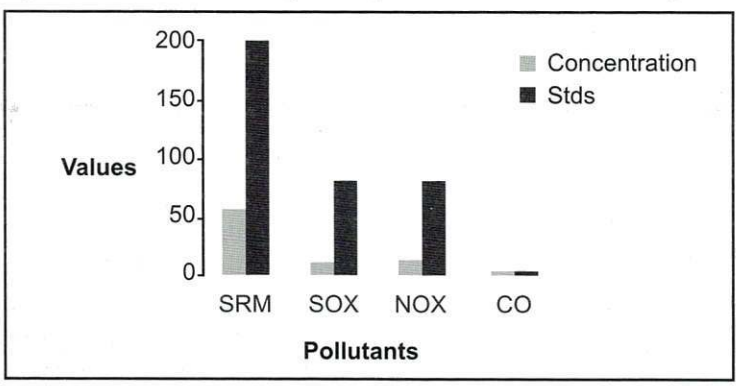
Table 2.4: AQI Calculation for CO

Stack Attached to	Carbon Monoxide	AQI	Category
Paint Booth-Primer application booth -1 vent1	0.1	5	Good
Top coat paint booth 1 Paint shop booth	0.1	5	Good
Oven for paint drying In paint shop	0.2	10	Good

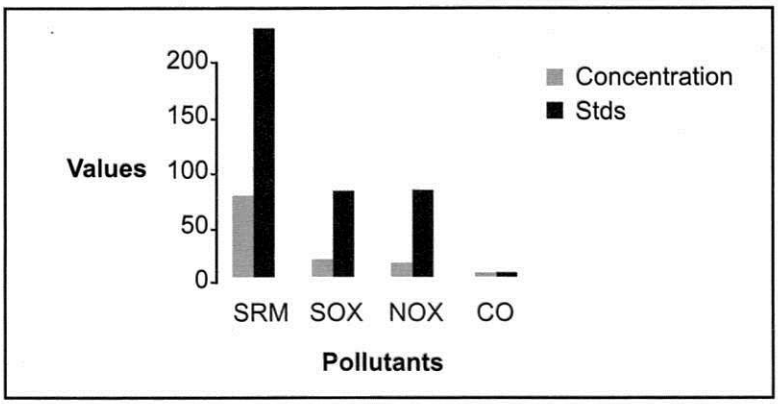
Graph 1.1: Location - Paint Booth-Primer application booth -1 vent1



Graph 1.2: Location - Top coat paint booth 1 Paint shop booth



Graph 1.3: Location - Oven for paint drying in paint shop

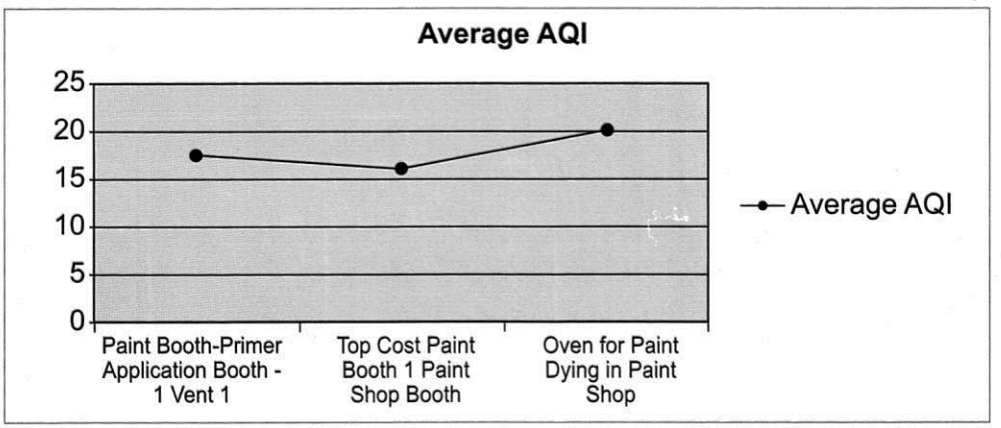


CALCULATION OF AVERAGE AQI

Table 3: Average Values of AQI at Different Locations

Location	Average AQI
Paint Booth- Primer application booth -1 vent1	17.5
Top coat paint booth 1 Paint shop booth	16.06
Oven for paint drying In paint shop	20.25

Graph 2: Plot of Average AQI at different Locations



6.0 CONCLUSION

Air pollution measured in the form of Air Quality Index provides a meaningful assessment of air pollution rather than individual air pollution level while planning prevention of air pollution in industrial areas. It is concluded from the observations at different monitoring stations the emission levels of pollutants are within permissible limits as specified by Central Pollution Control Board (CPCB).

Even though the AQI at all the three locations is much below the permissible range ,AQI at the oven for paint drying in paint shop location is relatively higher than the other two locations because of higher level of suspended particulate matter[SPM]. From the result we can conclude that the company is taking care of the working environment and keeping the premise clean and less polluted, the workers are provided with safety equipments while

working in the paint area and are also properly trained thus maintaining the health and safety of its employees. Since the AQI level of this company is well below the standards, there are no reports of any impact of pollution either on the environment or on the health of the employees. The strategy followed by the company is to regularly monitor the concentration of various pollutants with the help of a monitoring agency, ensuring regular medical checkups for the employees Further they have planted lots of trees to reduce the level of pollution, since trees help in trapping dust and also help in keeping the working environment green and less polluted. With this kind of working environment and pollution control methods one can say that the organisation is contributing to environment sustainability. We can say that he need of the hour is in striking the right balance between environmental, economic and societal concerns to minimize industrial emissions while supporting innovation and competitiveness.

ANNEXURE 1

Sub-Index and Breakpoint Pollutant Conentration for Indian Air Quaality Index (IND-AQI)

Sub-Index	Category	Pollutants (μ/m^3)					
		SO_2	NO_2	SPM	PM_{10}	CO	O_3
		24-h avg.	24-h avg.	24-h avg.	24-h avg.	8-h avg.	8-h avg.
0-100	Good	0-80	0-80	0-200	0-100	0-2	0-157
101-200	Moderate	81-367	81-180	201-260	101-150	2.1-12	158-235
201-300	Poor	367-786	181-564	261-400	151-350	12.1-17	236-784
301-400	Very Poor	787-1572	565-1272	401-800	351-420	17.1-35	785-980
401-500	Severe	> 1572	> 1272	> 800	> 420	> 35	> 980

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