ISSN: 0974-5823 Vol. 7 No. 2 February, 2022

International Journal of Mechanical Engineering

Assessment of Air Quality Index (AQI) in Jeedimetla Industrial Area, Hyderabad, India

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Abstract - Now a days, air pollution is a serious environmental threat throughout the world. The growth of large cities associated with the development of industrial hubs led to the fact that residential places are locating side by side with industrial areas. The current work is focused on the estimation of pollutant concentrations (PM10, SO2 and NO2) and Air quality index to assess the air quality and its health impacts in industrial area of Jeedimetla, Hyderabad. The pollutant concentrations (PM10, SO2 and NO2) were estimated by using Gravimetric Method, Modified West & Gaeke Method and Modified Jacob & Hochheiser Method, respectively. The air quality monitoring experiments were conducted using Respirable dust sampler during the time periods of March to June, 2019 and September to December, 2019 & reported the concentrations of PM10, SO2 and NO2. Based on the calculated AQI values concluded that air is moderately polluted. And also, the monthly PM10 average concentrations falls in the range of 150-225 µg/m3 may led to cause breathing problems in people having lung diseases and discomfort to children & older adults having heart problems. Average concentrations of NO2 and SO2 were obtained below the specified limits set by Central pollution control board.

Index Terms - AQI, Jeedimetla, Air pollutants, PM10 and Health effects.

INTRODUCTION

Air pollution is a severe environmental problem that have adverse effects on health of billions of people every year [1]. As per WHO, more than one-fourth of deaths reported around the world may be directly linked to air pollution [2]. And also, reports shows that 46% of urban people suffering from acute respiratory infections. Air pollution is growing day by day with individuals and nations are dumping lot of pollutants into the atmosphere results in causing climate shifts observed across the globe. To reduce air pollution, the first and most important steps need to be considered are identification of common prevalent pollutants, understanding source location and recognition of their effects.

Monitoring of air quality is significant in controlling pollution level [3]. It is important to determine levels of air quality at different places so as to examine the influence of air pollution on human health [4]. AQI considers key air pollutants such as carbon monoxide, particulate matter, sulphur dioxide, carbon dioxide, ozone and nitrogen dioxide. A separate sub-index is given to each pollutant and AQI is the maximum value of all these sub-indices. Based on calculated AQI values air quality predicted as good, satisfactory, moderate, poor, very poor and severe.

Outdoor air pollutants such as particulate matter, sulfur dioxide, carbon monoxide, nitrogen oxides, polycyclic aromatic compounds and volatile organic compounds are contributing major share in causing adverse respiratory effects in humans [5]. Inhalation of particulate matter results in attack of lungs and even enter into the blood stream and pose greater risk to health [6] and Chronic exposure of PM for longer periods was found to be correlated to health impacts namely infant mortality and cardiovascular diseases [7]. Nitrogen dioxide long term exposure at high levels leads to responsible for chronic lung diseases and impair the sense of smell [8]. Environmental adverse effects like acid rains and acidification of soil associated with sulfur dioxide emissions [9].

Pollution from pharmaceutical industries is growing day by day especially in various areas of Hyderabad city namely Patancheru, Jeedimetla, Choutuppal, and other areas. Every day, several villagers are deeply affected due to hazardous effluents, toxic air and waste. The primary and secondary air pollutants emit from the exhaust of pharmaceutical industries have adverse effect of human health and environmental stability. These air pollutants include carbon monoxide (CO), lead (Pb), ozone (O_3), Nitrogen dioxide (NO_2), Sulfur dioxide (SO_2), Particulate matter (PM), Carbon dioxide (CO_2) and methane (CH_4). The present study focused on measurement of ambient air quality of Jeedimetla industrial area of Hyderabad city to assess the health impacts of people residing in industrial area.

MATERIALS AND METHODS

I. Sampling methods for pollutants analysis

To estimate the concentrations of PM_{10}, SO_2 and NO_2 in atmospheric air at Jeedimetla industrial area (shown in Fig.1), sampling was carried out with the help of Repairable dust sampler (RDS) as shown in Fig.2, while sampling (data collection) varied source, population, topography and climatology. As per CPCB guidelines reported in 2014, 2015 and 2016, different analytical methods were adopted for analysis of pollutants, Gravimetric Method (RSPM cyclonic flow technique) for PM_{10} analysis, Modified West & Gaeke Method for SO_2 analysis and Modified Jacob & Hochheiser Method for NO_2 analysis. Sample collection was done on the basis of 8-hour average at sampling station.

Fig.1 Sample collection location at Gardenia-Modi Builders in Jeedimetla industrial area

Fig. 2 Respirable Dust Sampler used for sample collection

Air is sucked with a inlet filter size of 20.3 cm x 25.4 cm at flow rate of 1-1.5 L/min. Nitrogen oxide (NO_2) is collected by bubbling air through a Sodium hydroxide solution and sodium arsenate to form a sodium nitrite solution. The nitrite concentration is estimated calorimetrically by reacting with phosphoric acid, sulphanilamide and NEDA. The absorbance was measured at 540 nm.

Sulphur dioxide (SO_2) is absorbed from air in a solution of Potassium Tetrachloromercurate, resulted in the formation of dichlorosulphitomercurate complex which resists oxidation. The complex is made to react with Pararosaniline and formaldehyde to form the deeply coloured Pararosaniline methyl sulphonic acid. The colour is measured at 560 nm with spectrophotometer.

II. AQI Calculation

Determination of overall AQI is a two-step procedure, first one is the formation of sub-indices for each pollutant and second one is the amalgamation of sub-indices. Sub-index function gives correlation between pollutant concentration (X) and corresponding sub-index (I). Generally, the I-X relationship follows according to equation (1)

$$I = \alpha X + \beta \dots\dots\dots (1)$$ [10]

Where α is the slope and β is the intercept at X=0.

The equation for the sub-index of a given pollutant concentration is based on linear segmented principle is determined as per equation (2)

$$I_i = \left[\left\{(I_{HI} - I_{LO})/(B_{HI} - B_{LO})\right\} * (C_P - B_{LO})\right] + I_{LO} \dots\dots\dots (2)$$ [10]

Where, B_{HI}= Breakpoint concentration ≥ given concentration.

B_{LO}= Breakpoint concentration ≤ given concentration.

I_{HI} =AQI value at respective B_{HI}

I_{LO} = AQI value at respective B_{LO}

C_p = Concentration of pollutant

III. Air Quality Index (AQI)

In AQI calculation, maximum operator system has been considered and shown in equation (3)

$$AQI = Max\ (I_1, I_2, I_3 \dots\dots I_n) \dots\dots (3)$$ [10]

Status of air quality and its health impacts has represented in the Table. 1 which is adopted from IND-AQI.

Table 1 IND-AQI Category and Range [10]

AQI Range	AQI Category
0 – 50	Good
51 – 100	Satisfactory
101 – 200	Moderately-polluted
201 – 300	Poor
301 – 400	Very Poor
401 – 500	Severe

RESULTS AND DISCUSSION

Air quality at industrial hub of Jeedimetla is calculated based on the Air Quality Index (AQI). Samples were collected at sampling station on eight-hour time basis with RDS sampler for eight months in the year 2019. AQI is calculated for individual months from March to June, 2019 and September to December, 2019. At each month nine samples were collected in random days and calculated AQI for each sample by considering concentration of major pollutants like PM_{10}, SO_2 and NO_2. Highest average AQI of 183.6 was obtained in the month of June, 2019 followed by May (AQI-176.7), March (AQI-176.1) and December (AQI-174) and least average value of AQI is obtained in the months of September & October (AQI-146.1) as shown in Fig. 3. When the AQI values are higher, the level of air pollution is high results in greater health impact. During the aforementioned months AQI value falls in the range of 146 to 183.5, which clearly shows that air is moderately polluted as per 2014 guidelines of CPCB and MOEFCC as shown in Table. 1. Thus, the AQI values caution that there is need to take up immediate steps to enhance air quality.

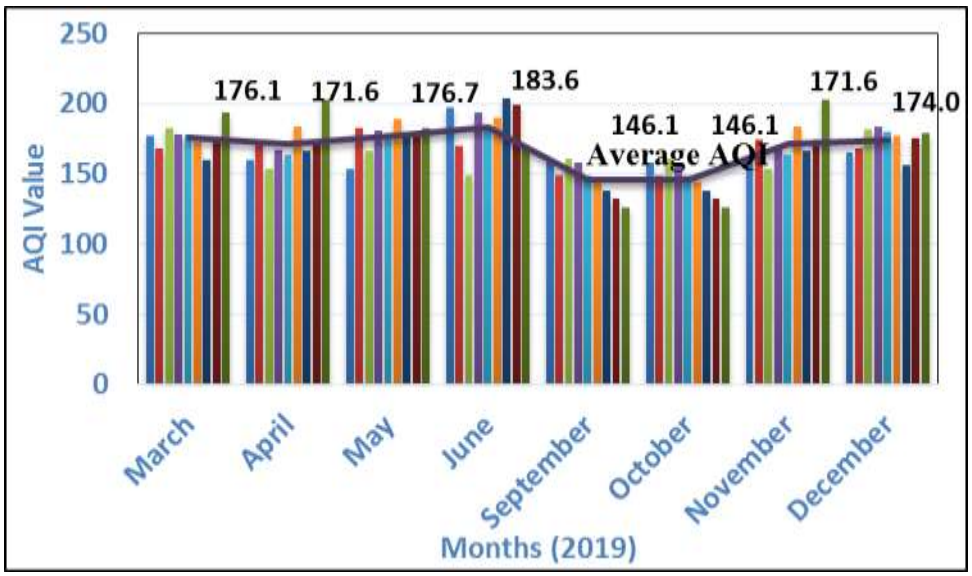

Fig. 3 Individual & Average AQI values during various months of 2019

PM_{10} average concentration at Jeedimetla area varies from 169.19 to 225.16 µg/m^3 during aforementioned months in the year 2019. The highest PM_{10} average concentration (225.16 µg/m^3) obtained in the month of June followed by May, March and December. The least average concentration reported in the months of September and October as shown in Fig. 4. And also, during all the months PM_{10} average concentrations are above prescribed limits set by National Ambient Air Quality Standards (NAAQS) of CPCB. It is recommended that stringent emission control and suitable strategic plan to reduce the PM_{10} emissions. The average monthly concentrations of NO_2 and SO_2 in all the months are within the prescribed limits as per CPCB guidelines as shown in Fig. 5 & 6.

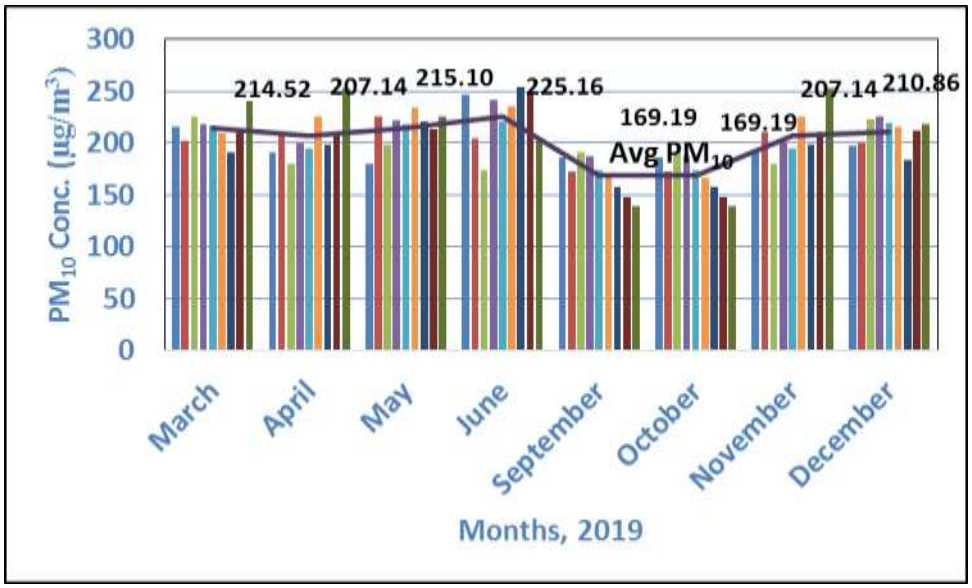

Fig. 4 Individual and Average PM_{10} concentrations at different months of 2019

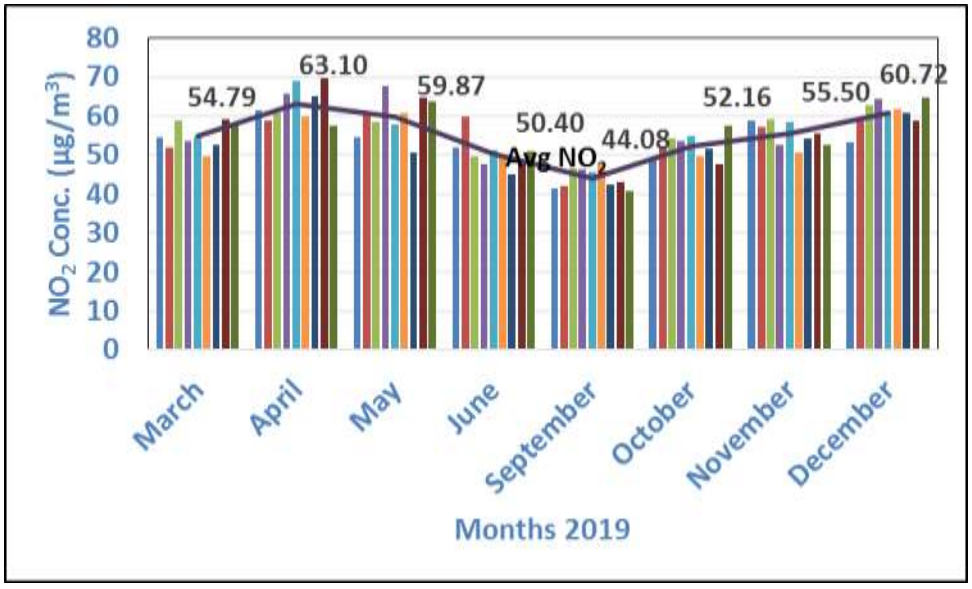

Fig. 5 Individual and Average NO_2 concentrations at different months of 2019

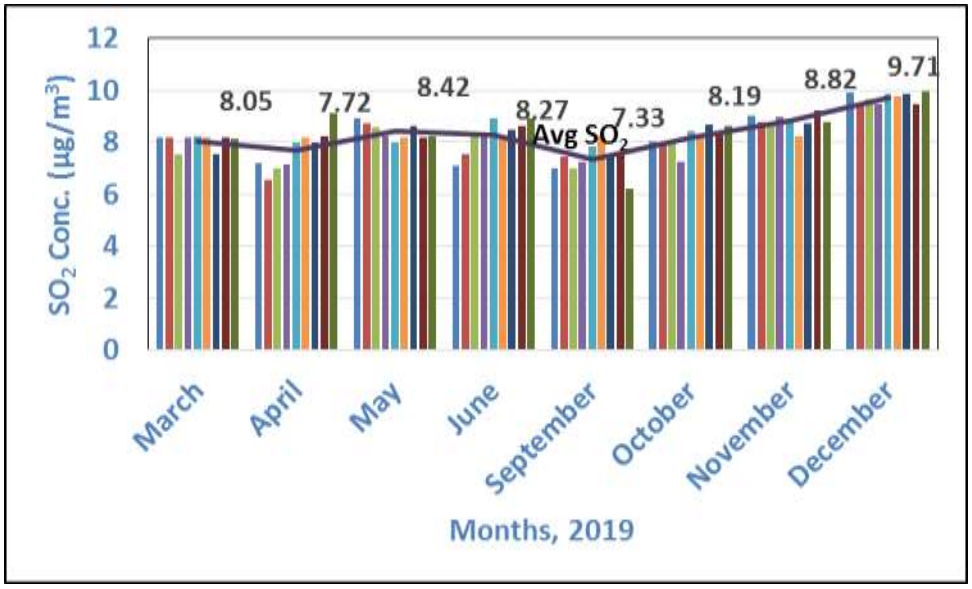

Fig. 6 Individual and Average NO_2 concentrations at different months of 2019

CONCLUSIONS

Air pollution is growing day by day due to increase in number of industries, vehicles and human activities. In this study, estimated AQI values and concentrations of pollutants at industrial area of Jeedimetla, Hyderabad. Compared these values with the National Ambient Air Quality Standards of CPCB and reported air quality. Resulted AQI values concluded that air is moderately polluted. Among three pollutants, PM_{10} concentrations exceeded permissible limits of CPCB and resulted health impacts are asthma and chronic obstructive pulmonary disease. State pollution control board and government should take necessary steps to reduce air pollution.

ACKNOWLEDGEMENT

The authors wish to thank Department of Chemical Engineering, Acharya Nagarjuna University for providing necessary laboratory facilities to carry out this work

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