Jr. of Industrial Pollution Control 34(1)(2018) pp 1900-1903
www.icontrolpollution.com
Research Article

THE AMBIENT AIR QUALITY CHANGES DURING DIWALI FESTIVAL IN BHOPAL CITY

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(Received 16 June, 2017; accepted 23 April, 2018)

Key words: Ambient air quality, Diwali, Air quality index, Particulate matter, Fire-crackers, High volume air sampler.

ABSTRACT

Diwali the "festival of lights" is celebrated by bursting a large quantity of fire-crackers. Bursting of fire-crackers deteriorates ambient air quality by releasing suspended particulate matter (SPM) and respirable suspended particulate matter (RSPM), consisting of metal oxides along with carbon particles, poisonous/toxic gases in atmosphere. Among the gases released are oxides of nitrogen, oxides of phosphorous, carbon monoxide, carbon dioxide and sulphur dioxide. This paper tries to investigate the air quality changes during Diwali festival in Bhopal by comparing ambient air quality of Diwali days with the ambient air quality of Diwali days of the same month in which Diwali was celebrated in 2011, 2012, 2013 & 2014. Determines the increase of the air pollution (i.e., SPM, RSPM, SO2 & NOX) during Diwali. The effect of bursting of fire-crackers on ambient air quality. Use of AQI (Air Quality Index) to determine the ambient air quality.

INTRODUCTION

Diwali (also spelled Devali in certain regions) or Deepavali, popularly known as the "festival of lights" is an important five-day festival in Hinduism, Jainism, and Sikhism, celebrated for different reasons, occurring between mid-oct and mid-November. For Hindus, Diwali is one the important festival of the year and is celebrated in families by performing traditional activities together in their homes. For Jains, Diwali marks the the attainment of moksha or nirvana by Mahavira in 527 BC. For Sikhs, Diwali is important because it celebrates the release from prison of sixth guru, Guru Hargobind, who also rescued 52 Hindus kings held captive by Mughal Emperor with him in the Gwalior fort in 1619 (Chauhan, *et al.*, 2010).

The name "Diwali" is a contraction of "Deepavali" (Sanskrit Deepavali), which translates into "row of lamps". Diwali involves the lighting of small clay lamps (diyas or dips in Sanskrit) filled with oil to signify the triumph of good over evil. During Diwali all the celebrants wear new clothes and share sweets and snacks with family members, and friends(Barman, *et al.*, 2007). Most Indians Business communities begin the financial year on the first day of Diwali (Dolti, 2010). Deepavali is celebrated in India, Nepal, Sri lanka, Myanmar, Guyana, Mauritius, Trinidad

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& Tobago, Suriname, Malaysia, Singapore and Fiji (Joshi, 1998; Bearu of Indian standards, 2003).

Air pollution is the presence in ambient atmosphere of substances, generally resulting from the activity of man, in suffient time and under circumstances which interfere significantly with the conformity, heath or welfare of persons or with the full use or enjoyment of property (BIS, 2003).

METHODOLOGY

The criteria parameter indicating air quality are the two chief groups of air pollutants namely Total suspended particulate matter (TSPM) o suspended particulate matter (SPM) and gaseous pollutants. The Total suspended particulate matter (TSPM) include the coarse as well as the respirable particulates or respirable suspended particulate matter (RSPM). Health hazards are cause primarily by the respirable particulates in the size range of 0.5 to 10 microns. TSPM originate mainly from work areas like cement and other air polluting industries. Gaseous pollutants include oxides of sulphur and nitrogen, halogens, ammonia, ozone and sulphides (Thakur, *et al*., 2010).

High volume air sampler

Air is sampled by using high volume air sampler. The sampler is suitable for monitoring air quality within work space environment as well as in ambient air outside. Particulates are measured by passing air at a high flow rate of 0.9 to 1.4 cubic meter per minute through a high efficiency filter media which retains the particles. The normal AC electrical blower of hand tools of Rally Wolf make has a free flow of 1.4 to 1.8 cubic meter per minute and is generally used to draw the required suction pressure. Once the volume of air sampled is known oven a period of time, the amount of particulates collected is determined gravimetrically by measuring the increase in the weight of filter paper due to sampling. Gaseous pollutants are absorbed in suitable absorbing reagent and analyzed spectrophotometerically (woodruff, *et al*., 1997).

Determination of nitrogen dioxide in the atmosphere (Jacob and Hochheisers method)

Ten ml of sampled absorbing medium are taken in a 50 ml volumetric flask. One ml of H_2O_2 solution, 10 ml sulfanilamide solution and 1.4 ml NEDA solution are added in the volumetric flask. For control absorbing medium along with these chemicals are used. Volumetric flask are shaken and allowed to stand for 20 minutes for the development of color. Transmittance is taken at 540 mm (Bates, *et al*., 1995).

Determination of sulphur dioxide in the atmosphere (weast and Geake method)

Ten ml of sampled absorbent sodium tetrachloromercurate solution is taken in a volumetric flask and then 1 ml of sulphamic acid, 2 ml of formaldehyde solution and 5 ml roaniline is added one by one. The solution is shaken gently. After 30 minutes the transmittance is determined at 550 mm in spectrophotometer. In the control (blank) in place of sampled absorbing medium is taken. The SO_2 is determined by including transmittance (%) value in the calibrated standard curve (Gordian, *et al*., 1996; Scantra, 2001; Zaiidudin and Siddiqui, 2006; Singh, 2009; www.mppcb.nic.in).

Air Quality Index (AQI)

The air quality index (AQI) is a measure of the ratio of the pollutant concentration to the status of ambient air in places. Indices of air pollution or air quality have been used for about 25 years. The following computation is used to derive the air quality index of the sites, which are under consideration.

$$AQI = 1/4\left[\frac{RSPM}{sRSPM}+\frac{SPM}{sSPM}+\frac{SO2}{sSO2}+\frac{NOx}{sNOx}\right]100$$

Where sRSPM, sSPM, SO_2 and sNox represent the ambient air quality standards as prescribed by the CPCB, for respirable suspended particulates, suspended particulates, sulphur dioxide and nitrogen oxides respectively. Whereas the RSPM, SPM, SO_2 and Nox represent the actual values of pollutants obtained on sampling.

AQI Scale

The AQI scale was divided into five categories, each category describes the range of air quality and its associated potential health effects. The five levels of AQI sale are depicted under (Zaiiudin & Siddiqui, 2006) (Table 1).

POLLUTANTS MONITORED

In this study following pollutnts were monitored

1. Suspended particulate matter (SPM)
2. Respirable suspended particulate matter(RSPM/ PM10)
3. Oxides of nitrogen (NO_2)
4. Oxides of sulphur (SO_2)

Table 1. AQI scale

AQI value	Description
0-25	Clean air
6-50	Light air pollution
51-75	Moderate air pollution
76-100	Heavy air pollution
>100	Sever air pollution

RESULTS AND DISCUSSION

The study was conducted during Diwali and non-Diwali days of the same month in 2011, 2012, 2013, 2014 and a comparison of pollution level was done with the help of air quality index. In each year three sites where taken involving residential, commercial and industrial areas. The results were as in Tables 2 and 3 (Fig.1 and 2).

Table 2. Changes in ambient air quality during Diwali days.

Year	Area Type	SPM	RSPM	SOX	NOX	AQI
2011	Residential	489.9	168	12	56	65
	Industrial	644	171	14	68	66
	Commercial	400	135	17	101	73
2012	Residential	472.3	177.5	9.4	43.3	85
	Industrial	285.3	187.2	5.8	18.4	66
	Commercial	450	387.4	15.2	30.4	167
2013	Residential	503.8	151.3	16.7	21.3	77
	Industrial	404.6	229.6	15.6	28.2	68
	Commercial	345.6	136.2	23.4	35.3	96
2014	Residential	512.2	156.2	5.9	33.4	75
	Industrial	404.6	229.6	15.6	28.2	68
	Commercial	456.6	300.9	11.9	28.7	145

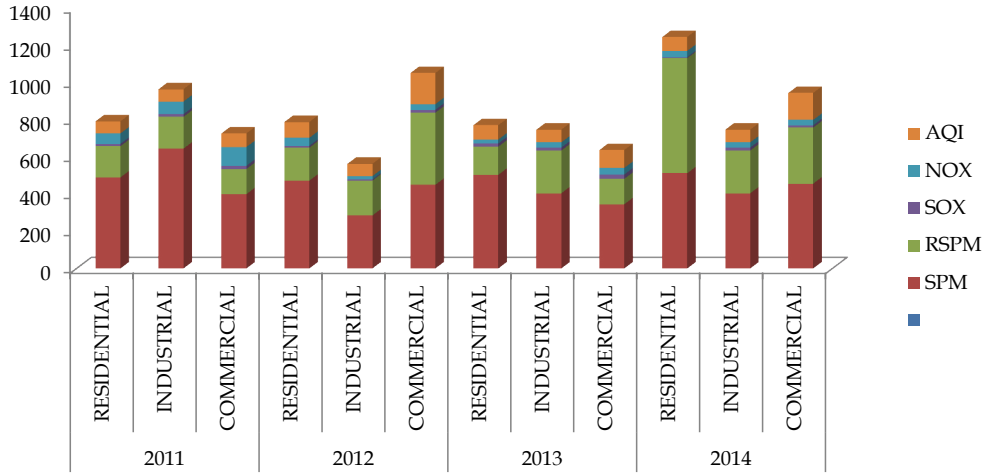

Fig. 1 Ambient air quality changes during Diwali days.

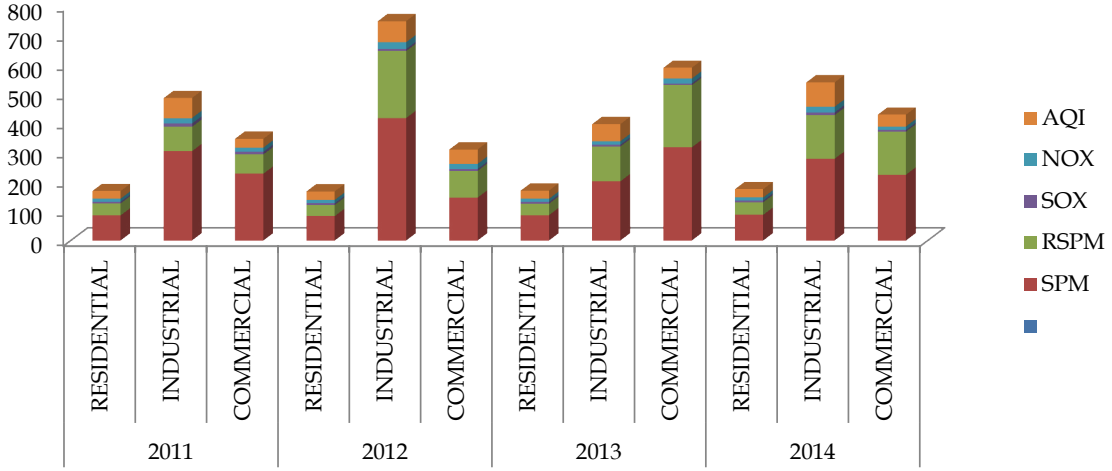

Fig. 2 Average of monthly observed ambient air quality during non-Diwali days.

Table 3. Average of monthly observed ambient air quality during non-diwali days.

Year	Area Type	SPM	RSPM	SO_x	NO_x	AQI
2011	Residential	86.0	41	5.1	10.9	26
	Industrial	305	83	10.8	19.1	68
	Commercial	228	66	8.5	14.7	30
2012	Residential	84	38	5.4	11.6	29
	Industrial	418.0	228.2	6.6	23.4	72
	Commercial	146.6	91.5	5.8	17.8	49
2013	Residential	87	39	5.5	11.2	28
	Industrial	202.3	119	5.5	12.3	58
	Commercial	318	212	5.6	16.8	37
2014	Residential	88	43	5.4	11	28
	Industrial	279	149	8.8	19.7	83
	Commercial	224.9	146.9	5.1	12.5	40

CONCLUSION

It is evident from the study that the ambient air quality in Bhopal city during Diwali festival changes when compared with non-Diwali days. The study sites showed mostly severe or heavy air pollution for all four years during Diwali days. It is evident from this study that the commercial and residential areas show heavy or severe air pollution during Diwali days whereas during non-Diwali pollution level is low. The industrial area shows low level of air pollution during Diwali days as compared to non-Diwali days.

SUGGESTIVE MEASURES

1. Public awareness.

2. Enforcement of special laws regarding the bursting of fire crackers.

3. Use of fire crackers should be decreased during Diwali festival as well as other days.

4. People should be motivated to burst fire crackers in groups.

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