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RESEARCH ARTICLE

AMBIENT AIR QUALITY ASSESSMENT DUE TO TOTAL SUSPENDED PARTICULATE MATTER (TSPM): A CASE STUDY WTE PLANT KATHONDA.

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Abstract

The beginning of the third millennium has been characterized by a progressive increase in the demand for fossil fuels, which has caused a steep rise in price of petroleum product. At the same time, several environmental disasters have increased the sensitivity of world-wide public opinion towards the effect that environmental pollution has on human health and climate change. These conditions have fostered a renewed interest in renewable energy like solar energy, wind energy, biomass and solid wastes. In addition, the disposal of municipal solid waste (MSW) has become a critical and costly problem. The traditional landfill method requires large amounts of land and contaminates air, water and soil. The paper takes the Waste to Energy Plant as the research subject and takes the samples of the Total Suspended Particulates (TSP) and Particulate Matter on all sides of the Plant as sample parameter to analyze the pollution and the pattern of pollution distribution. The study shows that the concentration of TSP and PM is very high and exceeds the national limit value .The study also evaluate the extent of environmental health risk from WTE plant along with waste dump site .In this site a Bio medical waste incinerator is also in working stage. Air monitoring has been done in all directions of selected site within 2 km radial distance from WTE plant. This area has WTE plant along with landfill site and biomedical waste incinerator .Two major colleges and residential habitants in its nearby premises are comes under the affected areas.

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Introduction:-

Risk to the environment especially air pollution is very common nowadays, globally. Recently Delhi Smog is its best example and the main parameter which subject to be concern is Particulate Matter. PM is major pollutant of concern internationally. As in major cities the concentration of particulate matter has been steadily increasing in recent years with an annual range much higher than prescribed limit of World Health Organization (WHO) guidelines [Sharmishtha Roy et al,2006]. Air pollution in India is estimated to kill 1.5 million people every year; it is the fifth largest killer in India. India has the world's highest death rate from chronic respiratory diseases and asthma, according to the WHO.

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According to the particle size, the atmosphere particulate can be divided into Dust Fall (with aerodynamic diameter of 100 - 1000 μm), TSP (with aerodynamic diameter of less than 100 μm), Inhalable Particulate Matter (PM₁₀, with aerodynamic diameter of less than 10 μm), Coarse Particulate (PM_{2.5} - 10, with aerodynamic diameter of 2.5 - 10 μm), and Fine Particulate (PM_{2.5}, with aerodynamic diameter of less than 2.5 μm) [Yao Zhao *et al* 2012]. At present, most researches concentrate on suspended particles and particulate matters in air of city area and there is little research about suspended particles along the area near to municipal solid waste dump site or the solid waste management site atmosphere, not to mention TSP or PM in all direction.

The Waste to Energy plant mainly influences economic, social and ecological environment nearby. In both the construction and operation phases, this project contributes to the economy and the society. Besides, it has great impacts on water environment, acoustic environment, soil environment and atmospheric environment [Hua li, *et al*, 2015]. Especially during the operation phase, with the dramatically increased vehicle flux, the vehicle exhaust, the road dust and the tear-and-wear of tires are diffused in the air, increasingly worsening the atmosphere quality on both sides of WTE plant along with dump site.

Except nitrogen oxides (NO_x), carbon oxides (CO_x), sulfur dioxide (SO₂) and other gaseous pollutants, there are more suspended particles and particulate matter present in the atmosphere. The suspended particles which are small and of strong adsorption can float in air for a long time so that they have a long-term impact on the environment along the site [Yao Zhao *et al*, 2012]. The floating particles influence animals, plants, workers and residents, as well as buildings nearby. Moreover, they can change the atmosphere compositions through chemical reaction and bring about long-term climate impact. Therefore, it is necessary to enhance the research on atmosphere particulate pollution in the plant area. Varied concentrations of PM₁₀ (225 $\mu\text{g}/\text{m}^3$ - 1600 $\mu\text{g}/\text{m}^3$) generated from boilers; vehicular emission and road construction; animal confinements and fodders; soil tillage operations; silica and cotton dust influenced respiratory disturbances, i.e., Chronic Obstructive Pulmonary Disease (COPD), chronic bronchitis, pneumonitis and excess risk of laryngeal cancer among workers [Sharmishtha Roy *et al*, 2006].

Materials and Methods:-

Site Selection:-

The site is exposure to particulate matter and other source of air pollutants as along with Waste to treatment plant the site also have landfill site, biomedical incinerator and slaughter house. All these reasons are enough to select the site for study. Air quality monitoring in this sector is yet to strengthen. The workers are not conscious about the health effects of PM.

Study Area:-

This study was conducted in the Jabalpur Municipal area, one of the oldest municipalities in Madhya Pradesh, India. Geographical spread of JMC is 215 sq.km with 1,267,567 populations as per census 2011 and generating 450TPD MSW. Jabalpur municipalities cover 53 sq km and have 79 wards and the plant having Area of 4 hac [JMC report under project UDAY]. The study was conducted in July to December 2017 with the average temperature ranging from 29°C to 14°C. The general direction of wind in winter towards North West. The windier part of the year lasts for 4.8 months, from April 6 to August 31, with average wind speeds of more than 7.4 miles per hour. The windiest day of the year is June 26, with an average hourly wind speed of 9.8 miles per hour. The calmer time of year lasts for 7.2 months, from August 31 to April 6. The calmest day of the year is October 23, with an average hourly wind speed of 5.1 miles per hour.

Methodology:-

The study was dealt through both quantitative and qualitative data collected primarily.

Monitoring Instrument:-

8 air samples were monitored by Aerocet 831 (aerosol mass monitor) digital Monitor through short term sampling from purposively chosen stations.

Description of monitoring Site:-

According to the field situation, the sampling section was set at the all direction. The monitor was put on all sides of the plant radial distance of 2 Km. The layout of sampling site is shown in **Figure 1**.



Fig1:- Image showing Radial 2Km distance around the WTE plant Kathonda,Jabalpur

The monitoring site is to the north of the WTE plant where there is entry to the plant which is approached by residential colony. On the south there is slaughter house along with dump site, east side waste water oxidation pond within residential area and at the west of it then there is a small village with rich vegetation and partially dumpsite. This study integrates several data sources to determine the emission source strength, in accordance with the practical situation of developed scenario. On site observation, measurement and monitoring of the waste treatment process provide the first-hand data source for the plant. The emission from stack was observed from plant only. The main monitoring item in this study is TSP and PMs. The monitoring was done twice. Each sampling time was from 9:00 am to 12:00 noon, peak working hours of waste dump site.

Results and Discussion:-

Analysis of Concentration:-

Air pollution parameters (TSP and PMs) on every sides of kathonda Waste to Energy plant is shown in Table 2 shows that concentration in atmosphere at the all four sides of WTE plant is different though the sampling sites are at the same distance from the Plant. To correlate it with temperature variation and humidity it was also recorded during the measurement of particulate matters (Table 1) on the south side, the vegetation is rich that trees, shrubs and grass form a three-dimensional greening system which has an obvious dust-retention effect. However, on the north side, few greening exists buildings just stop the diffusion of TSP. Moreover, temporary stopping of heavy trucks and a flow of people worsen the pollution. On South East the roads were not rigid and permanent hence it also enhance the concentration of PMs and Suspended particulates.

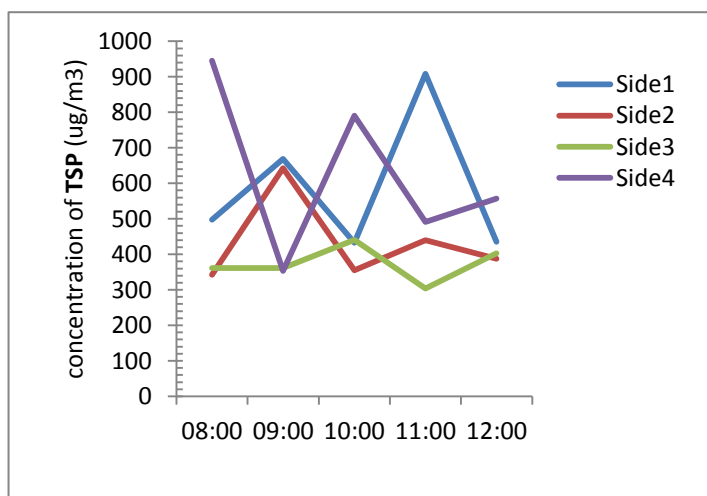
Table 1:-

S.no	Time	Temperature	Humidity
1	8:00	22.5 °C	56%
2	9:00	27.5 °C	40%
3	10:00	29.2 °C	37%
4	11:00	30.4 °C	35%
5	12:00	32.2 °C	30%
Maximum		40.7°C	82%
Minimum		11.4°C	10%

Table 2:-

S.no	Parameters	Side1*	Side2*	Side3*	Side4*	Permissible Values
1	TSP(ug/m ³)	588.48	433.64	374.06	627.4	360
2	PM1(ug/m ³)	65.48	53.28	42.26	25.6	-
2	PM2.5(ug/m ³)	183.86	134.1	101.02	70.1	60
3	PM4(ug/m ³)	271.22	192.7	147.48	121.1	-
4	PM10(ug/m ³)	486.92	340.10	285.5	371.76	100

*The above values are average of all sites in one direction

**Fig 1:-** Variation regularity of TSP on all sides of plant

This monitoring was carried out around the plant where mostly the vehicles carried MSW collected through city dumped into site for incineration without segregation. Hence the source of vehicular pollution is mainly due to them only and rest is dust particles on roadside, landfill site and waste loaded on vehicles.

Variation of TSP:-

The graph shows that variation in TSP was not constant especially in peak hours while at noon and at night it might be constant but it was seen it is higher than permissible value. The maximum variation was seen at North side of the plant i.e. at the approach of plant. This is due to uncertainty of the vehicles approaching to plant and the minimum variation at east as there is no vehicular movement. At the east side oxidation pond than crop farms are situated and after 1 km radial distance there is dense residential area. The variation of TSP was too much as its value frequently changes with traffic which was seen during monitoring and can also observe from above graph. The graph shows it is not depending on the time and temperature. If it is time and temperature dependent than it might be either increasing or decreasing. The maximum value of TSP observed as more than 900 ug/m³ while minimum was more than 300 ug/m³ which was already higher than permissible.

Variation of Particulate Matters:-

The variation in particulate matter was not varies too much except PM10 in any one direction but it is different in all four sides depending on the wind intensity, direction and area of that location. In this study along with PM2.5 & PM 10 which are mostly highlighted pollutant particulates we have also monitored PM1 & PM4.

PM1 are extremely fine particulate matter (PM) particles of diameter less than 1 micron — significantly smaller than PM 2.5 (of diameter 2.5 microns) that have been at the centre of discussions on particulate matter in Delhi's air. PM 10, PM 2.5, PM 1 & PM4 particles make up the total suspended particulate matter.

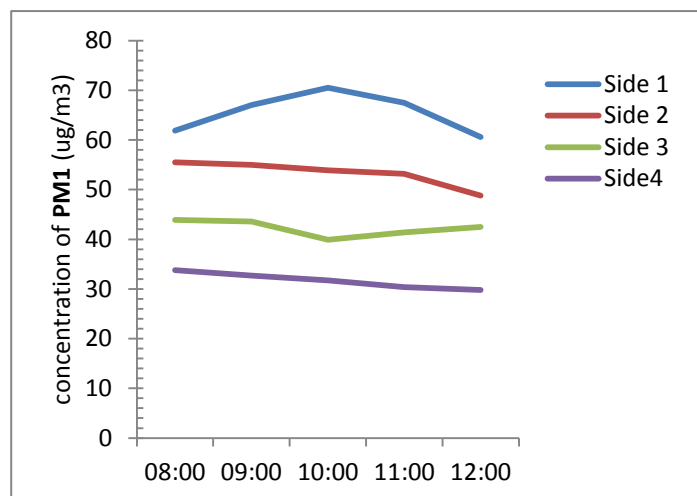


Fig 2:- Variation regularity of PM1 on all sides of plant

These particles, byproducts of emissions from factories, vehicular pollution, construction activities and road dust, are not dispersed, and stay suspended in the air that we breathe. 1 micron is about a thousandth of a millimeter.

The finer the particles, the more difficult they are to disperse — and the deeper they can penetrate into the blood stream, causing more harm. PM 10, which are smaller than 10 microns in diameter, enter the respiratory tract, and have been associated with risks like bronchitis, asthma, and upper respiratory tract infections. PM 10 aggravate symptoms of existing diseases more than triggering new conditions. PM 2.5 are considerably finer, penetrate into the lower respiratory tract or deeper in the respiratory tract, and the blood stream, causing cardiovascular problems. PM 1, which are so much finer than PM 2.5, can penetrate the cardiovascular stream even further, and give rise to lasting conditions, such as predisposing people to heart diseases. Studies in the west have shown that PM 1 can lead to premature births and affect fetal development.

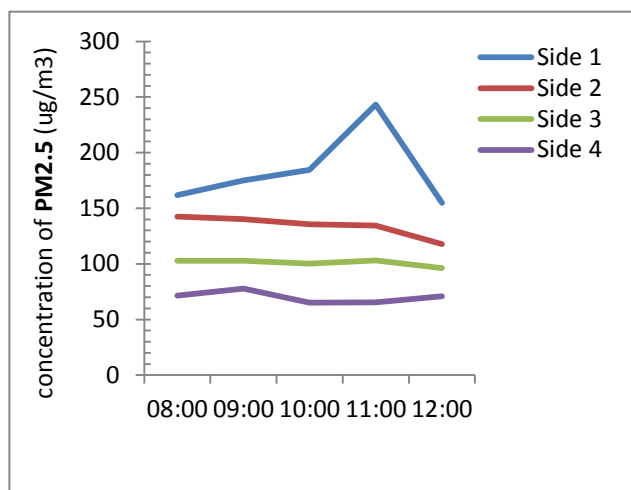


Fig 3:- Variation regularity of PM2.5 on all sides of plant

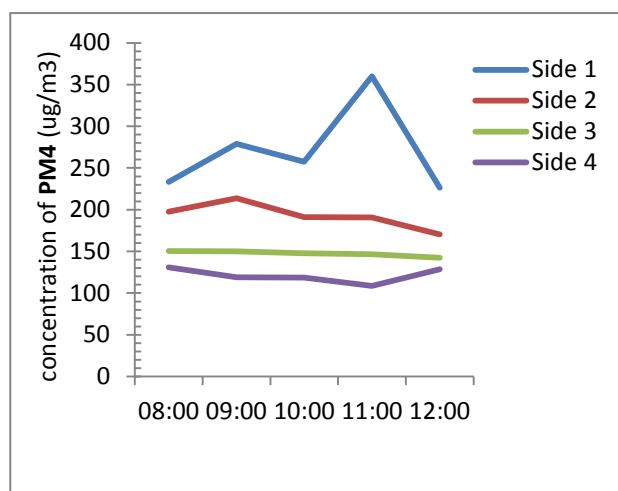


Fig 4:- Variation regularity of PM4 on all sides of plant

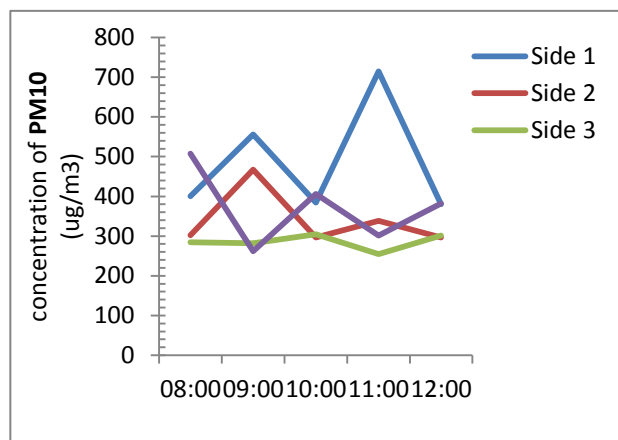


Fig 5:- Variation regularity of PM10 on all sides of plant

After monitoring it is found that concentration of PM is higher than the permissible value in all sides especially in approaching side(as shown in fig.) of the plant as there are more vehicle motion with carrying MSW. In city Jabalpur most of the waste collecting vehicles does not have any waste cover if few have just a thin plastic sheet (polyethylene type) .This type of cover is not beneficial for MSW collection and transportation. Along with all these factors Road side dust cannot be ignore as it contributes more air pollution in any place with few natural causes. From all the above graph it is observed that maximum concentration of TSPM was at 11AM which was also the peak time for human activities or can say get more affected with it.

Conclusion:-

The present investigation is based on the ambient air quality monitoring for TSPM, shows concentration above limit at eight strategic locations in and around MSW WTE plant Kathonda Jabalpur. The levels of all these air quality parameters were prescribed by CPCB for residential and industrial areas and on comparing it is found that TSP and PMs are all above it .They are threatened to human health .The more concentration of PMs can cause adverse effect on Human Health like irritation of respiratory tract, increase of chronic obstructive pulmonary disease and worsening of asthmatic mptoms[M.Vinceti et al,2005].However these uncertainties will always growing concern on this issue and should provide health surveillance program to the exposed community. Further Concentration of TSPM cannot completely avoided but can be reduced by adopting certain measures like using Covered vehicles, sprinkling water on road sides and provide mask to the workers ,drivers and other residents too who travelled along that road.

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