International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-2, Issue-6,June 2016
ISSN: 2395-3470
www.ijseas.com

EFFECTS OF PARTICULATE POLLUTANTS FROM SHIP EMISSIONS IN CHENNAI PORT

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Abstract **– The emissions from maritime transport contribute significantly to air pollution and climate change. This increase in ship emissions affects the nearby coastal communities. Ship emissions form excess cloud condensation nuclei (CCN) in the nearby coastal areas. This affects the radiation budget of the region. These factors are studied with the help of air quality data of the Chennai port. This paper analyses the impact of the increase or decrease in aerosol due to ship emissions on the Chennai port.**

Key words: Ship emissions, particulate matter, Chennai port, air pollution, health effects.

INTRODUCTION

In the recent years, the shipping sector is evolved as a massive transport. More than 97 percent of goods transported are based on maritime transport and their exhaust emissions have been subjected to increasing attention throughout the industrial world. In focus on port emissions data were uncontrolled particulate matter (PM), nitrogen oxides (NOx), sulphur oxides (SOx), and carbon monoxide (CO). Atmosphere overlying the ocean is very sensitive physically and chemically to air pollution. Clouds over the ocean are of a great climatic significance due to emission flux from ocean to atmosphere in many areas that result in excess cloud condensation nuclei (CCN).

AIR POLLUTION

Air pollution is the introduction of particulates, biological molecules or other harmful materials into the Earth's atmosphere causing disease, death to humans, and damage to other living organisms such as food crops, or the natural or built environment. Air pollution may come from anthropogenic or natural sources. Air is considered safe when it contains no harmful dust or gases.

Particulates pollutants are the minute solid particles or liquid droplets in air. These are present in vehicle emissions, smoke particles from fires, dust particles and ash from industries. Particulates in the atmosphere may be viable or non-viable. The viable particulates e.g., bacteria, fungi,

moulds, algae, are minute living organisms that are dispersed in the atmosphere. They cause plant diseases.

Non-viable particulates can be classified according to their size and nature in accordance to MARPOL73/78 - Annex VI (Prevention of Air Pollution from Ships).

It applies to all ships, fixed and floating drilling rigs and other platforms, but the certification requirements depend on size of the vessel and when it is constructed. Ships of 400 gross tonnes and above engaged in international voyages involving countries that have ratified the conventions, or ships flying the flag of those countries, are required to have an International Air Pollution Prevention (IAPP) Certificate.

PM CLASSIFICATION

Particulate matter (PM) is defined as any airborne finely divided solid or liquid material with an aerodynamic diameter smaller than 100µm. Super coarse is dust, dirt, soot, smoke and liquid droplets of size ranges 11-100µm in diameter. Coarse is PM_{10} with aerodynamic diameter of 10µm or less. Fine is $PM_{2.5}$ with AD of 2.5µm or less.

Inhalable is dust cloud that can be breathed into the nose or mouth. Thoracic is that which penetrates the head airways and enters the airways of the lung. Respirable is that which penetrates beyond the terminal bronchioles into the gas exchange region of the lungs. Aerodynamic diameter is the diameter of a hypothetical sphere of density 1g/cm^3 having the same settling terminal velocity in calm air as the particle in question, regardless of its geometric size (Nagendra, 2013).

	
Respirable sampler PM_{10}	Fine particular sampler $PM_{2.5}$ & PM_{10}
	
Dust Monitor Model 1.107 (PM_{10}, $PM_{2.5,}$ PM_1) works based on the principle of 1ight scattering with ±2% accuracy	Dust Monitor Model 1.108 (PM_{10}, $PM_{2.5,}$ PM_1) works based on the principle of 1ight scattering with ±2% accuracy

Figure 1: Monitoring instruments types and principle

ABOUT CHENNAI CITY

Chennai city experiences a tropical climate. It is in the coastal area with the Bay of Bengal on the eastern side. Thus the weather is typically hot and humid. Although it has the major seasons viz. summer, winter and monsoon, there is only a small variation between them due to

the location and proximity to the Indian Ocean. Chennai gets most of the rainfall from the northeast monsoon (mid-September to mid-December) while some rainfall is also there during the southwest monsoon (July to August). The hottest time period is typically May and June with a maximum temperature of about 42^{o}C and the coolest period is January with a minimum temperature of about 20^{o}C. In addition to this the proximity of the Bay of Bengal results in widespread showers whenever there is a depression in the Bay of Bengal.

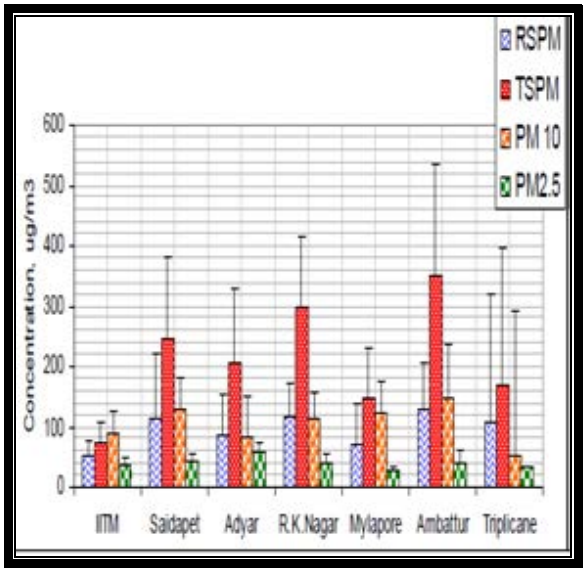

Figure 2: Comparison of PM values at six sites

RSPM is respirable suspended particulate matter, and TSPM is total suspended particulate matter.

Whereas Ambattur, Adyar, Triplicane and R K Nagar are nearby the port or industrial areas so the particulate matter observation is more. Sea water is the best particulate source sink in world, sometime this process also reduce the value of particulate emission.

Chennai, capital of the state of Tamil Nadu, is one of the four metropolitan cities in India and its particulate pollution level is high due to vehicular transport and industrial emissions.

Chennai port is located in latitude 13^{0}06N and longitude 80^{0}18E. It is well connected with road and rail transport. It has 24 alongside berth and two oil jetties. Workers per day are 8,500 and visitors per day are 10,000. The number of vessel reaching the Chennai port in a year is nearly 2,800.

Of past data of the Chennai port, the amount of particulate emissions from ships is considerably more and it will harm the people in near coastal area. The high pollution level is due to importing coal through the Chennai port. Now coal is imported through the Ennore port. When transportation of coal is not done in a safety manner without putting the enclosed shield over the coal carrying trucks and belt driven roller, it may lead to more air pollution in the region and the deposition of particulate matter.

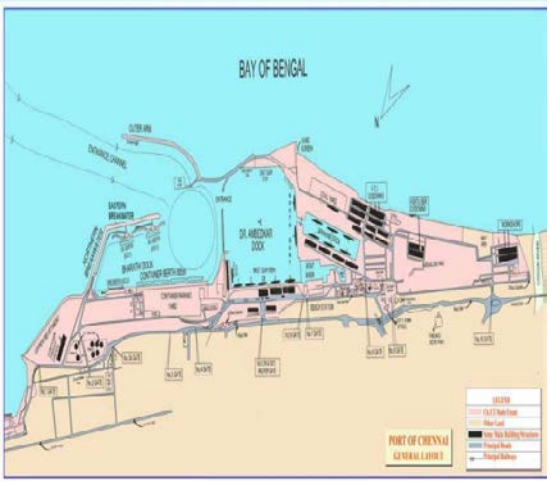

Figure 3: Layout of the Chennai port

With the help of the Chennai port we did the air quality sampling in the following places with respect to the locations, reference point and height of sampling point.

Table 1: Air sampling location in Chennai Port

Locations	Reference point	Height of sampling point (in metres)
Civil division central (A1)	Near gate No.10	7
Civil division central (A2)	South of Timber pond	9
SS area 5 office South Quay-111 (A3)	Near coal yard	6.5
Fire office (near anchor GateA4)	Near Anchor Gate	7.5
CISF NEAR barracks, Gate No.2 (A5)	Near new container freight station	5.5
Diesel Loco Shop (Near MOHP Area at Ore Berth) (A6)	Near MOHP area at berth	8.5

The collected the air quality data of the Chennai port depends on the factors such as nearby port emission contributors, vehicle's fuel type, engine size, age, condition and power output (Lloyds Register Engineering Services, 1990 & 1999). With response to the factors the emission range and air quality status of a particular place changes is identified. The use of low quality of fuel and old engines are the major causes of pollution.

When we compare the air quality status from 2007 to 2015 in Fig. 3&4 the particulate matter pollution for PM_{10} shows gradually reduction from the range of 350µg/m^3 to 60µg/m^3, and for $PM_{2.5}$ it shows gradually reduction from 450µg/m^3 to 90µg/m^3

ENVIRONMENTAL EFFECTS

Evaluation of air pollution from ships in ports showed an increasing ecological effectiveness of larger ship operations in ports. Emission forecast scenarios showed a positive effect of MARPOL73/78 Annex-VI. However, due to specifics of port operations the emissions reduction was not as large as it would be on the open sea operations (Smailys et al., 2013).

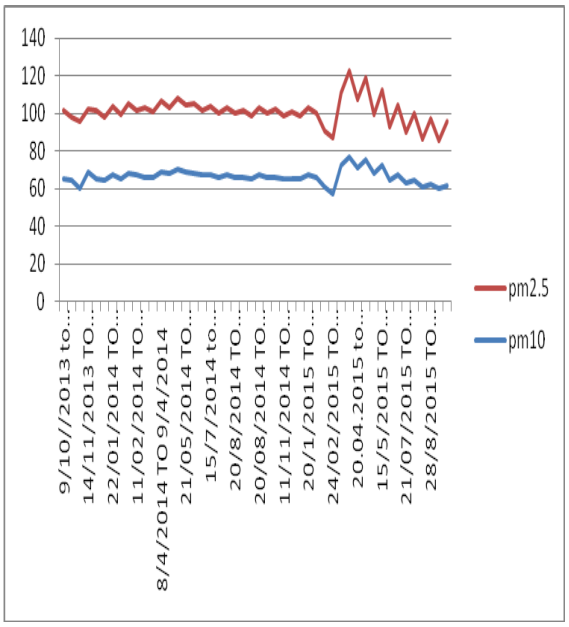

Figure 3: Contribution of particulate matter in Chennai Port from 2013 to 2015

According to IMO, the action developed to reduce the ship emission may leads to make the free green port with minimal emission and less pollution throughout the coastal areas. Another way to calculate the

ship emission is emission factor calculation based on the size and movement of vessel. The emissions produced by the ship depends on the ship size and type of the ships.

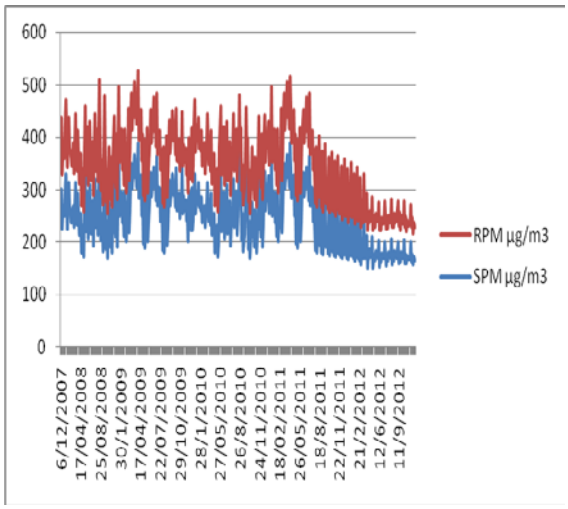

Figure 4: Contribution of particulate matter in Chennai port from 2007 to 2012

HEALTH EFFECTS

These emissions have potentially negative impacts on human health. The effects of air pollution on health have been extensively studied in recent years. The results of these studies showed that $PM_{2.5}$ emissions from shipping are responsible for approximately 60,000 cardiopulmonary and lung cancer deaths annually worldwide, with impacts concentrated in coastal regions on major trade routes (Fig. 5). Most of deaths occur near coastlines in Southeast Asia where high populations and high shipping-related $PM_{2.5}$ concentrations coincide (Ho, 2013).

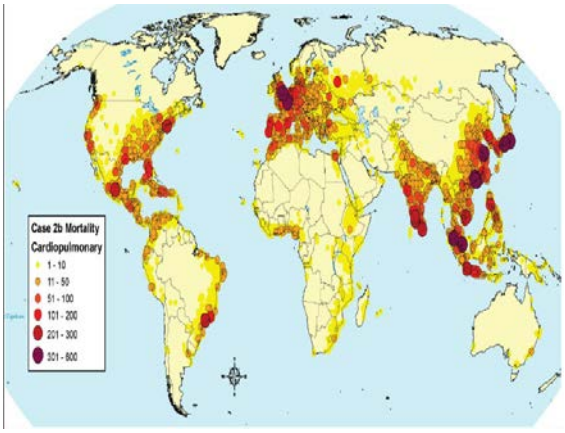

Figure 5: Cardiopulmonary mortality attributable to ship $PM_{2.5}$ emissions worldwide

After 2011, particulate emission has gradually dropped and this is because the Director General of Shipping showed gave much attention for air pollution in ports and ships, and this made the port authorities to follow the stringent rules and regulations and take necessary action on polluters.

From Fig. 5, in the nearby coastal area of south India the cardiopulmonary mortality rate is found to be more compared with all other regions in the globe. Especially in the Chennai coast region the morality due to cardiopulmonary disorder is more. This is probably because of shipping emission created by international and national ships in this region is not yet obeying the Annex-IV of International Maritime Organization's Prevention of Air Pollution from Ships, and all other ships from the outside countries are polluting this region, mainly due to less stringent rules. Ships from outside are not yet following the rules and convention in India, but they follow Annex-IV and amendments when in other countries because punishment and fine are more in other countries rather than India.

Ship exhaust has been shown to increase local marine cloud albedo by adding to the available nuclei on which cloud drops

form 23±25 (Capaldo et al., 1999). In addition, the large-scale effect of ship emissions of particulates on the background concentration of CCN over the ocean could also have an effect on regional and global radiative budgets. To estimate this effect, we apply the fuel-based emission factors for particulate matter reported by Lloyds26 to generate total annual particulate matter emissions for ships.

CONCLUSION

This “decreased” annual emission may be simply a result of the relevant amendments to rules and regulations of the International Maritime Organization. Since the movement of coal through the Chennai port was shifted to the Ennore port, this too resulted in reduced emissions at the Chennai port. The large-scale effect of ship emissions of particulates on the background concentration of CCN over the ocean could have an effect on regional and global radiative budgets too.

REFERENCES

1) Capaldo, K., Corbett, J. J., Kasibhatla, P., Fischbeck, P., & Pandis, S. N. 1999. “Effects of ship emissions on sulphur cycling and radiative climate forcing over the ocean.” *Nature*, *400*(6746), 743-746.

2) Ho, B. Q. 2013. Air emission inventories methodology for port and air quality simulation. *Modern Transportation*, *2*(1).

3) IMO Marpol 73/78, 2002. International Convention for the Prevention of Pollution from Ships, 1973.

4) Lloyds Register Engineering Services, 1990 & 1999.

5) Nagendra¸ S.M. Shiva. 2013. Urban Air Quality Management, TNPCB, Chennai.

6) Smailys, Habil D. V., Paulius Rapalis, Renata Strazdauskiene, and Kristina Bereisiene. 2013. Air Pollution from Ships in the Partner Ports. Cleanship, 3.1.