

Oily-Droplets in Ambient Air of Shillong

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Abstract

An attempt has been made to quantify the relative abundance and size distributions of oily-droplets in the ambient air of Shillong using an optical microscope. The sampling was carried out at controlled, moderate traffic, high traffic, traffic intersections, industrial estates and elevated specific locations in different seasons during 1998-2000. It was observed that the intensity of traffic and topography (plain or uphill) do not affect the relative abundance of oily-droplets as % of total suspended particulates (TSP). Release of terpenes and/or other oily chemicals from pine-trees and other vegetation appeared to be a major source of oily-droplets in the ambient air with the abundance of oily-droplets reaching up to 15-25% of the suspended particulates by number in close vicinity of such forests/vegetation growths. Release of oily-droplets from pine-trees appeared to be significantly affected by meteorological factors as higher temperatures and wind-velocities enhanced the release of oily-droplets while higher humidity suppressed it. Factor-wise study of sets of data for the pine-surrounded CB locations gave correlation of +0.95, +0.85 and -1.00 between relative abundance of oily-droplets and temperature, wind-speed and relative humidity respectively, clearly depicting such dependence. About 96% of the total oily-droplets at CB locations and 93% at other urban locations were below 2.6 μ size and hence formed part of fine particulate matter (FPM or PM_{2.5}). About half of these were of size 1 μ or less and hence were liable to be lodged deep inside the lungs. These oily-droplets could also have a role in the coalescing of particulates and self-cleansing processes of the atmosphere. As such, the subject of oily-droplets in ambient-air deserves more intensive and extensive research in different parts of the country.

Key Words: TSP, Relative Abundance (%), Oily-Droplets, Size Distributions, FPM

1. Introduction

An interesting finding in the field of air quality monitoring was the presence of significantly large number of oily-droplets in the ambient-air of Shillong particularly in the areas located close to coniferous (pine) forests/vegetation. While there are some scattered references to the presence of fine oily-droplets in ambient air of urban/industrial areas resulting from emissions or fugitive releases of various hydrocarbons from vehicular sources, petrol-stations and industrial or other urban sources and also mention of releases of terpenes and other oily substances from pine forests and other tree-species, the authors are not aware of any efforts made earlier to quantify the relative abundance and size distribution of such oily-droplets, particularly in India. Such an attempt was made by one of the author in the Ph.D. thesis titled "Assessment of Breathing Level Air-Quality in Shillong" submitted to North-Eastern Hill University, Shillong (Katiyar, 2002). The data and observations presented in this paper have been extracted from this thesis.

2. Methodology

Ambient air at 3 controlled (essentially no traffic), 24 moderate traffic, 24 high-traffic locations, traffic intersections (at Fire Brigade-TIF and Garikhana-TIG), industrial estates (IE) and elevated specific (Fire-Brigade Building-A) locations in Shillong was passed through 0.5 μ pore-size nitro-cellulose membrane filters for various durations as per standard procedures. Tiny oily-droplets were easily visible and their relative abundance (as % of total particulates by number) was determined using an optical microscope (Labor Lux D, Leitz, Weitzlar, Germany). Measurement of droplet-size and distribution of sizes was done at a magnification of 1562X using microscopic slides prepared by pressing a clean Mylar sheet against the sample on the filter paper.

3. Observations and Discussion

Several sets of monitoring were carried out at the 3 controlled (designated as CB), 24 moderate traffic, 24 high traffic, traffic intersections, industrial estates and elevated specific locations in different seasons during 1998-2000 and location-wise mean values of all sets of monitoring were taken where relevant. For better interpretations, the 48 sampling locations other than the CB ones were further classified into moderate-traffic plain-area (MP-13Nos), moderate-traffic up-hill-areas

(MU-11Nos), high-traffic plain area (HP-13Nos) and high-traffic up-hill-areas (HU-11Nos). The significant observations are as follows:

3.1 Relative Abundance of Oily-Droplets

Table 1 below gives the relative abundance of the number of the oily-droplets as % of TSP by number as location-wise mean values for the different category of the locations and also the peak values and the locations showing the peak values for each category:

Table 1: Relative abundance of the number of the oily-droplets

Group of Locations	No of Locations in the Group	Group Range of Location Mean % of TSP	Overall Group Mean % of TSP	Location With High Oil-drops		
				Location	Mean	Peak
CB	3	12.9% - 17.1%	15%	CB2	17.1%	19.9%
PM	13	3.2% - 9.8%	6.8%	MP-11	9.8%	12.3%
MU	11	3.9% - 7.3%	5.9%	MU-9	7.3%	12.4%
HP	13	4.0% - 10.0%	6.3%	HP-7	10.0%	16.9%
HU	11	3.0% - 10.0%	5.7%	HU-7	9.6%	19.6%

From Table 1 one can observe that

- Since the group-wise ranges and overall group mean values of % abundance do not differ significantly for the 4 groups MP, MU, HP and HU, the intensity of traffic and the topography (plain or uphill) do not appear to affect the relative abundance of oily-droplets as % of TSP and for the first assumption one could well adopt 6% as the mean relative abundance in Shillong (with range of 3-10%).
- The relative abundance was much higher at the control locations (CB) and also at locations HP-7 and HU-7 all of which had pine trees in significant numbers in nearby areas. Even MP-11 and MP-9 had pine-trees nearby though not as many as in case of CB and HP-7. Thus the release of terpenes and/or other oily chemicals from pine-trees and other such vegetation appears to be a major source of oily-droplets in ambient air and the abundance of oily-droplets could reach 15-25% of the suspended particulates by number in close vicinity of such forests/vegetation growths. A part of the oily-droplets released from Shillong forests can get dispersed all over the city. However, this could not be the only source of the oily-droplets. It also appears that traffic and other urban sources of TSP also contribute 5-6% of the particulates as oily-droplets. Frequencies of occurrence of above 8-9% locations in Shillong appeared to be essentially due to some coniferous vegetation close-by. The highest abundance of oily-droplets observed in this study was 20.4% at TIFS2 (south direction), 23.7% at TIGS2 (south direction) and 24.8% at IE-1all surrounded by pine forests.
- The release of oily-droplets from pine-trees appeared to be significantly affected by meteorological aspects of weather. Higher temperatures and wind-velocities enhanced the release of oily-droplets while higher humidity suppressed it. Factor-wise study of the several sets of data for the pine-surrounded CB locations gave correlation factors of +0.95, +0.85 and -1.00 between the oily-droplets relative abundance and the temperature, wind-speed and relative humidity respectively, clearly showing such dependence.
- In the case of the different floor terraces of the Fire-Brigade Building studied to examine the effect of height above ground-level, the relative abundance of oily-droplets was largest at 10.4% of TSP at the lowest terrace at 1.5m above GL (ground level) and systematically decreased with height to be only 3.7% at A4, 13.6m above GL. Thus the abundance of oily-droplets decreased sharply with increase in height above GL.

3.2 Size Distribution of the Oil-Droplets at Different Locations in Shillong

The relative abundance of the oily-droplets of different sizes in the sample slides for different locations in Shillong was carried out optically with an appropriately calibrated microscope-scale. Results processed group-wise are presented in Table 2 below:

Table 2: Size distribution of oily-droplets at different location categories in Shillong

Location Category	Relative Abundance of Oily-droplets of Size				Cumulative Abundance of Oily-droplets of Size		
	0.44 μ	0.88 μ	1.77 μ	2.6 μ	Upto 0.88 μ	Upto 2.6 μ	Above 2.6 μ
CB	4.7 + 6.1	51.8 + 1.6	30.7 + 5.1	8.8 + 1.7	56.5	96.0	4.0
MP	2.8 + 1.0	42.9 + 10.5	39.8 + 8.6	7.2 + 3.9	45.7	92.7	7.3
MU	2.6 + 4.1	40.3 + 10.7	40.1 + 11.6	10.3 + 4.4	42.9	93.3	6.7
HP	5.3 + 8.5	41.3 + 5.6	38.7 + 11.3	7.7 + 3.4	46.6	93.0	7.0
HU	3.4 + 3.0	41.4 + 9.5	40.3 + 6.4	8.5 + 4.4	44.8	93.6	6.4
Mean of 48 Locations	3.5	41.5	39.7	8.4	45.0	93.2	6.8

From Table 2 it can be inferred that

- a) The mean sizes of 0.88 μ and 1.77 μ are the most frequent. The mean size 0.88 μ accounts for around 50% of the total oily-droplets at CB locations and around 40% at all the other locations (48 urban locations in Shillong). The mean size 1.77 μ accounts for about 30% of total oily-droplets at CB stations and about 40% at other 48 locations. It is interesting to note that the sources of these two sizes i.e. 0.88 μ and 1.77 μ , either emit oily-droplets only in these sizes or these are the only stable aerodynamic sizes for such drops to remain suspended in ambient air. Finer drops of 0.44 μ accounted for only about 5% or less of total drops and those of 2.6 μ between 7 and 10% at different categories of locations.
- b) A look at the cumulative relative abundance shows that 96% of the total oily-droplets at CB locations and 93% at the other urban locations shall be below 2.6 μ size and shall hence form part of the fine particulate matter (FPM or PM_{2.5}) and shall be able to reach the lungs when breathed by humans. About half of these shall be of size 1 μ or less and hence liable to be lodged deep inside lungs for long times.
- c) It should be remembered that both the abundance of oily-droplets relative to TSP as given in section 3.1 above and the size-distribution frequencies given in section 3.2 above and the size-distribution frequencies were by numbers determined optically and can not be directly converted to concentrations by weight, the terms in which the standard limits are given. Nevertheless, their significant abundance at all locations (around 6% of TSP) and much higher abundance in the vicinity of certain types of vegetation make them important enough not to be ignored. That almost 95% of all the oily-droplets, as many as 95% are below 2.5 μ size, makes them of human-health significance. Not knowing their chemical composition one cannot say what the health effects would be, will that be negative or advantageous.

4. Conclusions

Ambient-air at all monitored locations in Shillong had at least some tiny oil-droplets. The relative abundance of such oily-droplets by number ranged between 3-10% of the TSP in general urban areas but could be higher if some pine-trees or other specific vegetation was around. In and near pine-groves this relative abundance could reach as high as 25%. From the data it appears that most of oily-droplets in ambient-air of Shillong were of terpenes and other organics from pine-trees. But this could not be the only source, traffic, domestic-cooking and other activities would also be contributing, as else the abundance could not be so wide-spread and near-uniform in the entire urban area.

Size wise almost 95% of the oily-droplets were below 2.5μ size and hence these could be of significant health concern. They could also have a role in the coalescing of particulates and self-cleaning processes of the atmosphere.

The subject of oily-droplets in ambient-air deserves more intensive and extensive studies in different parts of the country.

5. References

Katiyar S. C. (2002). Assessment of breathing level air quality in Shillong, Ph.D. Thesis, North Eastern Hill University, Shillong, India-793022.