Is There a Relationship Between Indoor and Outdoor Aerosol Concentrations?

Purpose

Aerosols are solid or liquid particles suspended in the air. Dust, dirt, smoke, bacteria and pet dander are examples of solid aerosols. Hair spray, bug spray, cooking oil and water are examples of liquid aerosols. Aerosols are important because we breathe them every day.
Filter samples containing aerosol particles were collected from indoor and out door sample locations. The purpose of this project was to determine whether the aerosol concentration of particulate material collected on the filters was greater indoors or outdoors and if there was a proportional relationship between inside and outside aerosol concentrations.

Hypothesis

Outdoor aerosol concentrations will be higher than indoor aerosol concentrations because of the weather and the amount of dirt outside. As outdoor aerosol levels increase or decrease, indoor aerosol levels will increase or decrease proportionally because some aerosol particles outside get transferred inside.

Materials

- 47 mm filters, Pallflex Fiberfilm, T60A20, Lot T7103C (Pall Gelman Corp., Ann Arbor, MI)
- Vacuum pump (Gast Manufacturing Corp., Benton Harbor, MI)
- 47 mm filter open-face filter holders (In-Tox Products, LLC, Moriarity, NM)
- Critical orifi, 10 L/min nominal flow rate (In-Tox Products, LLC, Moriarity, NM)
- DryCal DC-Lite primary airflow calibrator, DCL-H rev.1.08, S/N 7064 (BIOS, Butler, NJ)

Procedure

1. Calibrate critical orifice flow rates.
   - Outside critical orifice mean flow rate = 10.04 ± 0.05 L/min., n = 10
   - Inside critical orifice mean flow rate = 10.15 ± 0.03 L/min., n = 10
2. Install critical orifi in filter sample vacuum supply lines.
3. Connect filter sample lines to filter holders and vacuum pump.
4. Weigh filters – filter tare weight.
5. Record filter tare weights.
6. Load filters into filter holders.
7. Place outside filter holder in sample location.
8. Place inside filter holder in sample location.
9. Start vacuum pump.
10. Record sample start time.
11. Record weather outside.
12. Record indoor conditions, e.g. dusting, door open, etc.
13. Stop vacuum pump.
14. Record sample stop time.
15. Record weather outside.
16. Record indoor conditions, e.g. dusting, door open, etc.
17. Weigh filters – filter final weight.
18. Calculate filter net weight (µg):
    - Filter final weight – filter tare weight
19. Calculate filter sample collection time (min.):
    - Sample stop time – sample start time.
20. Calculate filter sample volume (L):
    - Filter sample flow rate, L/min. * filter sample collection time, min.
21. Calculate mass per unit volume aerosol concentration (µg/L):
    - Filter net weight (µg) / filter sample volume (L).
22. Calculate statistics: mean, standard deviation and coefficient of variation.
23. Record data.
24. Graph data.

Results

The outside aerosol concentration was always higher than the inside aerosol concentration except when the carpet was vacuumed or the heater was on. The inside aerosol concentration was higher than the outside aerosol concentration even when the lawn was mowed.

See Table 1. All Filter Data

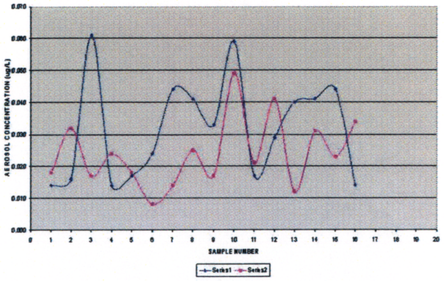
Inside aerosol concentrations and outside aerosol concentrations varied proportionally regardless of which was higher.

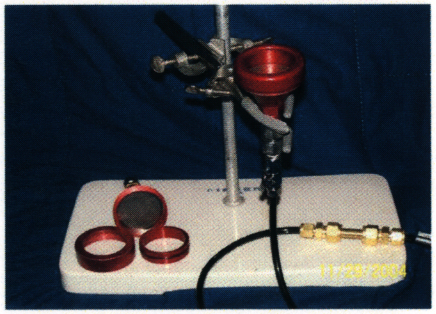
See Figure 1. All Filter Data Graph

Table 1. All Filter Data

Filter I.D.	Start Time (hhmmss)	Stop Time (hhmmss)	Sample Time (min)	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)	Flow (L/min)	Concentration (µg/L)	Weather Start	Weather Stop
FS1-I	20:30:00	7:00:00	630	64.477	64.567	0.090	10.15	0.014	N/A	N/A
FS1-O	20:30:00	7:00:00	630	63.362	63.479	0.117	10.04	0.018	calm	calm
FS2-I	19:35:00	6:45:00	670	62.432	62.538	0.106	10.15	0.016	N/A	N/A
FS2-O	19:35:00	6:45:00	670	62.084	62.298	0.214	10.04	0.032	windy	calm
FS3-I	6:55:00	17:55:00	660	63.866	64.272	0.406	10.15	0.061	N/A	N/A
FS3-O	6:55:00	17:55:00	660	62.124	62.237	0.113	10.04	0.017	calm	breeze
FS4-I	21:00:00	5:20:00	500	63.931	64.003	0.072	10.15	0.014	N/A	N/A
FS4-O	21:00:00	5:20:00	500	63.239	63.359	0.120	10.04	0.024	calm	breeze
FS5-I	5:30:00	18:45:00	795	63.287	63.422	0.135	10.15	0.017	N/A	N/A
FS5-O	5:30:00	18:45:00	795	63.972	64.118	0.146	10.04	0.018	breeze/rain	rain
FS6-I	19:00:00	5:15:00	615	63.813	63.961	0.148	10.15	0.024	N/A	N/A
FS6-O	19:00:00	5:15:00	615	62.919	62.968	0.049	10.04	0.008	calm	calm
FS7-I	16:05:00	5:20:00	795	63.989	64.343	0.354	10.15	0.044	N/A	N/A
FS7-O	16:05:00	5:20:00	795	63.906	64.018	0.112	10.04	0.014	breeze	calm
FS8-I	5:25:00	15:50:00	625	61.932	62.190	0.258	10.15	0.041	N/A	N/A
FS8-O	5:25:00	15:50:00	625	63.306	63.466	0.160	10.04	0.025	calm	wind/rain
FS9-I	17:00:00	7:00:00	600	63.145	63.348	0.203	10.15	0.033	N/A	N/A
FS9-O	17:00:00	7:00:00	600	62.317	62.420	0.103	10.04	0.017	calm	calm
FS10-I	9:30:00	18:00:00	510	61.844	62.152	0.308	10.15	0.059	N/A	N/A
FS10-O	9:30:00	18:00:00	510	62.662	62.911	0.249	10.04	0.049	calm	calm
FS11-I	20:20:00	7:00:00	640	63.281	63.393	0.112	10.15	0.017	N/A	N/A
FS11-O	20:20:00	7:00:00	640	62.465	62.602	0.137	10.04	0.021	breeze	calm
FS12-I	7:00:00	18:07:00	662	62.875	63.071	0.196	10.15	0.029	N/A	N/A
FS12-O	7:00:00	18:07:00	662	61.722	61.995	0.273	10.04	0.041	breeze	wind
FS13-I	17:10:00	5:25:00	735	62.842	63.144	0.302	10.15	0.040	N/A	N/A
FS13-O	17:10:00	5:25:00	735	62.675	62.763	0.088	10.04	0.012	windy	calm
FS14-I	5:30:00	19:30:00	840	62.935	63.288	0.359	10.15	0.041	N/A	N/A
FS14-O	5:30:00	19:30:00	840	62.258	62.522	0.264	10.04	0.031	calm	calm
FS15-I	17:15:00	6:55:00	800	61.548	61.908	0.360	10.15	0.044	N/A	N/A
FS15-O	17:15:00	6:55:00	800	63.197	63.383	0.186	10.04	0.023	breeze	calm
FS16-I	7:00:06	20:05:00	785	61.455	61.565	0.110	10.15	0.014	N/A	N/A
FS16-O	7:00:00	20:05:00	785	62.721	62.990	0.269	10.04	0.034	calm	windy
							MEAN	0.028		
blue = day time							STDEV	0.014		
black =night time							% CV	50.3		

Figure1. ALL FILTER DATAGRAPH





47 mm Open-face Filter Holders

Critical Orifice

Conclusions and Discussion

Multiple filter samples were collected simultaneously from the same indoor and outdoor sample locations to see if there was a relationship between inside and outside aerosol concentrations. The hypothesis was that outdoor concentrations would be higher than indoor aerosol concentrations and that as outside aerosol concentration increased or decreased, inside aerosol concentration would vary proportionally. The hypothesis was correct with the exception of the inside aerosol concentration being higher than the outside when the carpet was vacuumed and when the heater was on at night. Of particular interest was how high the indoor aerosol concentration increased when the carpet was vacuumed and the possible implications to public health, especially for people with asthma or compromised immune systems.

References

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