Evaluating the Performance of the OSHA Versatile Sampler (OVS) as an Inhalable Sampler

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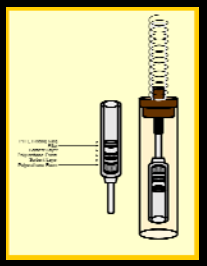
Background



Semivolatile organic compounds (SVOCs) such as organophosphorus and organonitrogen pesticides exist as both gases (vapors) and particles simultaneously in air.

The OSHA Versatile Sampler (OVS) was designed to measure particles and vapors simultaneously.

Many OSHA and NIOSH sampling and analytical methods for pesticides require the use of the OVS.

The ACGIH has an Inhalable Fraction and Vapor (IFV) endnote for chemicals that need to be evaluated for both the inhalable fraction of their particle-phase and a vapor-phase due to their volatility. The majority of chemicals with the IFV endnote are pesticides.[1]

The IFV endnote requires the inhalable particle fraction to be analyzed, and many IFV chemicals require an OVS for sampling.

However, the OVS is not recognized as an inhalable sampler, and there is no published literature on the sampling performance of the OVS, nor any other sorbent-containing sampler.

Objectives

To evaluate the particle-phase collection efficiency of the OVS and compare its performance to the IOM inhalable sampler.

To determine whether modifications to the OVS can enhance its ability to sample similarly to the IOM sampler.

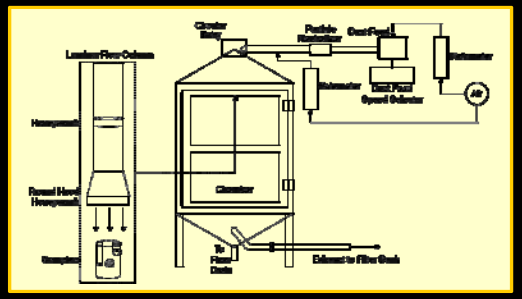
Methods

The OVS (1 L/min), IOM sampler (2 L/min), and 25-mm cassette (isokinetic reference sampler; 0.83 L/min) were placed inside a 'calm air' chamber.

In order to best mimic the collection efficiency of the IOM sampler, the OVS flowrate was set to achieve the same entry velocity as that of the IOM sampler. This flowrate for the OVS also met the upper flowrate allowed in the NIOSH and OSHA methods.

Aluminum oxide dusts (6, 26, 58 µm) were used as test aerosols.

Each trial lasted for approximately 20 minutes, and for each OVS configuration, three trials were conducted per particle size. Concentration was measured for each sampler.



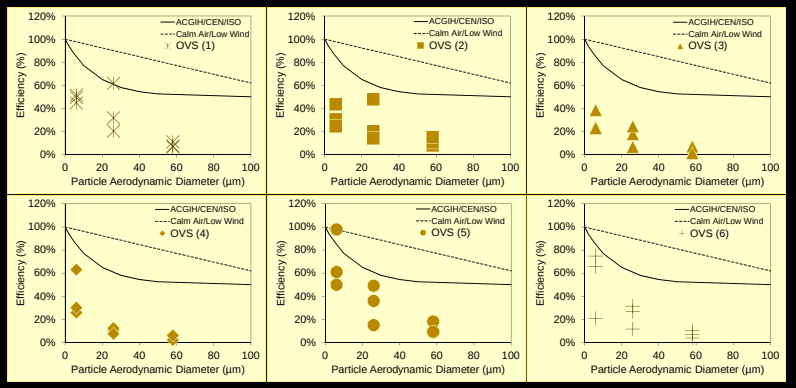
The OVS was evaluated in its original configuration and five modifications.

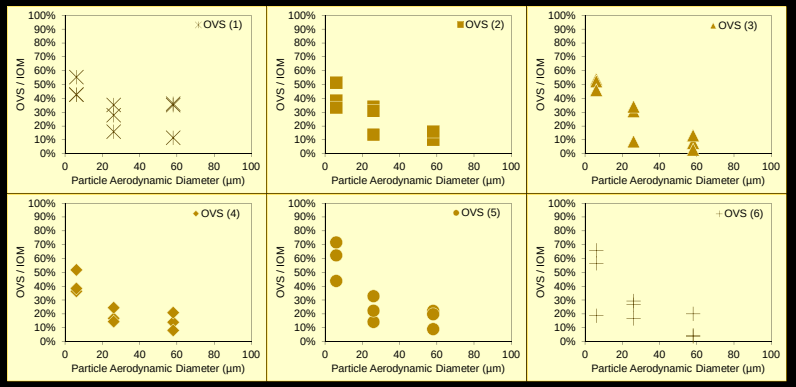
OVS Configuration	Orientation	Tube Holder	Modification
1	Vertical	☒	None
2	Horizontal	☒	None
3	Horizontal	☐	None
4	Horizontal	☐	Filter closer to inlet
5	Horizontal	☐	Flanged adapter
6	Horizontal	☐	Conical adapter

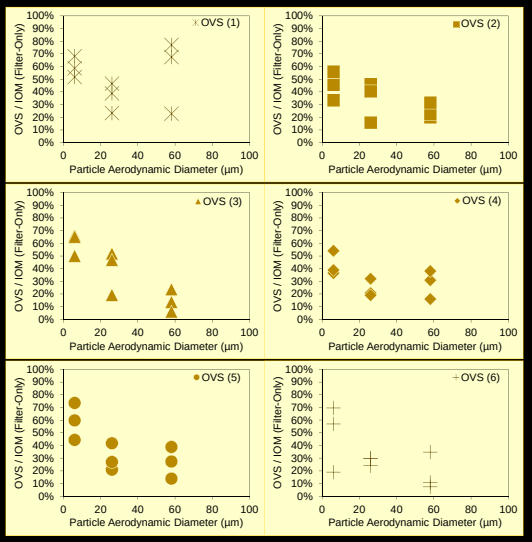
The OVS does not have a cassette to account for wall losses, so the filter of the OVS was compared to the filter of the IOM by itself as well as the IOM filter and cassette as a unit.

Concentration ratios were computed: OVS/Cassette, OVS/IOM, and OVS/IOM (Filter-Only). The OVS/Cassette ratios were compared to the ACGIH-CEN-ISO inhalable convention curve and the proposed calm air inhalability curve.[2,3] A two-sample t-test was conducted to determine if the measurements of the IOM filter and cassette as a single unit were different from the measurements of the IOM filter by itself.

Results







There was a statistically significant difference between the measurements of the IOM filter and cassette as a single unit and measurements of the IOM filter by itself for particle sizes at 26 µm ($p = 0.024$) and 58 µm ($p = 0.015$), but not for 6 µm ($p = 0.297$). This was expected since larger particles are more likely to settle on the cassette walls before reaching the filter of the IOM sampler.

Conclusions

All six configurations of the OVS under-sampled when compared to the IOM sampler, the inhalable convention curve, and the proposed calm air inhalability curve.

The efficiency of all six OVS configurations matched the efficiency of the IOM filter by itself better than the efficiency of the IOM filter and cassette as a single unit.

None of the five modifications made any significant improvements to the first configuration except when considering particles captured directly onto the IOM filter by itself.

Further research should include assessing the performance of the OVS using semivolatile pesticides and developing an inhalable particle and vapor personal sampler that is commercially available in the United States.

References

1. American Conference of Governmental Industrial Hygienists (ACGIH). The Threshold Limit Values (TLVs®) and Biological Exposure Indices (BEIs®). Cincinnati, OH: ACGIH; 2017.
2. Soderholm SC. Proposed international conventions for particle size-selective sampling. The Annals of Occupational Hygiene. 1989;33(3):301-2
3. Aitken RJ, Baldwin PEJ, Beaumont GC, Kenny LC, Maynard AD. Aerosol inhalability in low air movement environments. Journal of Aerosol Science. 1999;30(5):613-26

Acknowledgements

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