

ACCOUNTING FOR CASSETTE WALL DEPOSITS

Background

Aerosol sampling methods typically employed in North America, specify the use of 37mm closed-face sampling cassettes. Both OSHA and NIOSH consider that all particles entering the opening of closed-face sampling cassettes should be included as part of the sample whether they deposit on the filter media or on the inside surfaces of the sampler used.

A detailed discussion of this phenomenon can be found in NIOSH Manual of Analytical Methods (MNAM) 'Sampler Wall Losses' Chapter 0 [1]. OSHA has also addressed this issue, in its gravimetric method PV2121 [2].

How to account for cassette wall deposits

To obtain the highest accuracy of occupational exposures, one must include all aerosol particles entering the sampler. Therefore following the collection of samples, steps must be taken during the sample preparation procedures, to account for material adhering to the internal surfaces of air sampling cassettes. Various researchers, starting as early as 1989, have shown that particles deposited on the interior surfaces of air sampling cassettes, often constitutes a significant portion of the aerosol that enters the cassette [3][4][5][6] and in some cases exceeds that that is collected on the filter [7]. Due to high variance of this wall deposit phenomenon, a standard correction factor cannot be developed. Even the act of transport can cause particles to alter their location from the filter to the walls.

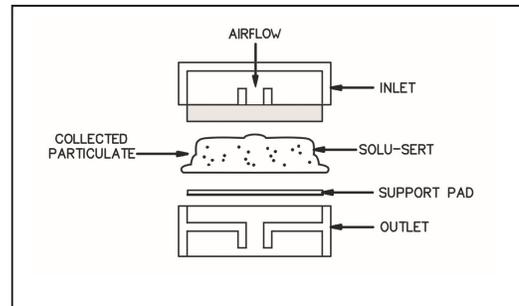
Several methods to account for wall deposits are available to the laboratory analyst:

- Rinsing the internal surfaces of the cassette and adding the rinsate to the filter sample preparation is a basic approach.
- Wiping the internal surfaces with an appropriate wipe medium and adding the wipe to the filter sample preparation is another approach. [8][9]
- In situ extraction of the cassette is third approach. [10][11][12]
- The use of a cellulosic cassette insert that is digestible by acidic "cocktails" typically used to digest the MCE filters is the most appealing and efficacious approach. [13][14][15]

Each of the alternatives described above need to be evaluated, taking into consideration the contaminant and the method of analysis. Each approach needs to be validated for recovery and ease of manipulation by laboratory personnel.

The Zefon Solu-Sert™ Solution

The Zefon Solu-Sert™ filter capsule is a self-contained filter “cassette capsule” that captures all particles collected by a filter cassette. It consists of an MCE filter membrane sealed to a cellulose shell to create the capsule. This capsule is then inserted into a Zefon 2-Piece filter cassette with a support pad as a complete unit. After sampling the entire capsule is removed, digested in an acid solution, and then analysis performed. This process eliminates the need to rinse or wipe the cassette interior to account for "wall deposits" and makes it ideal for performing airborne metals analysis.



Benefits

- Recommended by NIOSH as a viable method of accounting for cassette wall deposits.
- All particulate entering the cassette is collected and captured within the filter insert.
- Easier to process in the laboratory than rinsing or wiping cassette walls.
- Lightweight design keeps the content of cellulose acetate plastic used low, contributing to less background and improved limit of detection.
- More reliable than rinsing internal cassette walls [8]
- Less time consuming than wiping. Studies have shown it can sometimes take more than 1 wipe to effectively account for the entire sample.

FAQ

Q1. Why should I be concerned about cassette wall deposits?

A1. Studies have shown that a significant portion of the sample collection may be adhering to the walls of a cassette. By not including the deposits on the cassette walls in your sample results, your sample

results are being under reported. In a typical 37mm 2-Piece cassette, up to 32% of the sample may be adhering to the wall. In a 37mm 3-Piece cassette this number increases to up to 55%. References to numerous studies supporting this are included at the end of this document.

Q2. Is inclusion of cassette wall deposits a recommendation, or an enforceable requirement?

A2. As of August 2013, this varies by agency, however it is projected that in due time all agencies will make it mandatory as standards get updated. NIOSH has begun by publically making this a recommendation, and has indicated they are starting the process of revising the 30+ methods affected by this recommendation. For sampling to OSHA standards compliance, accounting for cassette wall deposits is already mandatory for metals analysis. Standards agencies ASTM and ISO are also in the process of adding this requirement to their standards.

Q3. Why should I consider using the Solu-Sert over some of the other methods available to account for wall deposits, such as wiping or rinsing?

A3. Wiping and rinsing are certainly options. However rinsing in particular has shown to not be very effective and publicly stated so by OSHA[8]. This forces laboratories who choose to use the rinse the burden of demonstrating its effectiveness. Wiping the cassette interior is also an option. In some cases it can take more than 1 wipe to collect the majority of the deposits. What Solu-sert offers to a lab is time, a process that eliminates the human error variable of improper technique, and a process that works without having to demonstrate its effectiveness. The amount of time to prepare a Solu-Sert is substantially less than wiping or rinsing. It's a better method that takes less time.

Q4. Is the Solu-Sert™ the same as the Accu-Cap product from SKC?

A4. No. The Solu-Sert™ is fully digestible. As of September 2013, there is no other fully digestible filter capsule product commercially available that we are aware of. There are however references in literature to an Accu-Cap product that is digestible. To the best of our knowledge these were prototypes of a future product which at this time has not been made commercially available.

Q5. Can the Solu-Sert be used for gravimetric sampling?

A5. No. The Solu-Sert™ shell is manufactured from a cellulose acetate material that is very hydroscopic. Thus weight reproducibility would be problematic. Zefon has a different cassette capsule made from PVC called Gravi-Sert. It is specifically designed for gravimetric analysis.

Q6. Why is the shell of the Solu-Sert so lightweight?

A6. This is by design. Use of the smallest amount of material possible is ideal for this purpose. It keeps any potential analysis interference to a minimum and allows the limit of detection for nearly all elements to be extremely low.

Q7. Which NIOSH methods can be used with Solu-Sert?

A7. Solu-Sert™ is suitable for collecting the following contaminants:

Contaminant	NIOSH Method
Aluminum	7013
Arsenic	7900
Barium	7046
Beryllium	7102
Cadmium	7048
Chromium	7024
Cobalt	7027
Copper	7029
Elements	7300, 7301 & 7303
Lead	7082 & 7105†
Tungsten	7074
Zinc	7030

†= Blanks may have to be determined prior to analysis

Q8. What type of background metal content is typical on a Solu-Sert?

A8. Solu-Serts have been shown to exhibit background levels at or below the detection limit of 25 elements. Measurable background levels of Ca, Mg and P, have been detected, however these levels are not significant in relation to the exposure limit for e.g., Ca, (OH)₂, MgO or H₃PO₄. These findings were reported by NIOSH in a recent presentation [15].

Actual levels may vary slightly from lot to lot of material. As part of a normal laboratory quality program laboratories must validate background levels of each lot they intend to use. To assist laboratories with this, Zefon purchases raw materials in large lots to help maintain consistency over long periods of time. In addition, laboratories who wish to purchase in quantities of 1,000 unit or more, Zefon will arrange to build the entire shipment from the same raw lots of filter membrane and shell material for the entire order. Please contact your Zefon salesperson to discuss this if interested.

Q9. Why can't I use a capsule made from PVC?

A9. A PVC capsule is not suitable for the acid digestion required for analysis. You can digest a PVC filter, but the shell will not be digested.

Q10. Who is "Air Sampling Devices, LLC"?

A10 The Solu-Sert was designed by the founder of Air Sampling Devices, LLC, Eli Smyrloglou. As such, some reference material and presentations that have been published mention Solu-Sert and its association with Air Sampling Devices. Zefon has since purchased the Solu-Sert product line from Air Sampling Devices LLC and taken over manufacturing of the product. This is enabling Mr. Smyrloglou to continue his mission of developing specialty air sampling devices. Mr Smyrloglou is an expert in membrane filtration and many other aspects of industrial hygiene sampling. He is still involved with the Solu-Sert product and is a technical consultant to Zefon.

Prior to founding Air Sampling Devices, Eli Smyrloglou founded Omega Specialty Instruments in 1982 and served the industrial hygiene community in various capacities for 21 years.

[1] Baron, P.A.: Factors affecting aerosol sampling NIOSH Manual of Analytical Methods (Chapter O) Cincinnati OH NIOSH 2003

[2] OSHA method PV2121. Sampling and Analytical Methods Sandy, UT OSHA 2003
www.osha.gov/dts/sltc/methods

[3] Demange, M., J.C. Gendre, B. Herve-Bazin, B. Carton and A. Peltier: Aerosol evaluation difficulties due to particle deposition on filter holder inner walls. Ann. Occup. Hyg. 34: 399-403 (1990)

[4] Demange, M., P. Gorner, .M.Elcabache and R. Wrobel: Field comparison of 37mm CFC and IOM samplers. Appl. Occup. Environ. Hyg. 17:200-208 (2002)

- [5] Dobson, L.,L. Reichmann and D. Popp: Evaluation of quartz residue on cassette interiors of AIHA proficiency samples. J. ASTM Int .2(4); DOI; 10.1520/JAI12229(2005)
- [6] Puskar, M.A., J.M. Harkins, J.D. Moomey and L.H. Hecker: Internal wall losses of pharmaceutical dusts during closed face 37mm polystyrene cassette sampling, Am. Ind. Hyg. Assoc. J. 52: 280-286 (1991)
- [7] Harper, M., and M. Demange: Concerning sampler losses in the chemical analysis of airborne metals. J. Occup. Environ Hyg. 4 D81-D86 (2007)
- [8] Hendricks, W.,F. Stones, and D. Lilquist: On wiping the interior walls of 37mm CFC's An OSHA perspective. J. Occup Environ. Hyg 6, 732-34 (2009)
- [9] OSHA: methods ID-121, ID 125g and ID-215. Osha Sampling and Analytical Methods. Sandy, UT: OSHA, (2008)
- [10] Ashley, K., R.N. Andrews, L. Cavazos, and M. Demange: Ultrasonic extraction as a sample preparation technique for elemental analysis by atomic spectrometry. J. Anal. At. Spectrom. 16:1147-53(2001)
- [11] Ashley,K.,G.T.Applegate,A.D.Marcy,P.L.Drake,P.A.Pierce,N.Carabin,and M.Demange: Evaluation of sequential extraction procedures for soluble and insoluble hexavalent chromium compounds in workplace air samples J. Environ. Monit. 11: 318-325 (2009)
- [12] Institut Naional de Recherche et de Securite (INRS): Metaux- Metalloides (Fiche 003). Metrologie des Polluants- Evaluation de L'Exposition Professionnelle - Methodes de Prelevement et d'Analyse de l'Air. Paris : INRS (2009)
- [13] Volkwein, j.C., A.D. Maynard and M. Harper: Workplace aerosol measurement(chap 25). In aerosol Measurement- Principles, Techniques, and Applications, 3rd ed.; P.Kulkarni, P.A.Baron, and K. Willeke, Eds. New York: Wiley, 2011
- [14] Harper, M., and K. Ashley: Preliminary studies on the use of acid-soluble cellulose acetate internal capsules for workplace metals sampling and analysis. J. Occup. Environ. Hyg. 9:7,D125-D129, 2012
- [15] Harper, M., and K. Ashley: Guidelines for Aerosol Sampling Presentation.
https://bhsc.llnl.gov/documents/04_13_BHSC_Meeting/NIOSH_Guidelines_for_Aerosol_Sampling_MartinHarper.pdf