

PASSIVE INTEGRATIVE MERCURY SAMPLER (PIMS)

The PIMS (U.S. patent no. 6,129, 843) is an effective alternative to conventional sampling for mercury vapor (Hg^0) and is highly suitable for long-term unattended sampling. It consists of a semi-permeable polymeric membrane containing a mercury-sequestering reagent sealed inside (Figure 1). Because mercury vapor readily permeates the membrane and is rapidly oxidized and stabilized inside the membrane, sampling intervals of weeks to months are possible. The PIMS sampling reagent is amenable to direct analysis for mercury (no chemical treatment required) by conventional methods (AA, AF, or ICP-MS) with virtually no interferences. Preliminary results indicate that the PIMS is also applicable for water sampling of neutral mercury species.

Features:

- Passive sampling requires no pumps, traps, or electrical power.
- Integrative sampling for up to 90 days.
- Clean-room mercury facilities generally not required.
- Particularly useful for applications requiring unattended sampling for extended periods at remote locations.
- Sampler reagent is conveniently analyzed for mercury directly by ICP-MS, CVAf, or CVAA without chemical treatment.
- Simple alternative for Hg vapor screening and detection; sampling precision ~ 5-10% RSD.
- Potentially applicable for gaseous Hg sampling in soil and water.

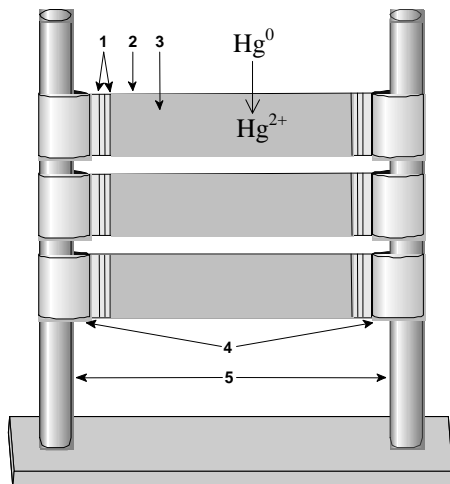


Figure 1. Free-standing PIMS configuration (left) for environmental air sampling of Hg vapor. 1 = heat seals, 2 = polyethylene layflat tubing, 3 = Hg-stabilizing reagent inside sampler, 4 = tether loops, 5 = stainless steel rods. Stainless steel canister configuration (right) for hanging or underwater deployment contains up to five individual 7.5 x 2.5-cm PIMS, mounted in an alternating 90-degree orientation.

Temperature Dependence. The sampling rate (volume of air quantitatively sampled per unit time) increases linearly with temperature (Figure 2). However, accurate temperature measurement during sampling is usually unnecessary because the dependence is not great. For example, the sampling rate at 20 °C is only about 25% higher than at 10 °C. In cases where the temperature cannot be estimated or if large temperature fluctuations are anticipated, a digital temperature data logger can be attached to the deployment canister.

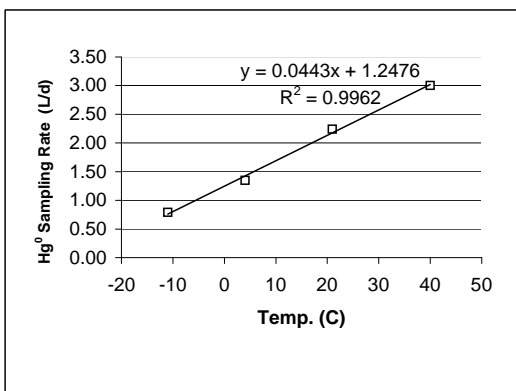


Figure 2. PIMS sampling rate of Hg⁰ as a function of temperature.

Comparison to conventional air sampling. In a separate 4-week study, the PIMS sampling approach was compared with the conventional pump-and-trap method at a site near a probable Hg emission source. The overall 4-week mean Hg air concentration (± 1 s.d.) for the PIMS, estimated from experimentally-determined sampling constants was 5.2 ± 1.8 ng/m³ (n=5) as compared with 5.1 ± 2.8 ng/m³ (n=8) measured for semi-weekly one-hour pump-and-trap sampling.

Long-term air monitoring. Long-term air sampling of Hg by the PIMS in the vicinity of a coal-fired power plant over a 12 week interval is illustrated in Figure 3. Triplicate samplers retrieved after 4, 8, and 12-week intervals were in good agreement with the corresponding sums of separate 4-week samples, indicating that the sampling was nearly linear over the entire 12-week interval (the air concentration decreased slightly during the 12 weeks). The mean air concentration of Hg vapor determined by PIMS sampling was 25 ng/m³ over this time interval. Blank concentrations have been reduced substantially since this experiment.

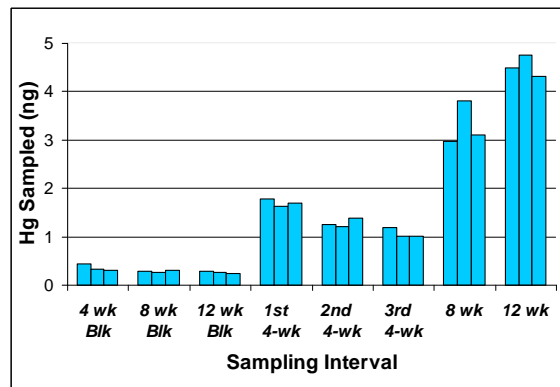


Figure 3. PIMS sampling of Hg from air near a coal-fired power plant over a 12-week period. (Blk = PIMS method blank sealed in a glass jar)

Water sampling. Results from a preliminary field study indicate that the PIMS is effective for sampling gaseous Hg, and possibly other neutral Hg species from water. A four-week PIMS deployment in a mercury-contaminated stream produced concentration factors of greater than 100 (concentration of Hg in PIMS reagent divided by concentration of total Hg in filtered water). The mean mass of Hg sequestered by PIMS at different deployment sites ranged from 0.68 to 1.86 ng and the within-site precision for replicate PIMS averaged 15% RSD. Blank PIMS (n=5) contained Hg near the atomic fluorescence detection limit (0.5 ng/L or 0.0025 ng/PIMS).

References:

1. Brumbaugh, W.G.; Petty, J.D.; May, T.W.; Huckins, J.N. 2000. A passive integrative sampler for mercury vapor in air and neutral mercury species in water. *Chemosphere: Global Science Change* 2:1-9.
2. Petty, J.D.; Brumbaugh, W.G.; Huckins, J.N.; May, T.W. 2000. U.S. patent no. 6,129,843, Device for the removal and concentration of neutral mercury species from air and water.

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