Manual Atmospheric Mercury Sampling

Asia Pacific Mercury Monitoring Network

Center for Environmental Monitoring and Technology
National Central University

Reference

EPA/625/R-96/010a

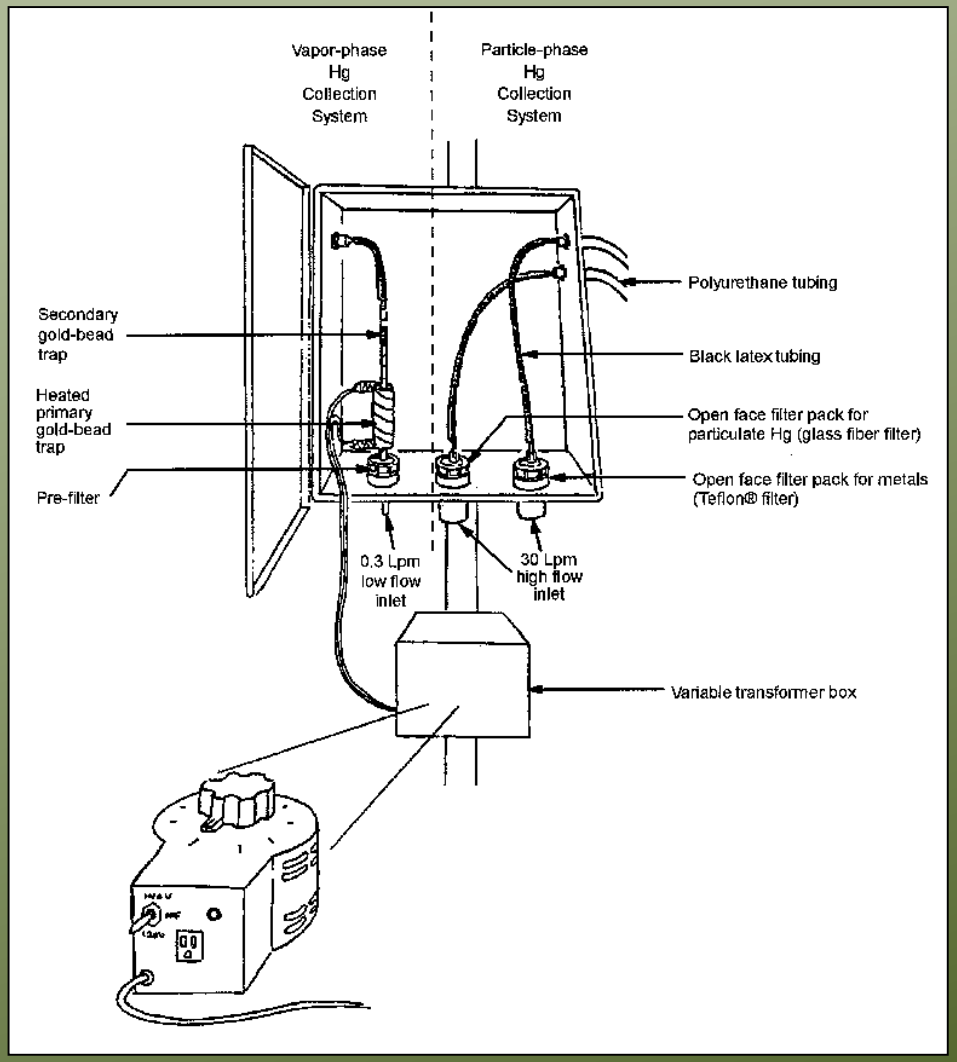
Compendium of Methods
for the Determination of
Inorganic Compounds
in Ambient Air

Chapter IO-5

SAMPLING AND ANALYSIS
FOR ATMOSPHERIC MERCURY

Center for Environmental Research Information
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH 45268

June 1999



Method Summary

- The collection of mercury, from ambient air in the vapor and particulate phase, involves use of gold-coated bead traps and glass-fiber filters.

- Vapor-phase Hg is collected using gold-coated glass bead traps. Air is pulled through the vapor-phase sampling system using a mass-flow controlled vacuum pump at a nominal flow rate of 0.3 Lpm.

Method Summary

- Particle-phase Hg is collected using a glass-fiber filter in an open-faced Teflon® filter pack. Air is pulled through the particulate sampling system using a vacuum pump at a nominal flow rate of 30 Lpm.

- The detection limits achieved using Method IO-5 are 30 pg/m^3 for particulate Hg and 45 pg/m^3 for vapor mercury.

Definitions

- Particle-phase Hg is collected using a glass-fiber filter in an open-faced Teflon® filter pack. Air is pulled through the particulate sampling system using a vacuum pump at a nominal flow rate of 30 Lpm.

- The detection limits achieved using Method IO-5 are 30 pg/m^3 for particulate Hg and 45 pg/m^3 for vapor mercury.

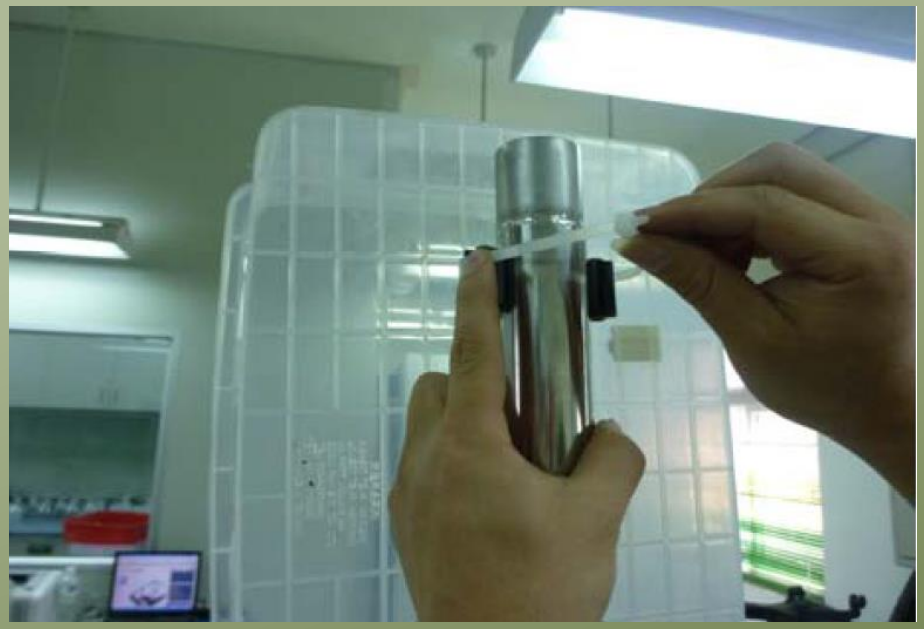
Equipment

Flow control box

- Pump
- Needle Valve
- Mass Flow Meter
- Exhaust fan

Set Up

Set up the sampling box/Shelter



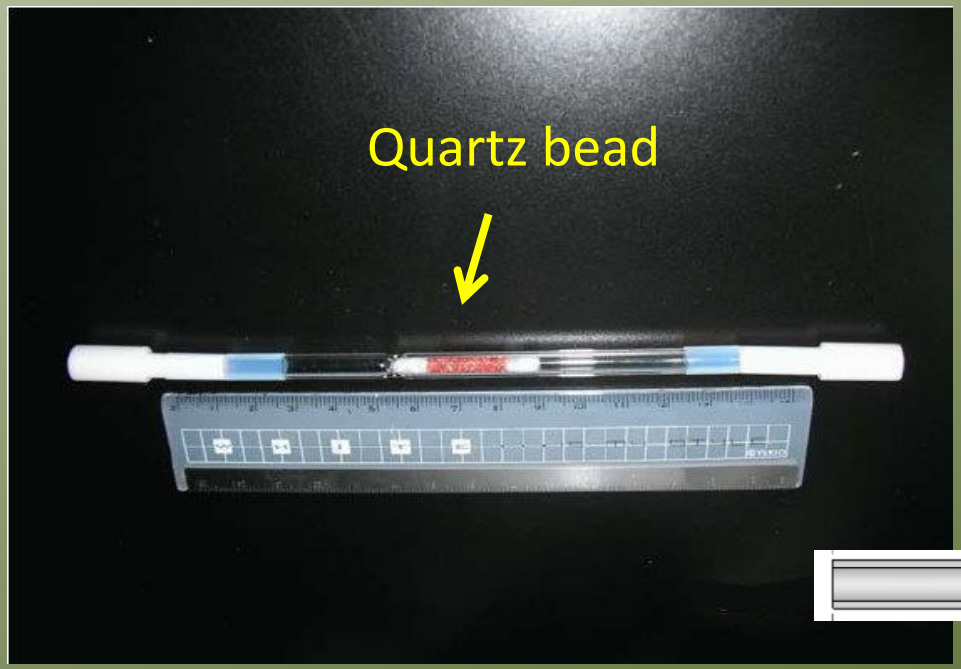
Set Up

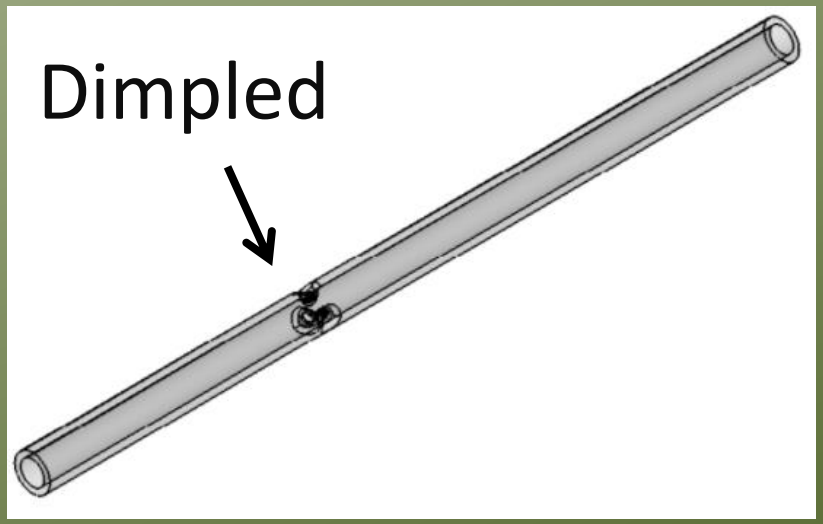
Connect and fix tubing

Developed Sample

Amalgamation cartridge

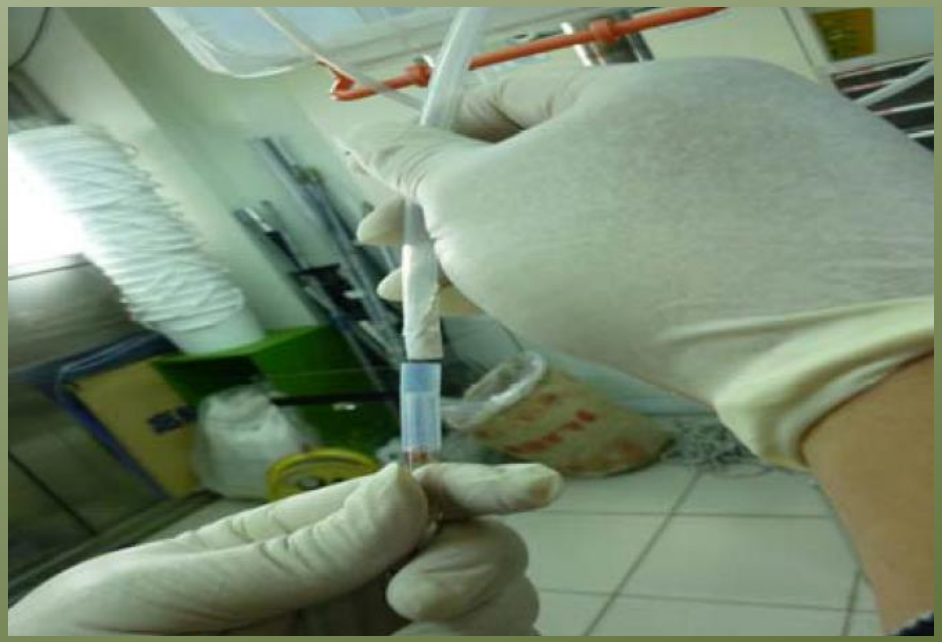
- Quartz glass tube
- Gold coated quartz bead
- Two traps as a set





Flow

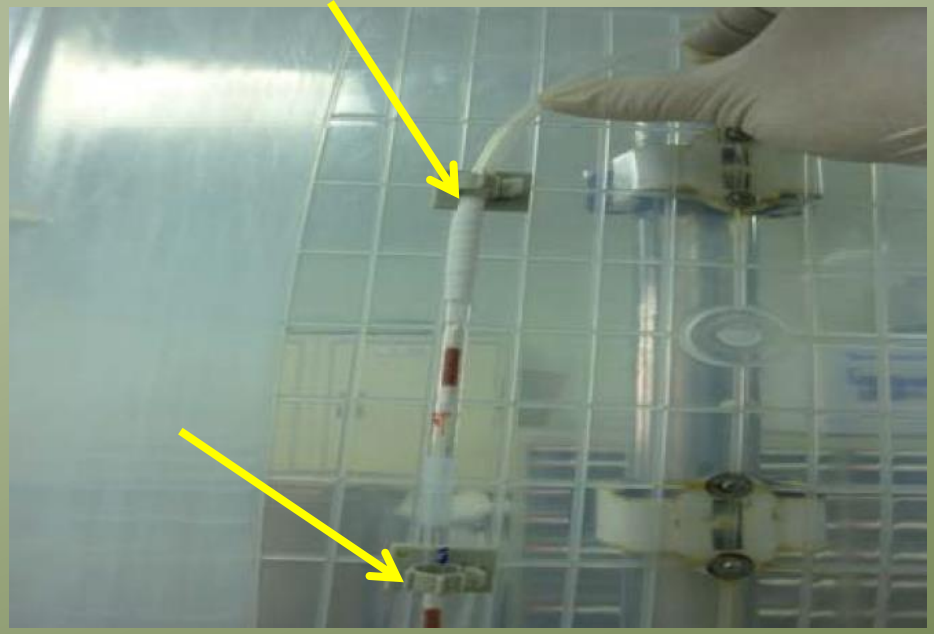
Developed Sample

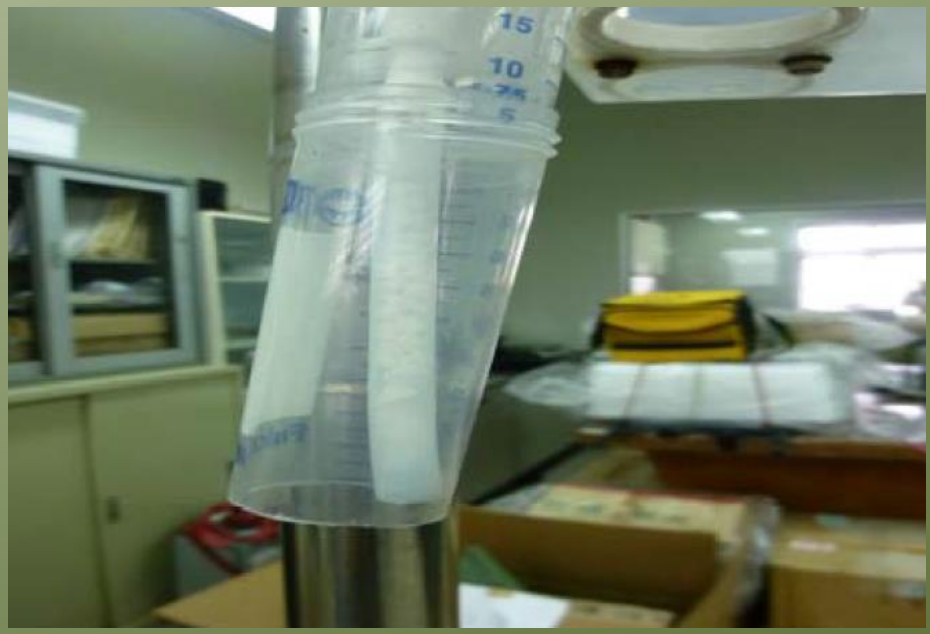


Pretrap/Sodalime

Developed Sample

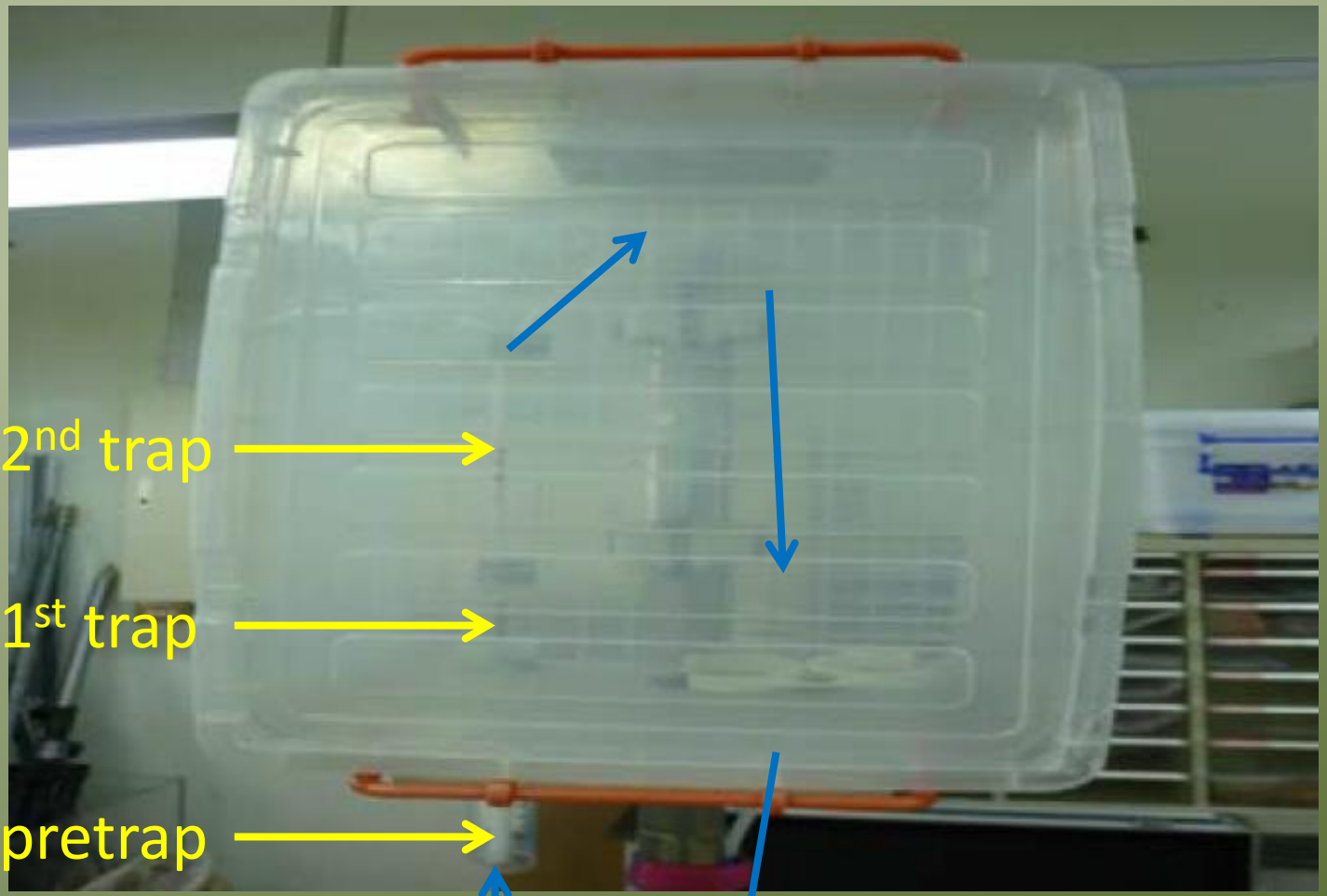
Secured for sampling trap



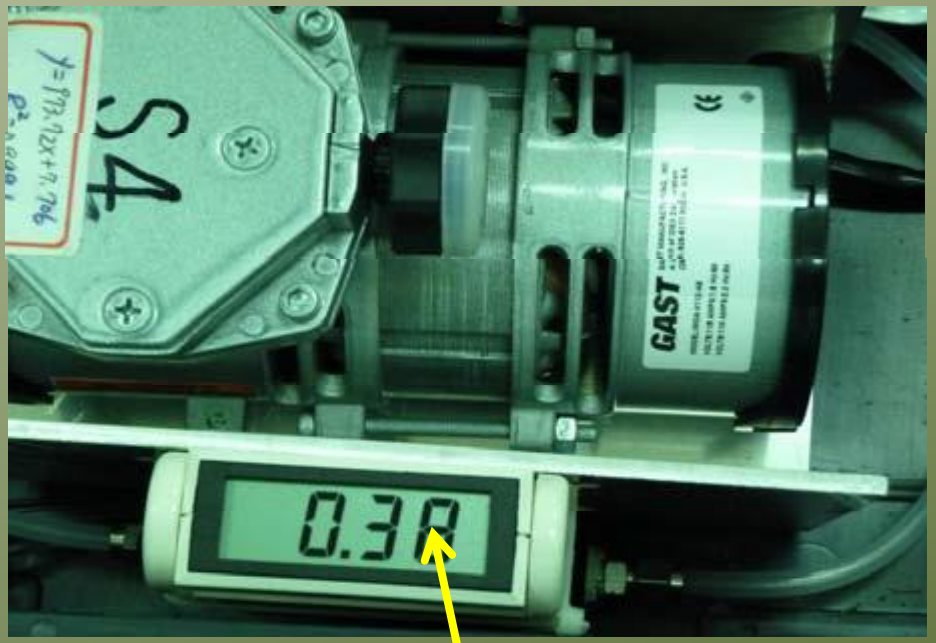


Prevent to take raindrop

Developed Sample



Sampling



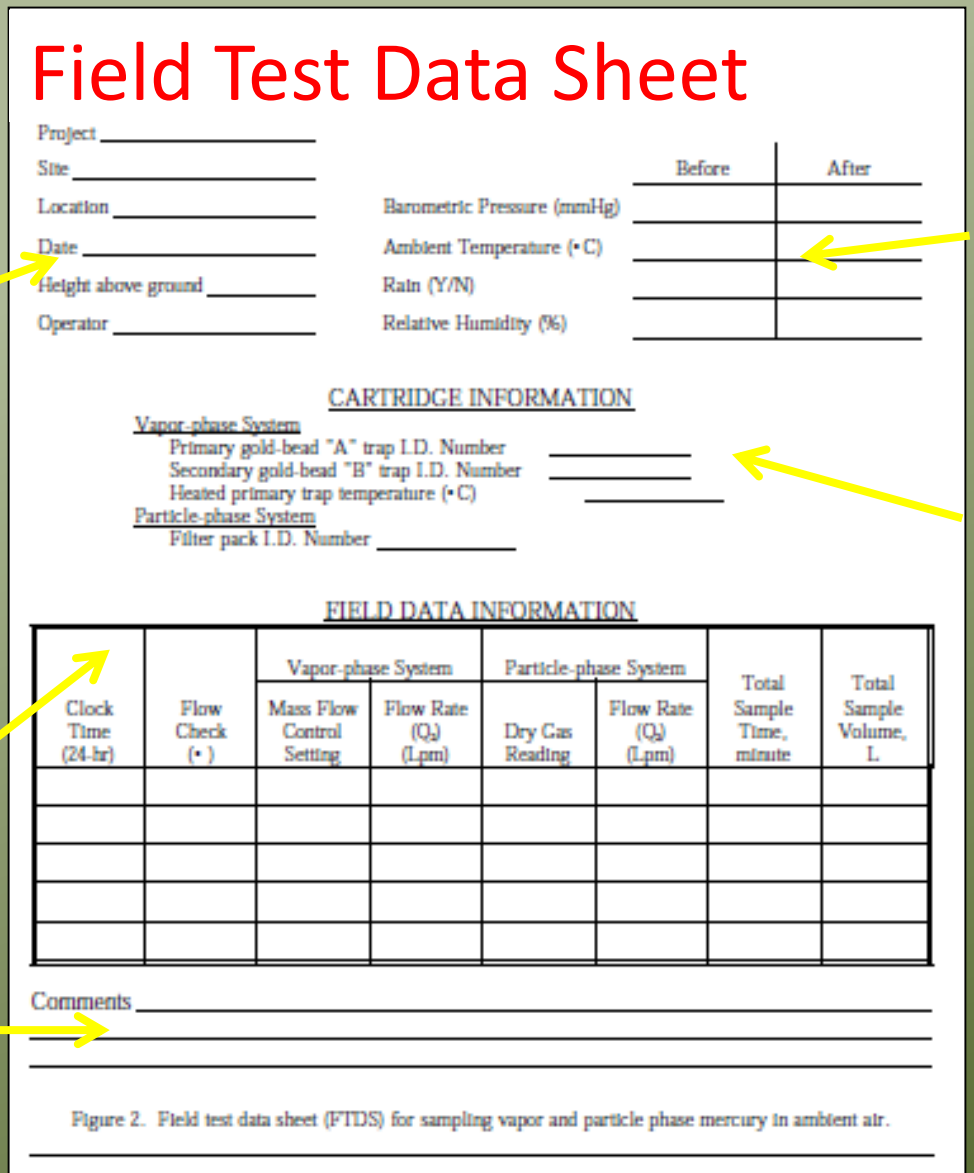
Needle valve

Adjust flow rate

Mass flow meter

~0.3 Lpm

Sampling



Field Test Data Sheet

Project _____

Site _____

Location _____

Date _____

Height above ground _____

Operator _____

	Before	After
Barometric Pressure (mmHg)		
Ambient Temperature (•C)		
Rain (Y/N)		
Relative Humidity (%)		

CARTRIDGE INFORMATION

Vapor-phase System
- Primary gold-bead "A" trap I.D. Number _____
- Secondary gold-bead "B" trap I.D. Number _____
- Heated primary trap temperature (•C) _____

Particle-phase System
- Filter pack I.D. Number _____

FIELD DATA INFORMATION

Clock Time (24-hr)	Flow Check (•)	Vapor-phase System		Particle-phase System		Total Sample Time, minute	Total Sample Volume, L
		Mass Flow Control Setting	Flow Rate (Q_s) (Lpm)	Dry Gas Reading	Flow Rate (Q_s) (Lpm)		

Comments _____

Figure 2. Field test data sheet (FTDS) for sampling vapor and particle phase mercury in ambient air.

General information

Met. data

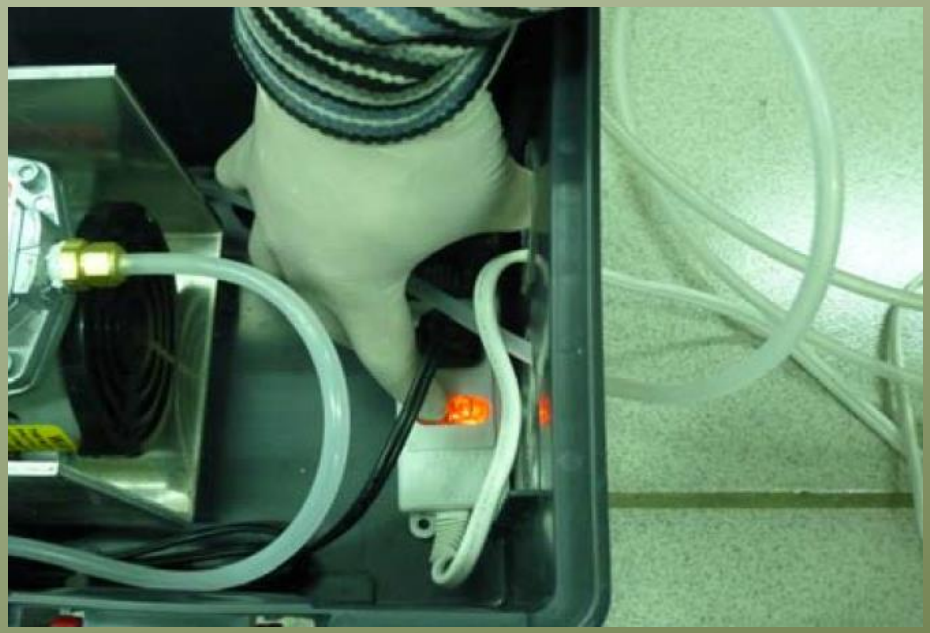
Cartridge/filter information

Field data

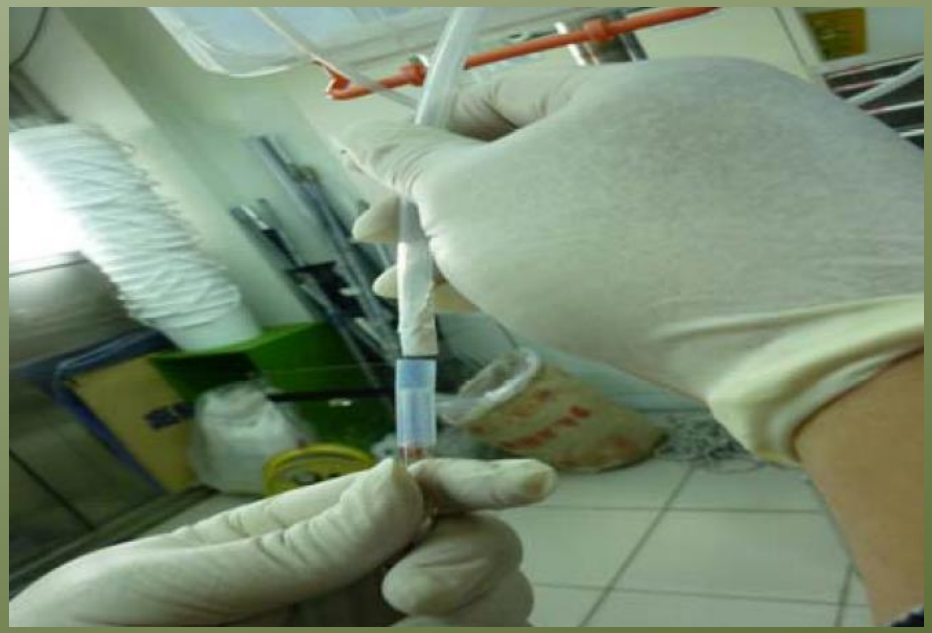
comments

Retrieve sample

Record flow rate and turn off pump



Disconnect tubing



Retrieve sample

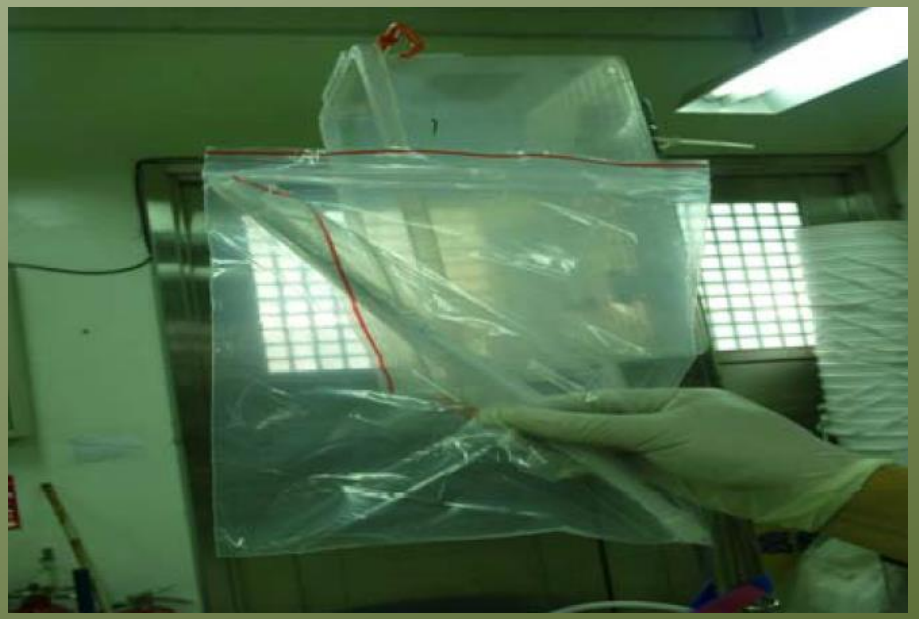
Remove pretrap

Cap with teflon sleeve

Retrieve sample

Seal ends

Pack with doudle PE bag

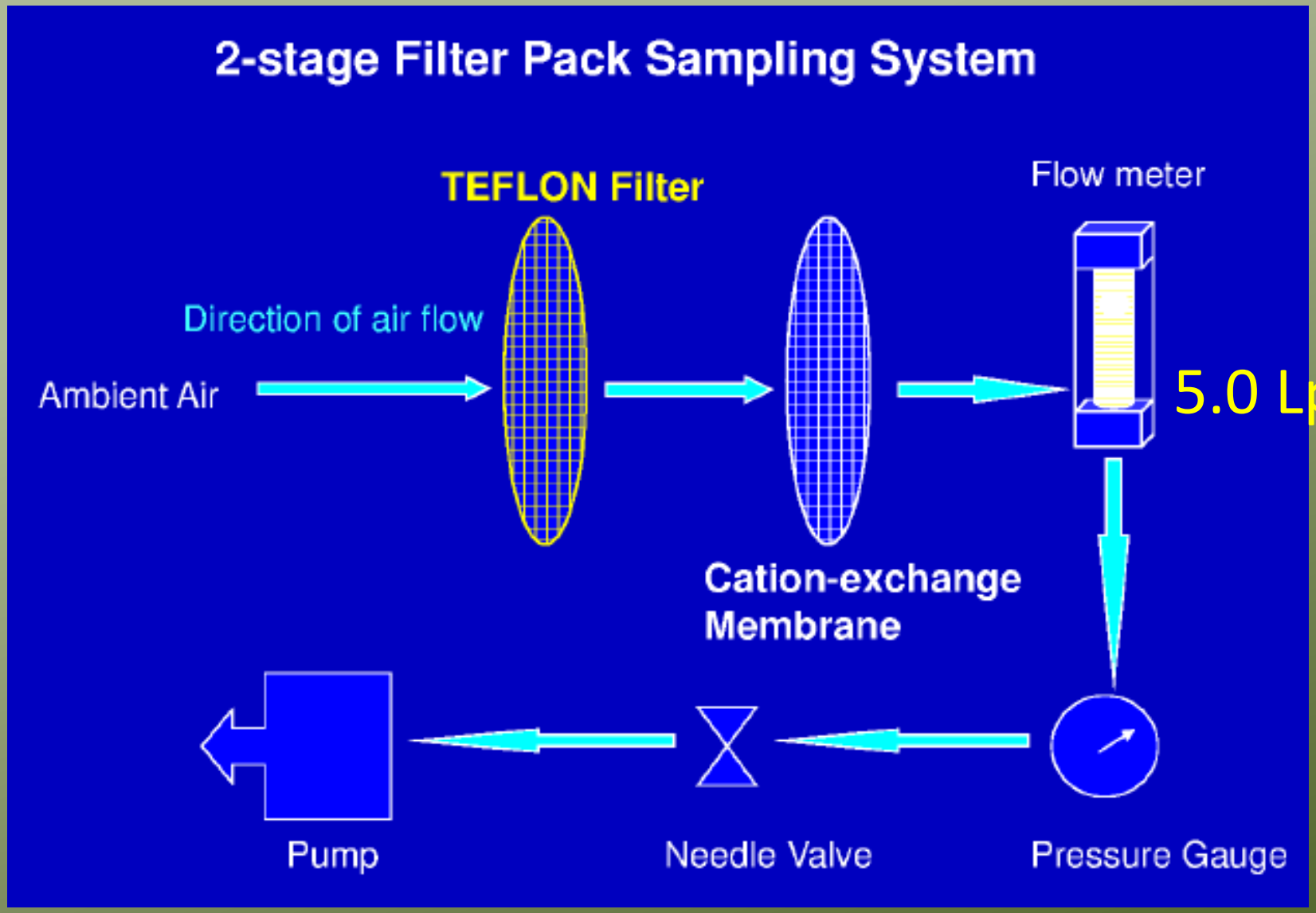


Retrieve sample

Name the sample

Ready for analysis !

Filter Sampling



Filter Sampling

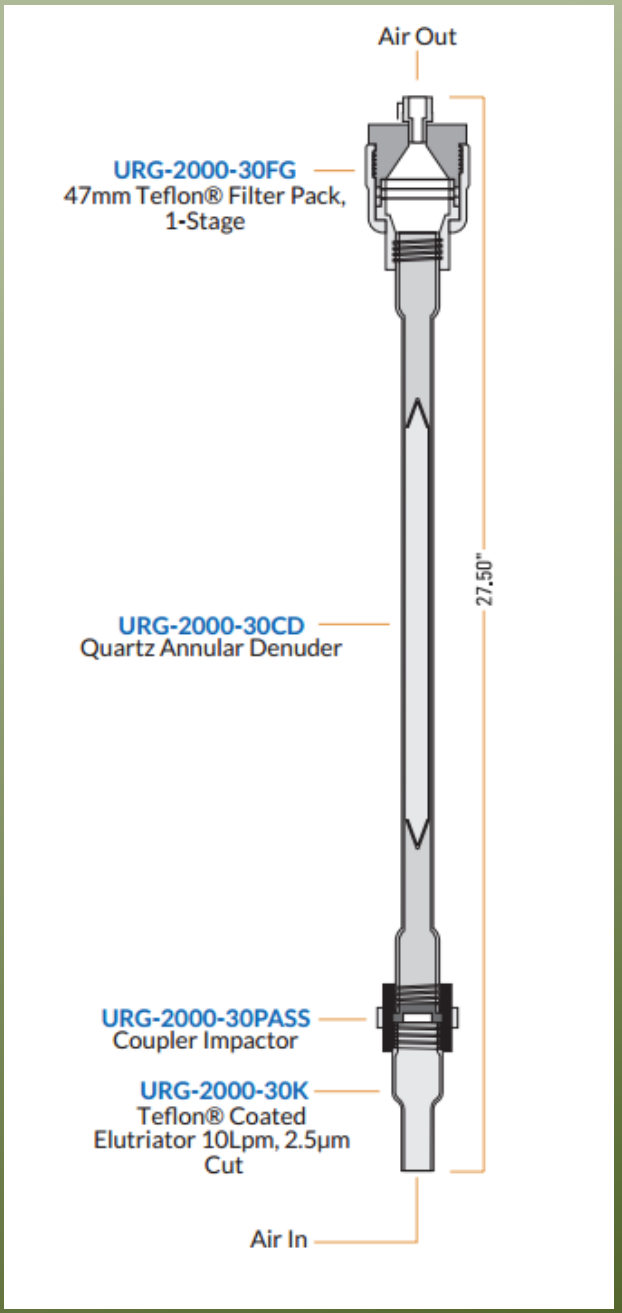
- Glass fiber
- Teflon (PTFE)
- Cation exchange membrane
- Nylon
- …

URG 3000M

Manual sampling instrument for RGM and PBM

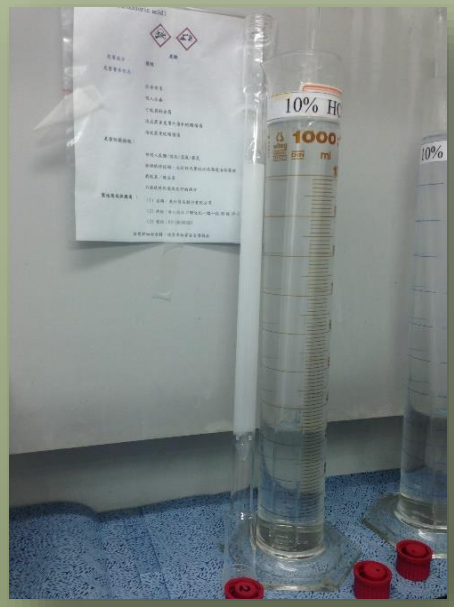
Introduction

URG Teflon coated $PM_{2.5}$ inlet coupled to a quartz annular denuder. The aerosol is collected on a URG 47 mm Teflon filter supported by a quartz or nickel screen. This sampling arrangement eliminates positive Hg(p) measurement artifacts.



Denuder coating

Acid cleaning

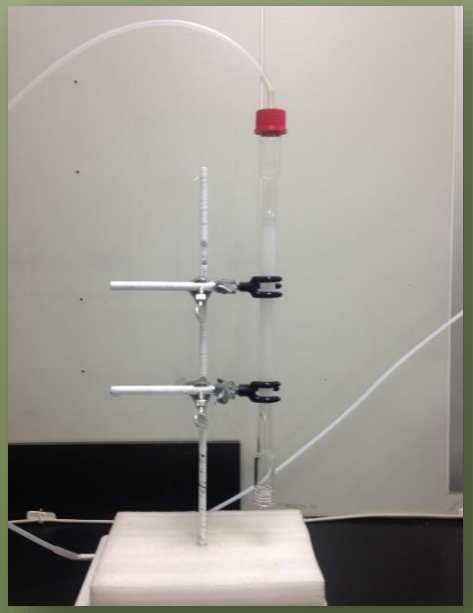


10% (v/v) HCl
72 hours

Rinsing

DIW (3~5 times)
Methanol

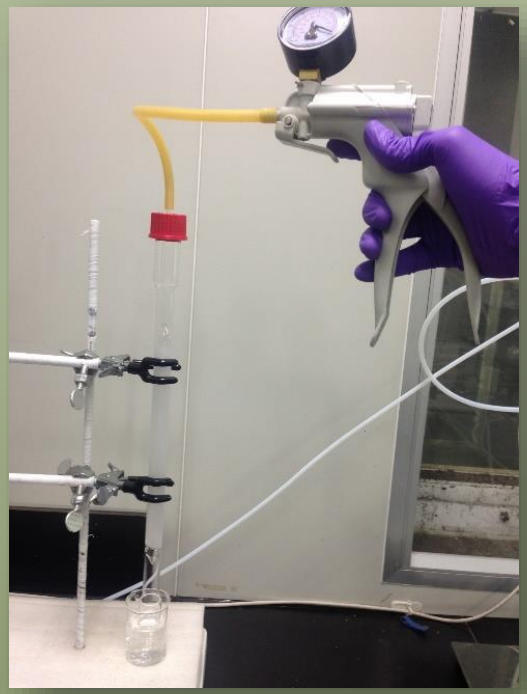
Drying



Ar supply

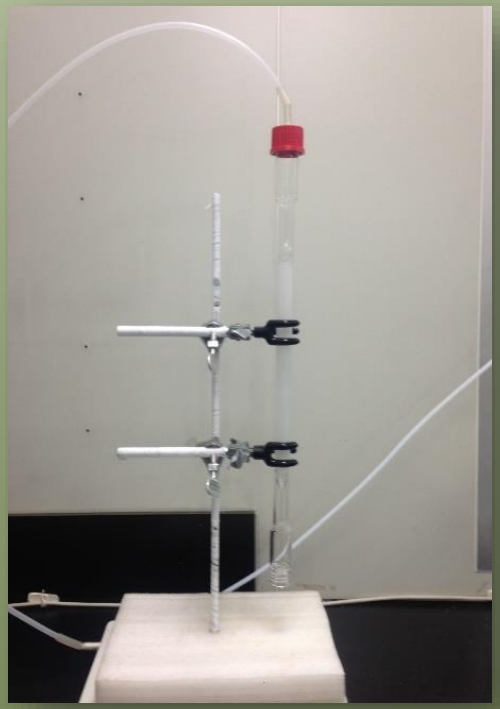
Denuder coating

Coating



3M KCl

Drying

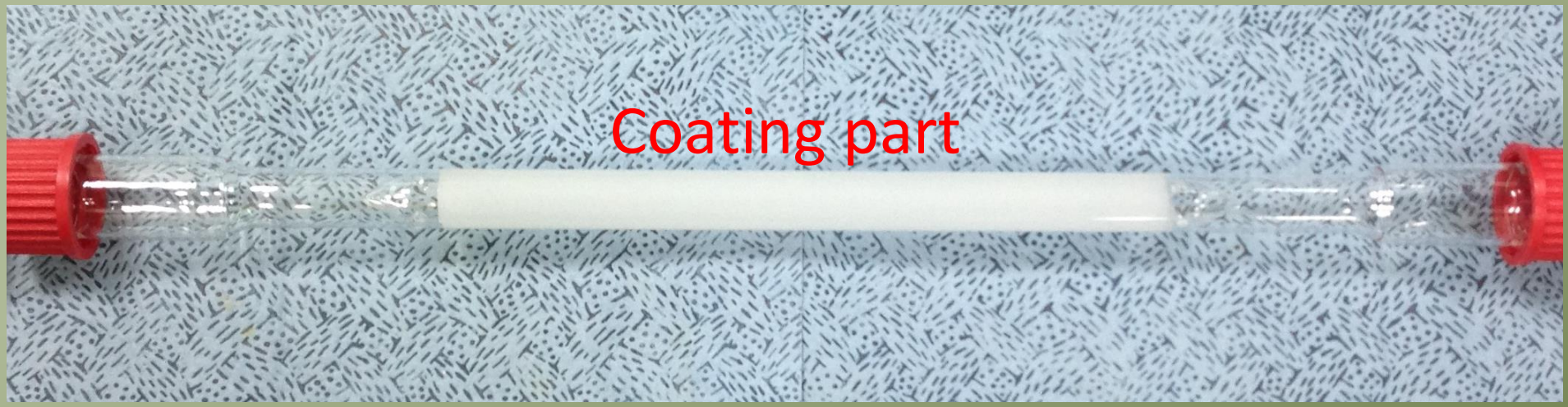


Ar supply

Blanking

Set 500℃,30mins
Ar purge

Denuder coating

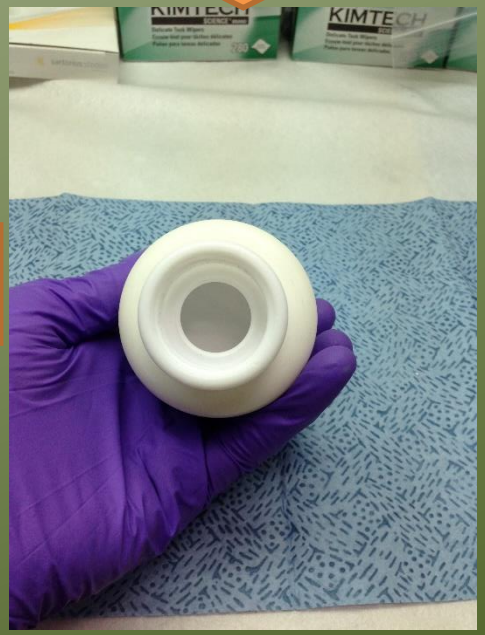


Ready for use

Cyclone and filter

Elutriator/Cyclone

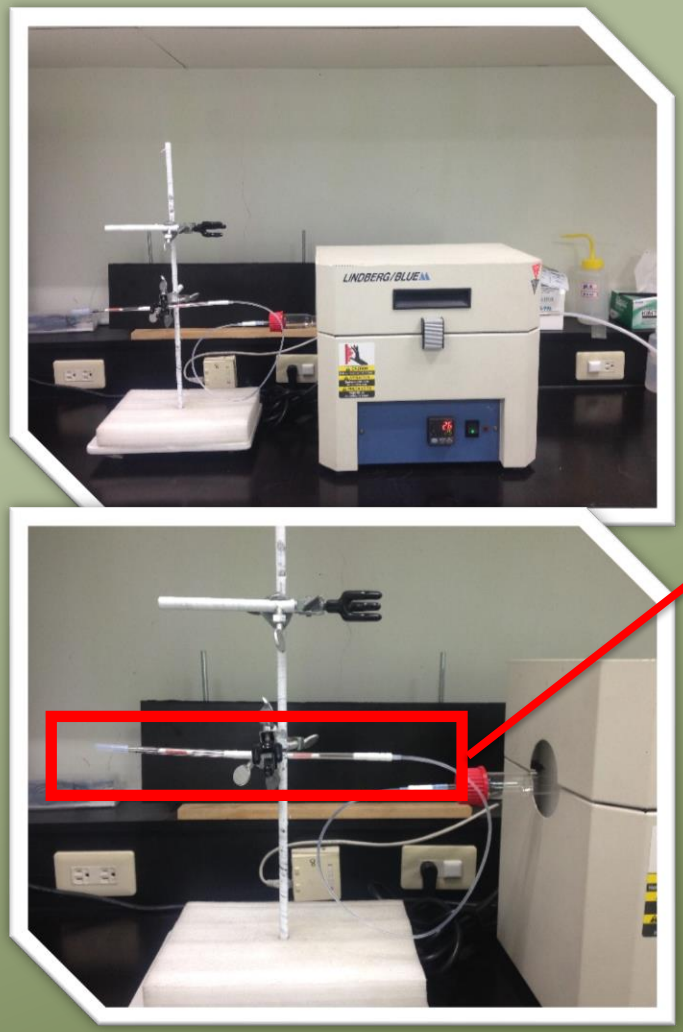
2.5 µm cut-off

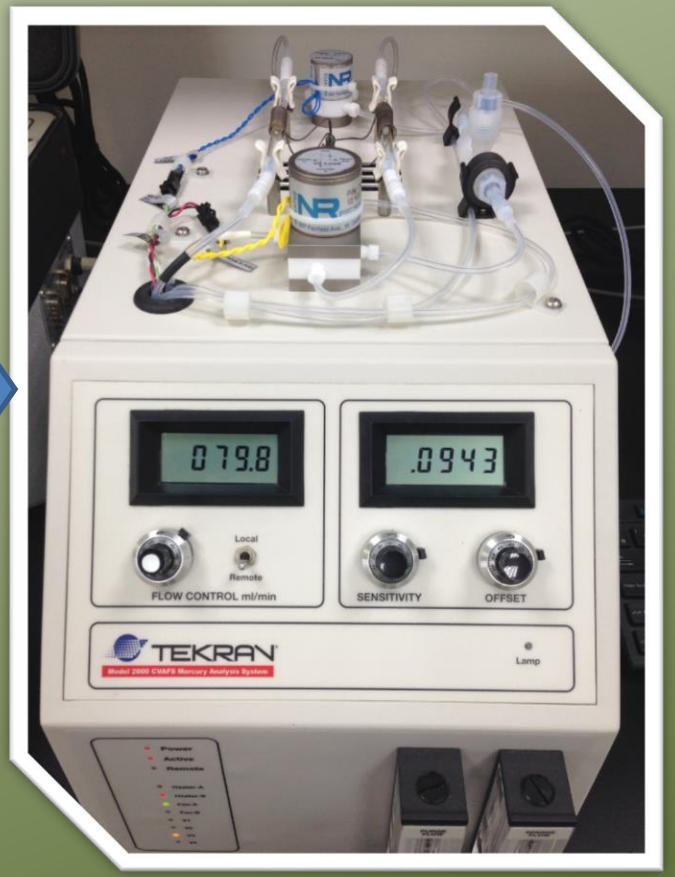


Setup and Sampling

Flow rate: 10 L/min

Thermal desorption

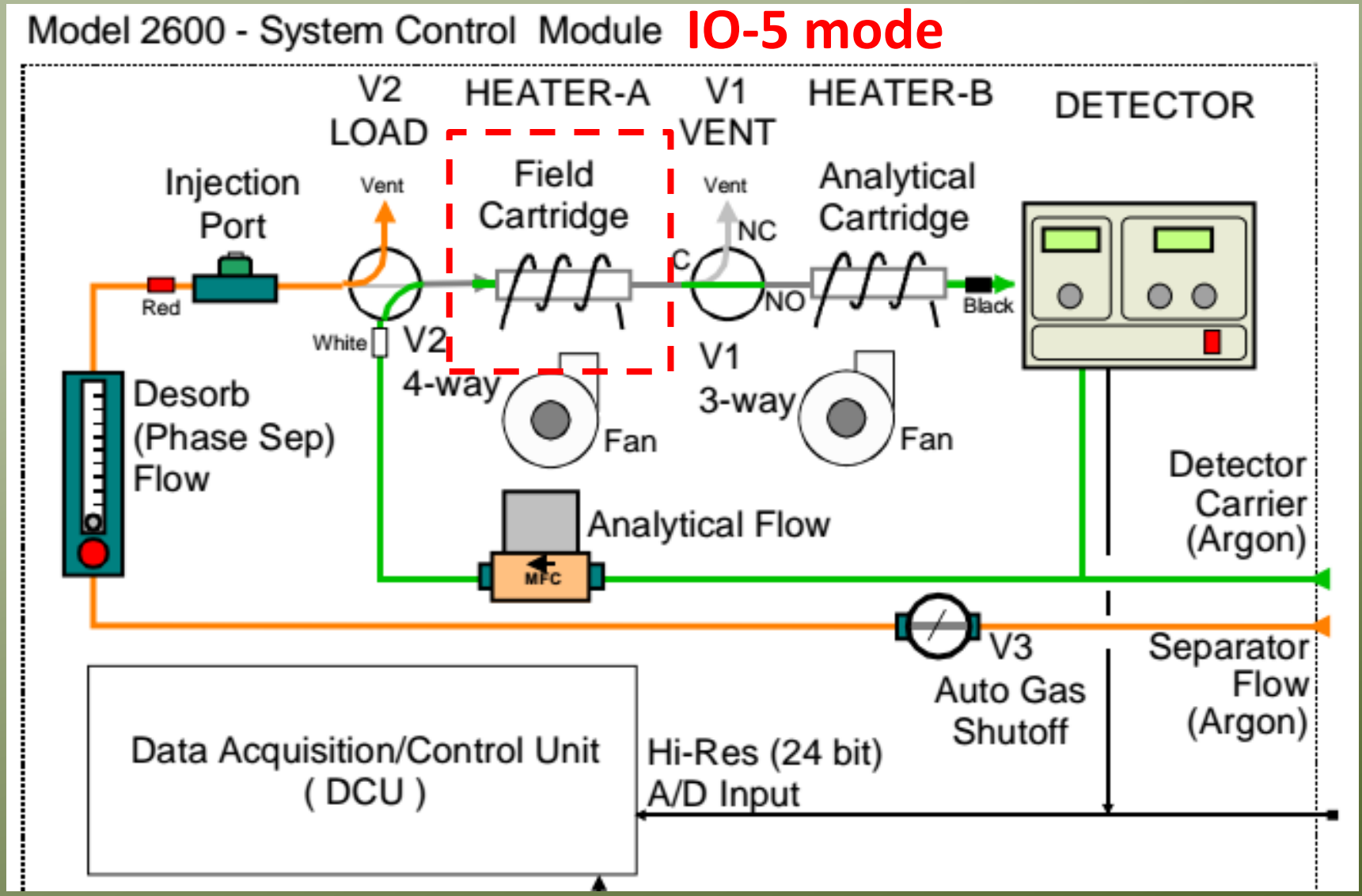




2600 analyzer

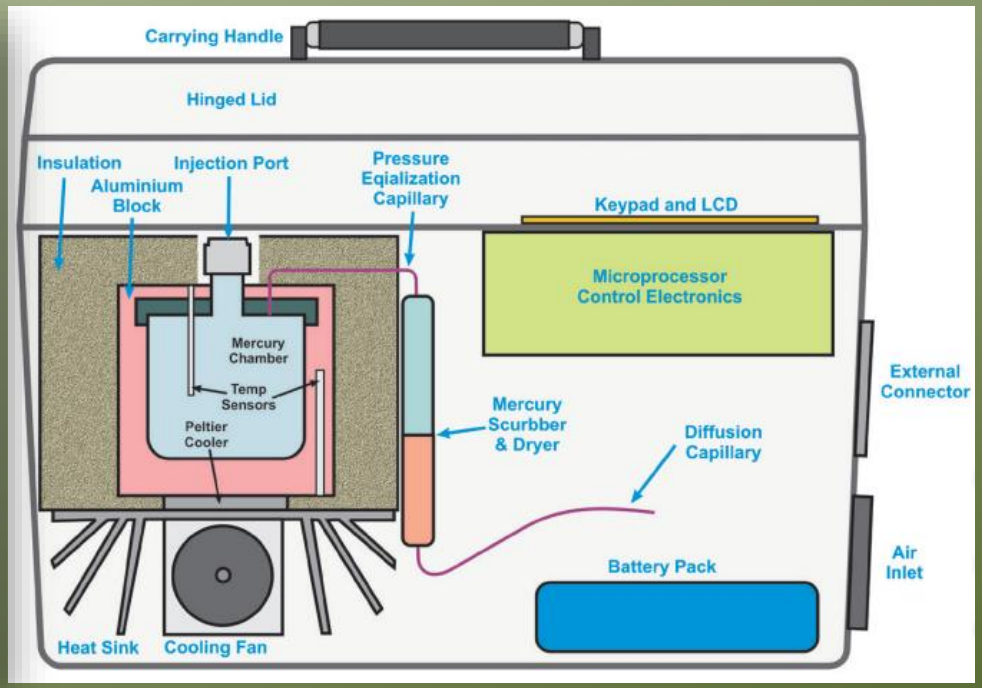
30 min; max temp: 500^{0}C; Ar : 0.3 Lpm

Flow Diagram



Mercury Vapor Primary Calibration Unit

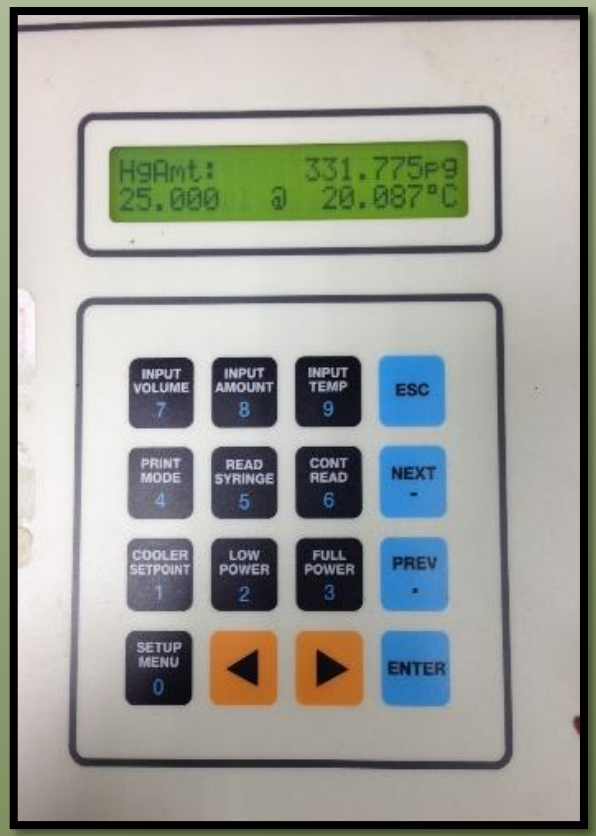
Tekran model 2505



IO-5 method operation

Calibration curve and duplicate

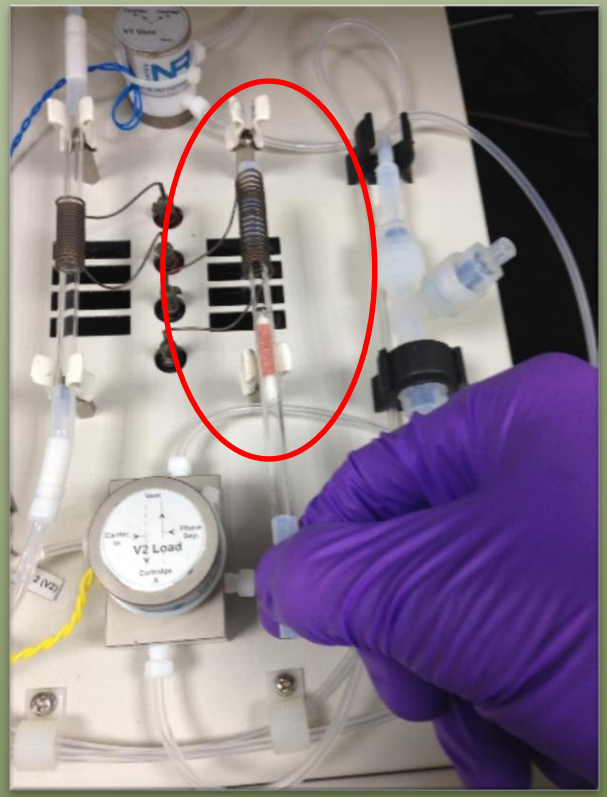
1, 5, 10, 25, 50, 75, … µL



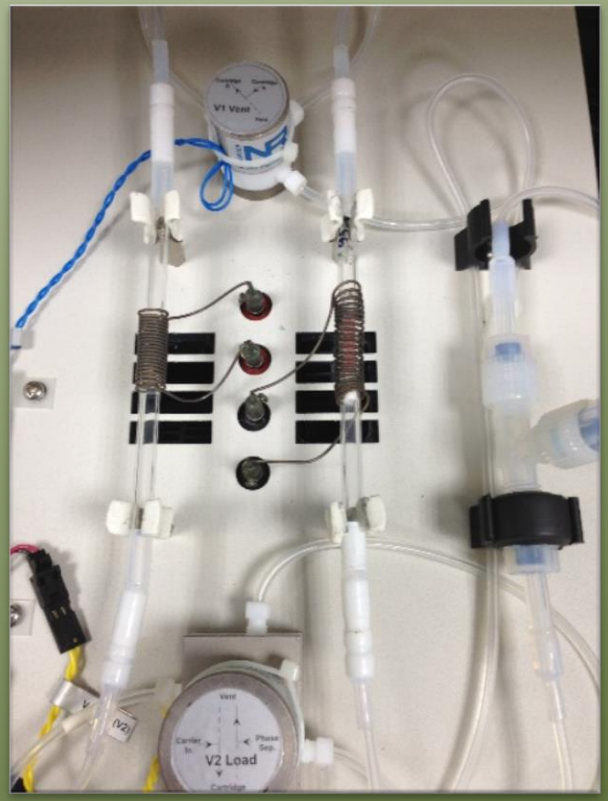
IO-5 method operation

Sample analysis

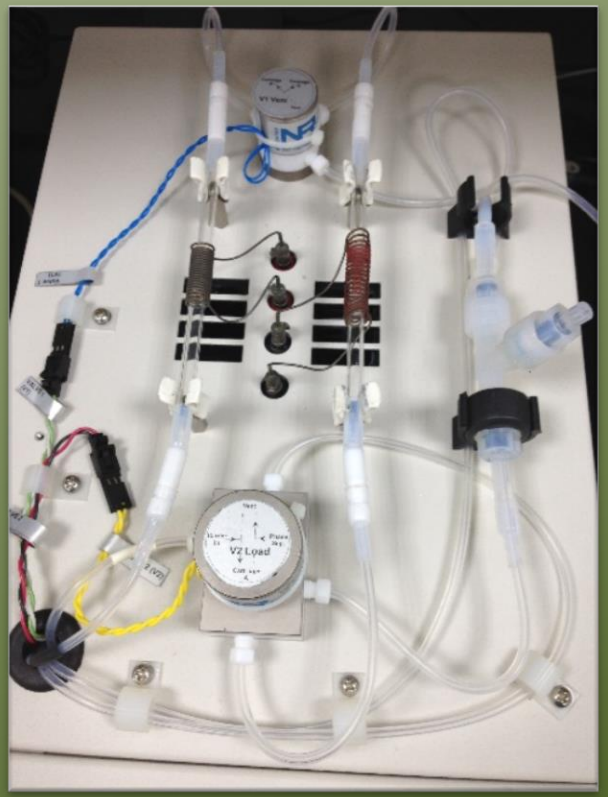
Remove the original trap



Connect the sampling trap



Heating



IO-5 method operation

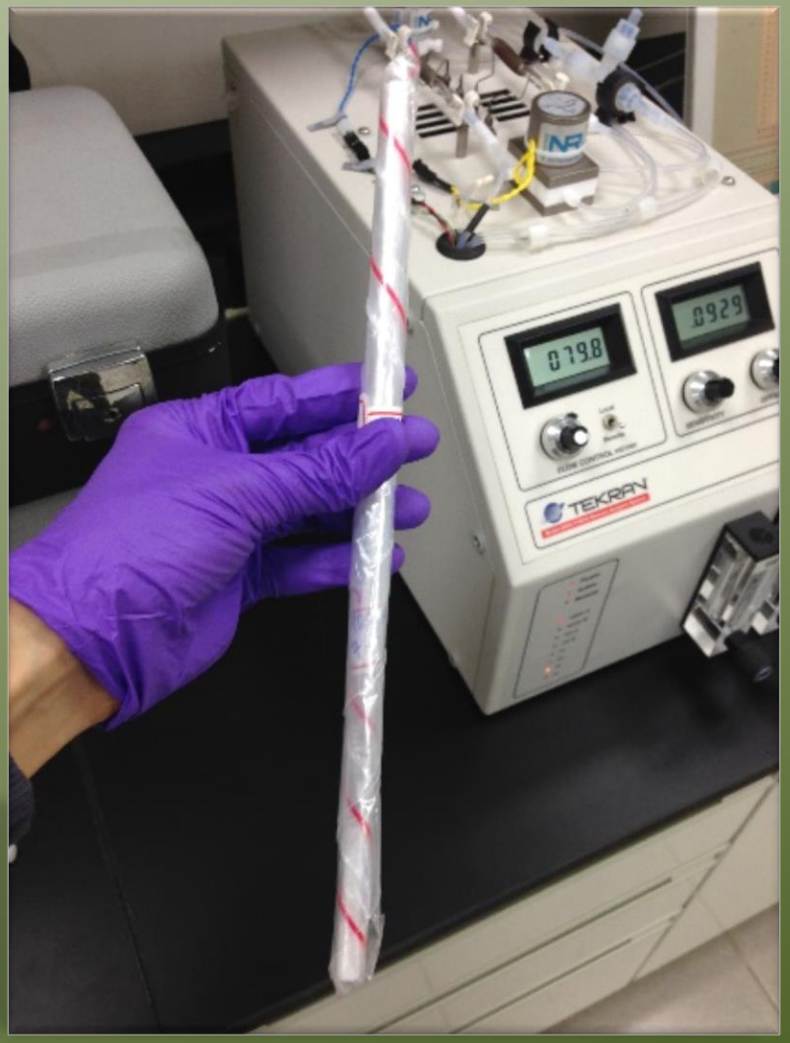
After analysis

Blank

- Extra desorption cycle

Duplicate

- Recovery test
  > 80% - 1st trap
  < 80% - 2nd trap



Active v.s. passive sampling methodology

Active sampling	Passive sampling
Compatible speciation measurement	Component indistinguishable
High temporal resolution	Wide-range deployment
Power required	No power or infrastructure required
Limited spatial coverage	Good spatial coverage
Trained manpower	Easy to manipulate
Limited concentration range	High dynamic range

Passive air sampler

McLagan et al., 2016

Tekran MerPAS

Pilot study in tropical/subtropical region

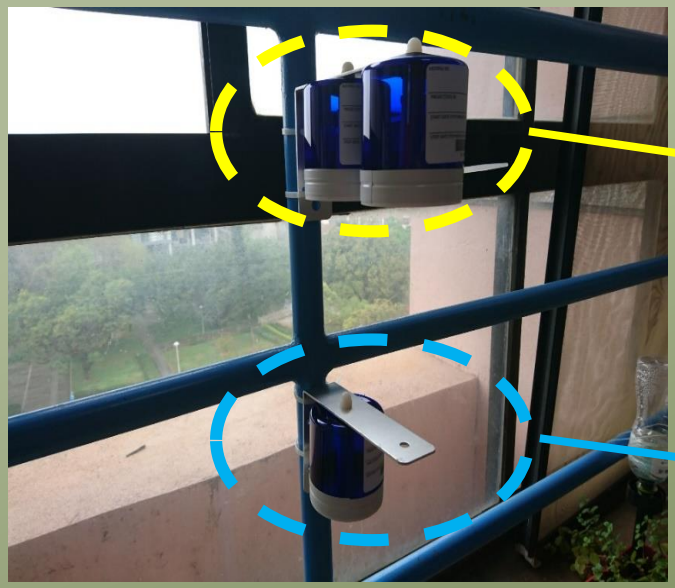
- NCU, Chungli
- 108 m asl
- Suburban/rural

- LABS, Nantou
- 2862 m asl
- Remote mountain

Experiment setup

- The sampling bracket is fixed by cable tie
- Replicates are sampled at same elevated height.

Experiment setup

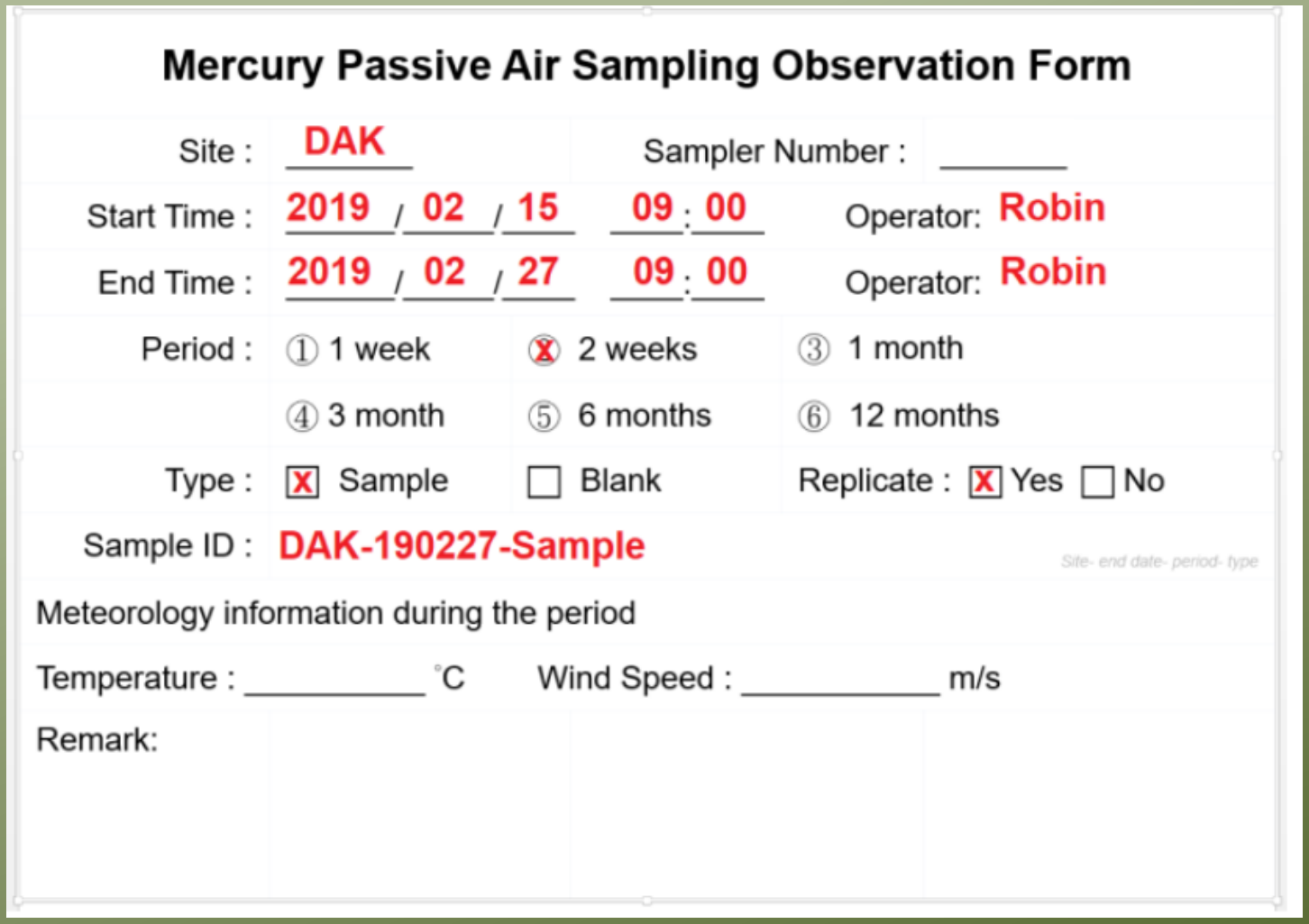


SAMPLES: lid opened

BLANK: lid **NOT** opened

Retrieve the PAS

Recording



Mercury Passive Air Sampling Observation Form

Site : DAK Sampler Number : _____

Start Time : 2019 / 02 / 15 09 : 00 Operator: Robin

End Time : 2019 / 02 / 27 09 : 00 Operator: Robin

Period : ① 1 week ☒ 2 weeks ③ 1 month

④ 3 month ⑤ 6 months ⑥ 12 months

Type : ☒ Sample ☐ Blank Replicate : ☒ Yes ☐ No

Sample ID : DAK-190227-Sample

Site- end date- period- type

Meteorology information during the period

Temperature : _____ ˚C Wind Speed : _____ m/s

Remark:

Analysis

METHOD 7473

MERCURY IN SOLIDS AND SOLUTIONS BY THERMAL DECOMPOSITION, AMALGAMATION, AND ATOMIC ABSORPTION SPECTROPHOTOMETRY

SW-846 is not intended to be an analytical training manual. Therefore, method procedures are written based on the assumption that they will be performed by analysts who are formally trained in at least the basic principles of chemical analysis and in the use of the subject technology.

In addition, SW-846 methods, with the exception of required method use for the analysis of method-defined parameters, are intended to be guidance methods which contain general information on how to perform an analytical procedure or technique which a laboratory can use as a basic starting point for generating its own detailed standard operating procedure (SOP), either for its own general use or for a specific project application. The performance data included in this method are for guidance purposes only, and are not intended to be and must not be used as absolute QC acceptance criteria for purposes of laboratory accreditation.

1.0 SCOPE AND APPLICATION

1.1 This method is for the determination of the following RCRA analyte in solids, aqueous samples, and digested solutions in both the laboratory and field environments:

Analyte	CAS No.[a]
Mercury total (organic and inorganic)	7439-97-6

[a]Chemical Abstract Service Registry Number

Analysis

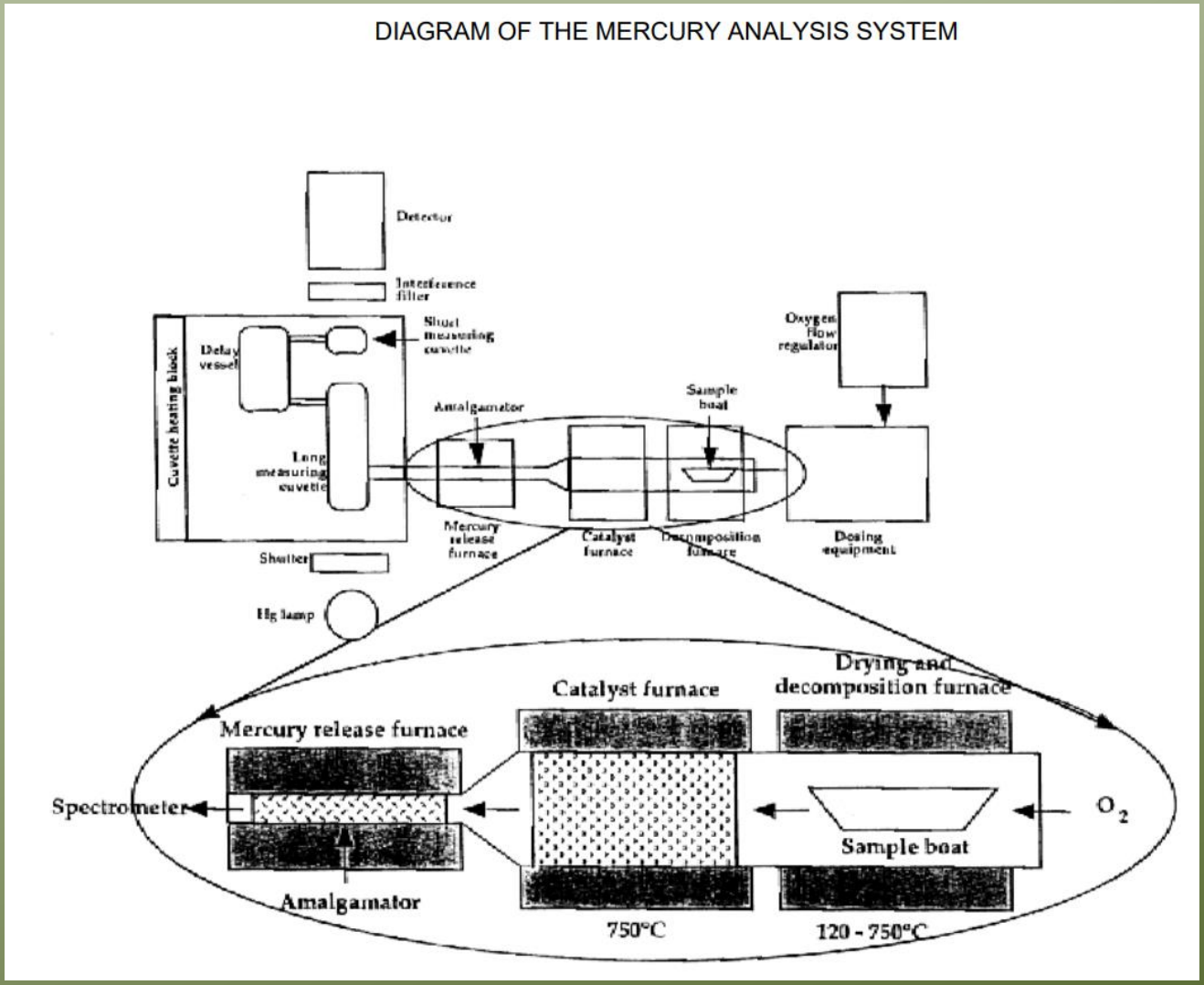


DIAGRAM OF THE MERCURY ANALYSIS SYSTEM
Detector
Interference filter
Cuvette heating block
Delay vessel
Short measuring cuvette
Long measuring cuvette
Amalgamator
Sample boat
Oxygen flow regulator
Mercury release furnace
Catalyst furnace
Decomposition furnace
Dosing equipment
Shutter
Hg lamp
Drying and decomposition furnace
Catalyst furnace
Mercury release furnace
Spectrometer
Amalgamator
Sample boat
O_2
750°C
120 - 750°C

Applications

JGR Atmospheres

Research Article | Full Access

Characterization and Quantification of Atmospheric Mercury Sources Using Passive Air Samplers

David S. McLagan, Fabrizio Monaci, Haiyong Huang, Ying Duan Lei, Carl P. J. Mitchell, Frank Wania

First published: 31 January 2019 | https://doi.org/10.1029/2018JD029373

Environmental Research Letters

LETTER

Identifying and evaluating urban mercury emission sources through passive sampler-based mapping of atmospheric concentrations

David S McLagan[1], Batual Abdul Hussain[1], Haiyong Huang[1], Ying D Lei[1], Frank Wania[1] and Carl P J Mitchell[1,2]

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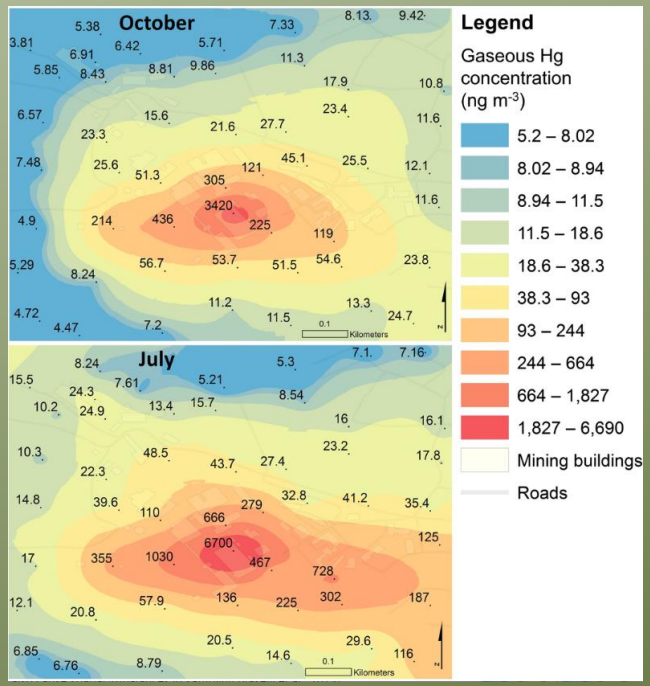

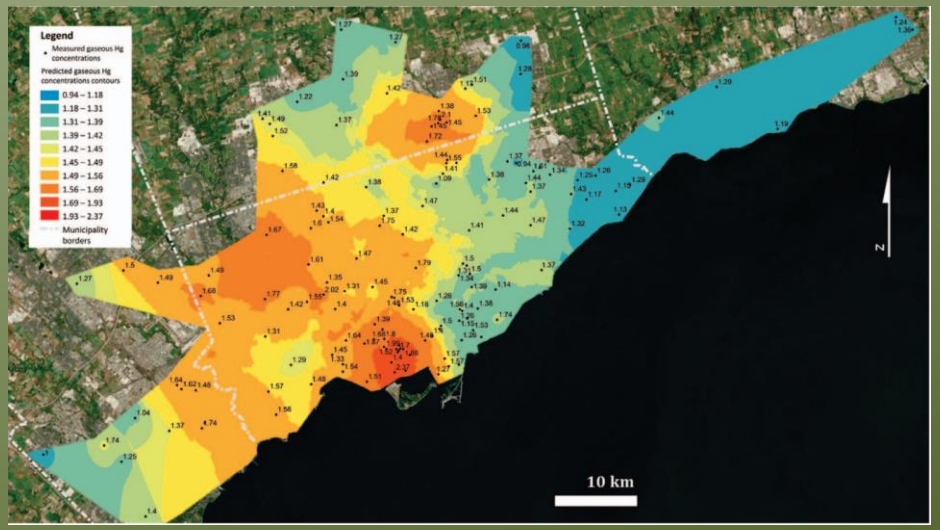

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Asia Pacific Mercury Monitoring Network

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National Central University