

Measurement of Fumigants

Introduction

Fumigants are widely used for pest control by sterilizing soil before planting, and during storage and shipment of foods and other plant-derived materials such as wooden furniture and wood chips. Many seaports now require fumigation before wood-containing products can be released for overland shipment. Common fumigants include phosphine (PH_3), methyl bromide (CH_3Br or MeBr) and Vikane (sulfuryl fluoride, SO_2F_2).

Phosphine is the most common fumigant, while methyl bromide is being phased out due to its ozone-depletion effects. But MeBr is also used as a pharmaceutical intermediate and will still be used for some time as a fumigant. Methyl bromide and phosphine have low exposure limits, with 8-hr ACGIH TWAs of 1 ppm and 0.3 ppm, respectively (see Table below). Typically, it is desired to measure high initial concentrations of several hundred ppm to ensure an adequate fumigation dose, followed by low concentrations after ventilation to prevent over-exposure of workers entering to load the goods. Fumigation during ship transport is done at lower concentrations but can last for weeks, and the crew's living quarters need to be monitored in case some fumigant leaks over from the vessel holds.

Fumigant Toxicity

	PH_3	MeBr
ACGIH TWA	0.3 ppm	1.0 ppm
ACGIH STEL	1.0 ppm	
OSHA Ceiling		20 ppm
IDLH	50 ppm	250 ppm
Lethal in 45 min	500 ppm	
Lethal in 1-3 min	2000 ppm	



Phosphine (PH_3)

Phosphine is a gas that is supplied either directly from a cylinder or is generated on-site from solid forms (usually aluminum phosphide or calcium phosphide) by reaction of with moisture in the air or the stomach acid of rodents. Common trade names for PH_3 -generating solids include Phostoxin, Agtoxin, Celphos, and Quickphos. These pellets can be placed in the fumigation area for slow release of PH_3 , or they can be converted more quickly using generators.

Phosphine can be measured at sub-ppm levels using a UNI badge-type single-gas monitor:

PH_3 Monitor	UNI
Range	0-20 ppm
Extended Range	0-100 ppm
Resolution	0.01 ppm
Detection Limit	0.05 ppm
Response Time	$t_{90} \leq 60$ s
Temp. Range	-20 to +50°C
Battery Life	up to 3 years
Part Number	M001-0016-000



This low-cost UNI personal monitor is convenient for both post-fumigation worker entry, and for long-term continuous ship-cabin monitoring because the battery lasts up to 3 years.

Phosphine by PID

Phosphine has reasonable sensitivity on a PID, (Correction Factor of 4 @ 10.6 eV) but tends to form a coating on the PID lamp, which reduces the response even when concentrations are constant. To minimize this effect, we recommend 1) keeping the exposure concentrations and times as low as possible (<10 ppm for <1 minute or so), 2) performing frequent bump checks with calibration gas, and 3) cleaning the lamp if readings are low. We do not recommend using a PID to measure high initial doses or using a fixed PID for PH_3 . Sometimes such measurement is not needed because the initial dose is calculated from the mass of fumigant added and the volume of the chamber being treated.

Methyl Bromide (MeBr)

MeBr can be measured by PID at both high initial concentrations and low clearance concentrations. With the 10.6 eV lamp, the Correction Factor is 1.7, which gives a detection limit of about 0.05 ppm using the NEO handheld or VOXI fixed PID with standard ranges. These monitors can also measure the high initial doses of MeBr, if needed (no lamp-fogging issues occur with methyl bromide the way they do with phosphine).



Food stacked for fumigation upon receipt in port

MeBr Monitor	NEO	POLI	VOXI
Portability	Handheld	Handheld	Fix-Mounted
Range	0-5000 ppm	0-2000 ppm	0-5000 ppm
Resolution	0.01 ppm	0.1 ppm	0.01 ppm
Detection Limit	0.05 ppm	0.5 ppm	0.05 ppm
Response Time	$t_{90} \leq 3$ s	$t_{90} \leq 15$ s	$t_{90} \leq 30$ s
Temp. Range	-20 to +50°C	-20 to +50°C	-40 to +70°C
Run Time	24 hrs	12 hrs	continuous



NEO MP181
Handheld PID



VOXI MP812
Fixed PID

POLI Multi-gas Meters for Fumigants

A POLI multi-gas monitor fitted with a PID sensor is a low-cost option for PID for MeBr. However, it is marginal in being able to measure accurately at a 1 ppm TWA, and therefore the NEO is recommended. The POLI has an advantage in that it could have both a phosphine sensor and a PID for MeBr, should both fumigants be used in the same facility.



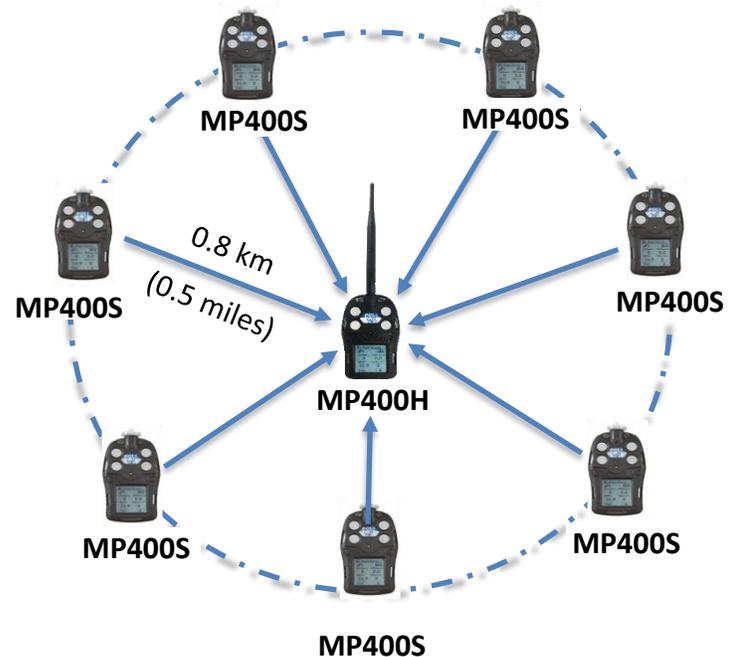
POLI MP400
Multi-gas Meter

POLI for Confined Spaces and Fumigants

A POLI could also be fitted as a 5-gas monitor for confined spaces (LEL, O₂, H₂S/CO) and the 0-20 ppm PH₃ sensor for the 5th sensor, to serve both confined space entry and fumigation needs.

mSquad Wireless Systems for Remote or Perimeter Monitoring

POLI multi-gas meter with fumigant sensors can be connected in a wireless networks for remote or perimeter monitoring. In mSquad systems with up to 8 monitors communication is up to 0.5 miles (line of sight) to the head monitor and in mPlatoon systems with up to 64 units up to 2 miles distance (line of sight) to an mLink modem can be connected.



mSquad remote monitoring system

Other Fumigants: Vikane and Methylisothiocyanate

Vikane (sulfuryl fluoride), commonly used in home tenting for termites, cannot be detected by PID or a simple electrochemical sensor.

Some less-common alternative pesticides such as Metam-sodium (methylisothiocyanate) can be detected with a PID using the standard 10.6 eV lamp. The response is quite sensitive, with a correction factor of 0.6. Contact mPower if there is any question whether the fumigant can be measured.