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WEB BASED FUMIGATION MONITORING FOR QUARANTINE FUMIGATIONS PART IV

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ABSTRACT

The predominant measurement technologies for fumigation gases over the past 60 years include colorimetric tubes, photoionization detectors and thermoconductivity detectors. Their limitations and inaccuracies are well known and documented. In the past fifteen years advances in non-dispersive infrared monitors (NDIR) have increased their adoption as a valuable fumigation tool. Any compliant fumigation monitor must be accurate, reliable and affordable. Stored Product Protection has additional requirements in remote regions such as Central China and Western Australia. In these cases the value of real time access via the internet to fumigation data collected with NDIR Technology from a remote location adds heretofore unknown benefits. Allocation of manpower and materials resources are optimized by access to information about fumigant gas levels in grain storages via the internet. Data is automatically transferred to a central database that can be accessed in real-time from any location with internet access. Intelligent monitors with built-in diagnostics tracking barometric pressure, temperature, sample flows and detector voltages are described. This data collection, data warehousing and reporting platform maintains measurement traceability to certified compliance with secure, encrypted electronic notebook format. Knowing REAL phosphine concentrations allows informed decisions to be made to achieve required CxT and avoid situations leading to target pest phosphine resistance.

Key words: NDIR, non-dispersive infrared, fumigation gas monitors, phosphine, web, internet, remote access

INTRODUCTION

Stored Product Protection requires a compliant fumigant to be applied as a gas and achieve penetration within the grain mass. Control of insect populations necessitates precise phosphine fumigation control and accurate gas concentration measurements. Phosphine has achieved premier status as the fumigant most used worldwide. It is inexpensive, offers good results when used correctly and leaves no residues but also has unique requirements for accurate measurement.

At the present time stored grain is heavily reliant on phosphine to eradicate infestations. The warmer climates have increased likelihood of more widespread insect occurrence stored grains. Countries such as Australia have used phosphine since the 1950s. As the need for low

chemical residues on grains was mandated on international markets through the 1980s; phosphine became the viable solution and its use increased significantly through the 1990s. World-wide, some estimate that phosphine is used over 80% of the time in grain storage/pest control applications.

PHOSPHINE RESISTANCE

Along with the increased use of phosphine there has been a well-documented increase in the frequency of global resistances of major target pests. This resistance to phosphine is a major challenge to the worldwide grain market. Insect resistance to phosphine occurs because of improper application of the product usually applied as aluminum phosphide tablets under various trade names. In grain storages these react with moisture in the air to release phosphine gas. This can take only a day at high temperatures, or as long as four days at low temperatures. The gas moves around by diffusion and in air currents inside the silo. Phosphine leaks in non-gas tight silos are quite common as shown in Figure 1.

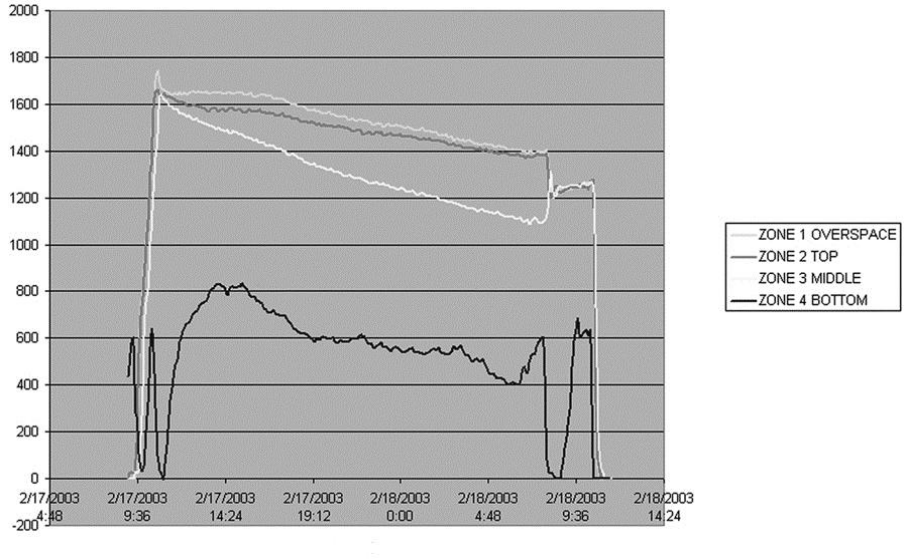

Fig. 1- Four-Position phosphine fumigation at a grain processing facility. Each line represents one sampling point of gas concentration vs. time and shows compromise (loss of gas) over time at one of sampling positions (Zone 4). Courtesy of Fosfoquim SA.

The widespread use of phosphine gas fumigation in unsealed silos in farm, merchant, and bulk handling facilities has significantly contributed to insect resistance to phosphine fumigations. Also, frequent exposure of insect populations to sub-lethal dosages allows some insects with a new resistance gene to survive treatment and continue breeding, passing on their resistance. Repeat fumigations favour the insects that carry the resistance gene by allowing them to survive, but killing normal, susceptible insects.

When strongly resistant insects are present, phosphine fumigation in an unsealed silo will have virtually no effect on the insects. One key to success is the ability of a silo to pass a pressure test. Compliant Silos that can be sealed well enough will hold the required

concentration of phosphine for long enough to kill all stages of the insects, including resistant insects.

In addition there is a cylinder delivery system (Horn Diluphos System) which applies pure phosphine avoiding the pyrophoric characteristics of the gas.

MONITORING PHOSPHINE FUMIGATION GAS CONCENTRATIONS

Accurate measurements of phosphine gas concentrations will increase the likelihood of successful fumigations. A precise dose level is desired. Situations are avoided where either too little or too much gas is used. Dissemination of measured physical parameters in a timely manner will aide in informed decisions to make this all happen.

Spectros Instruments has shown and proven infrared monitoring to be a superior analytical tool for the practical measurement of fumigation gases as shown in Table 1.

Table1. History of Fumigation Gases Monitored by Spectros Instruments

Year	Fumigation Gas	Development Partners
1996	Ethylene Oxide	Johnson & Johnson
1998	Phosphine	Lorillard; RJR
2004	Sulfuryl Fluoride	Dow Chemical
2005	Methyl Bromide	USDA APPROVED
2009	Ethanedinitrile	Linde

Infrared Spectroscopy measures absolute physical constants and allows monitor immunity to changes in temperature; barometric pressure; relative humidity as well as other interfering gases. Goals of increased efficiency, secured electronic records, compliance proof (traceability) and financial savings have been realized. Confidence in target CxT is achieved. Spectros Instruments has implemented its' latest real world solution for phosphine fumigation monitoring, the PM400 with Fumigation Hub as shown in Figure 2.

Fig. 2- Multi-position fumigation monitor for phosphine with integrated internet/cellular /ethernet communication capability.

Precise measurements of phosphine are now coupled with commonly available communication protocols and data transfer options as shown in Figure 3.

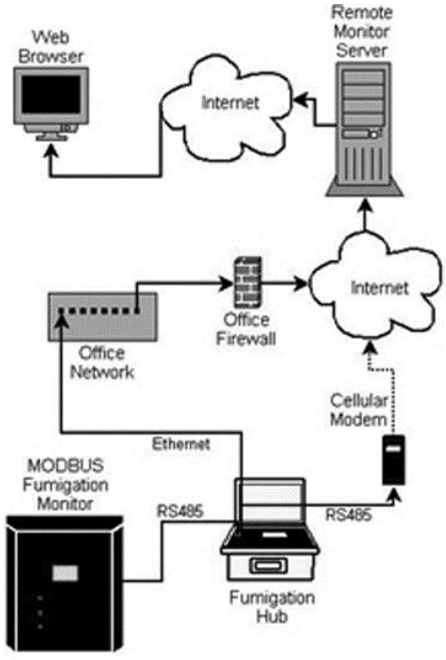

Fig. 3- Multi-position fumigation monitor communication architecture for secure communication of fumigation data to the ethernet, internet, and cellular options.

The Spectros Instruments PM400 Monitor with Fumigation Hub provides communication for remote collection, organization, and reporting of fumigation data that the phosphine monitor collects as well as any alerts generated. There are three ways to communicate with The Fumigation Hub as the LCD Interface, Built in Web Server and Spectros Portal to the Internet**.** The LCD interface is for local access when no network is available. The Web Server exposes more functionality when a network is available but is not connected to the internet. The Portal is the most functional but requires internet connectivity to show GUI's (Graphical User Interfaces).

LCD INTERFACE

The Fumigation Hub has a built in LCD interface with a keypad for navigation and a set of LED's for notification of operation status.

Moving thru the menu tree presents the Home Screen and Main Menu from which fumigation event jobs may be created, viewed and managed. It is possible to confirm your access to the internet and to get the information for accessing the onboard web application.

WEB SERVER

The Fumigation Hub has a built in Web Server. This web server exposes configuration and diagnostic information beyond what is available via the LCD interface. It also provides a

better method of managing events when an internet connection is not available. This feature is especially helpful for fumigation jobs in remote locations where an internet connection is not available and more information is needed.

FUMINATOR-IR: DESK TOP-PC APPLICATION

The Spectros FuminatIR Software Package is a desktop application that communicates with your Spectros MODBUS monitor and presents the data collected in a variety of formats. It can poll latest readings from an active fumigation, or download historic information from a completed job. It can post information to the Spectros Portal for Remote Access as well as provide real-time multi-position phosphine concentration trends. The console and graphical output are shown in Figure 4.

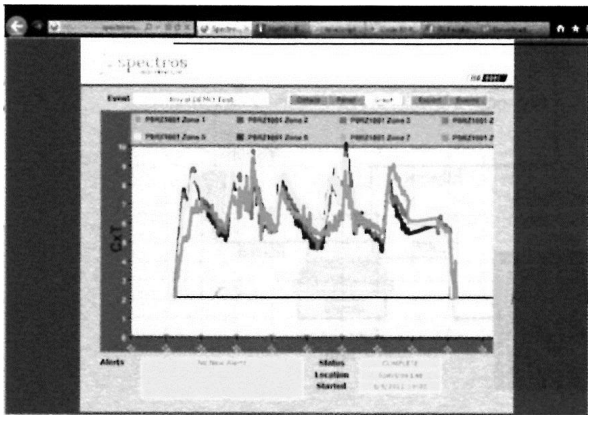

Fig. 4- Multi-position phosphine fumigation monitor showing gas concentration over time. Data is recorded, archived, and transmitted to web host and reviewed remotely.

CONCLUSIONS

Accurate, traceable and accessible phosphine concentration monitoring technology offers a residue free fumigation solution with enhanced safeguards to minimize potential insect resistance. These fundamental advantages will allow an expanding global market to reasonably rely on a compliant, uninterrupted supply chain for stored grain stuffs. Data accuracy and integrity of collection and transfer is key for informed decisions.