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AUTOMATIC ONLINE PHOSPHINE MONITORING SYSTEM FOR FUMIGATION

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ABSTRACT

Fumigation is one of the most important procedures followed all over the world for infestation control of stored products. Though there are several fumigants used for the purpose, phosphine is one of the most widely used fumigants for stored products. The present paper describes a fully automatic online fumigation monitoring system for phosphine which eliminates the need of an operator to make periodic measurements during fumigation lasting over several days. The online monitoring system consists of i) A sampling line having a set of solenoid valves and manifold ii) a microprocessor based control unit housing the sample draw pump and sensor and iii) a GSM modem for data transmission.

The instrument is programmed in the beginning by setting all the relevant parameters such as sampling time, purge time, sleep time between two cycles and the total number of cycles of measurement. Once it is programmed and the fumigation started, the instrument sequentially draws sample gas to the sensor from four different locations of a silo and the measured concentration data is stored on the control unit. After one cycle of operation, the sensor is purged with fresh air and the instrument goes into sleep mode till the next cycle starts after the preset period. The measurement cycle repeats till the end of fumigation. The instrument has data-logging facility which stores data with ID-tag. The stored data can be transferred to a computer via Bluetooth or to a GSM modem through RS-232 communication. GSM modem can send the data to a pre-configured mobile as an SMS. It can also send this data to pre-configured email IDs or can upload this data on a chosen FTP server. This server data can further be accessed by a user through web-application.

Key words: Fumigation, Fumigant, Phosphine, Aluminium Phosphide, Silo, Infestation Control.

INTRODUCTION

Phosphine remains the fumigant of choice for all the bulk storage operators and grain growers because of its effectiveness and environmental suitability. It also scores over other fumigants on many aspects including the ease of application, low cost, less residue problem and least effects on treated food commodities. Fumigation is generally carried out by covering the commodities with a leak proof enclosure and applying phosphine gas from phosphine cylinders or using appropriate amounts of ALP as a source of phosphine. In either case,

phosphine concentration of 500-2000 ppm is used. However to keep a watch on the concentration- time profile as a quality control procedure during fumigation, phosphine concentration has to be measured periodically during the entire period of fumigation lasting several days.

Ideally an online monitoring system should be the right choice. But because of the high fumigant concentration involved in the fumigation process, the sensors, particularly for phosphine, do not last long. The present online monitoring system described below and meant for phosphine monitoring overcomes the problem of sensor mortality by exposing the sensor to phosphine only during measurement and keeping it in ambient air during idle time. The smart sensor used in this instrument can be easily replaced when it fails by another smart sensor already calibrated at the factory.

DESCRIPTION

The automatic online fumigation monitoring system for phosphine described in this paper mainly consists of two parts - (i) a central processing module and (ii) a sampling line. Fig.1 shows the block diagram of the complete automatic fumigation monitoring system. The central processor module has the microcontroller which forms the heart of the entire monitoring system. It also has a signal conditioning unit, a digital display, a keyboard, a power supply and RS 232 serial communication port for data communication to PC.

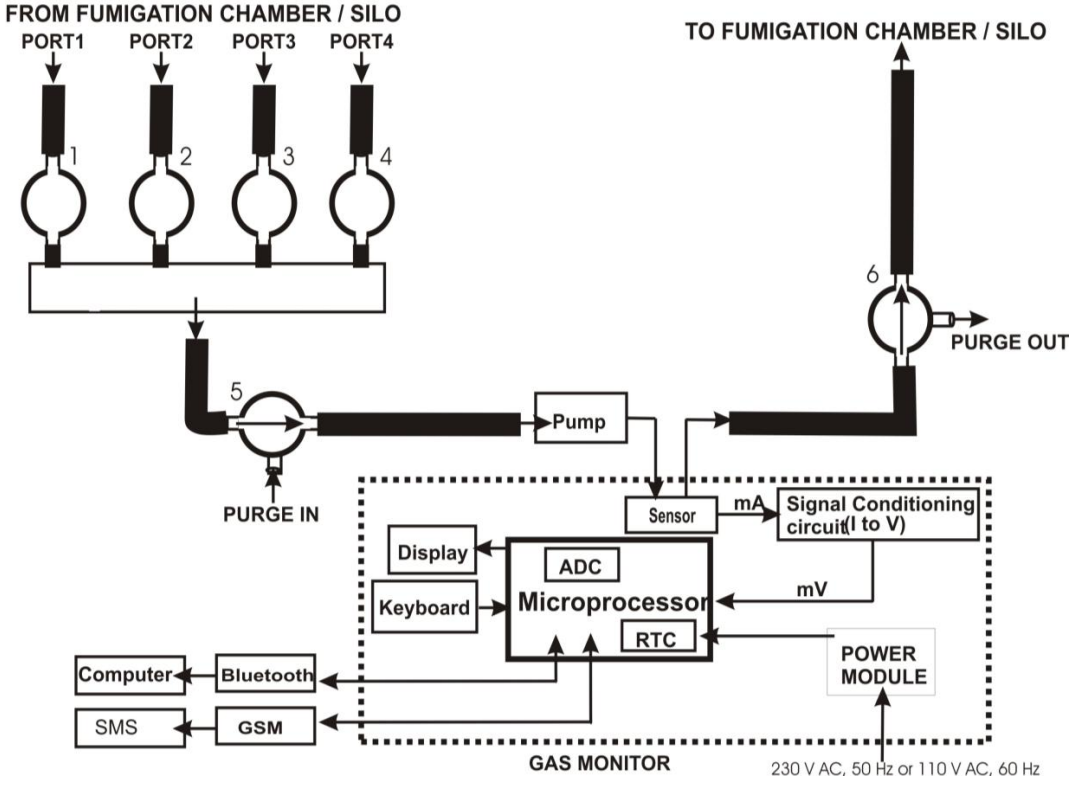

Fig. 1- Block diagram of automatic online fumigation system.

The sampling line consists of a set of solenoid valves, a manifold and sample draw pump connected together as shown in Fig.1. As per the set of instructions from microcontroller, the sampling line can draw air sample from four different locations and bring the sample air to the smart sensor. The smart sensor is designed in such a way that, if the sensor fails, it can be easily replaced at the fumigation site by plugging in another smart sensor which is factory calibrated. The pluggable smart sensor module has an electrochemical sensor for the detection of phosphine in the range of 0-2000 ppm.

Being a microprocessor based unit, the instrument has data-logging facility which stores data with ID-tag. The stored data can be transferred to a computer via Bluetooth or it can be transferred to a GSM modem through RS-232 communication. GSM modem can send the data to a pre-configured mobile as a text message (SMS). It can also send this data to any pre-configured email IDs or can upload on a chosen FTP server. The data on the server can further be accessed by a user, through web-application.

OPERATION & CALIBRATION

The instrument has several modes of operation such as sampling mode, parameter setting mode, calibration mode etc. Navigation between one mode to another and setting the required parameters can be done using four membrane keys provided on the monitor. For making measurement, the relevant parameters like sampling time, purge time, interval between two cycles etc. are to be set by entering into parameter setting mode. Once the required parameters are set, measurement can be started by entering into the sampling mode. The instrument has six solenoid valves out of which, four (1-4) are two way valves and the remaining two are 3 way valves (5&6). When the sampling starts, the instrument is first purged with air for 30/60 sec during which all the 2 way valves (1-4) will be closed and valves 5&6 will remain open to free air. After purging, the sample gas from port 1 is drawn for measurement which passes over the sensor and is sent back into the silo. During this time the valves 1, 5 and 6 are all open to allow the gas to flow from the silo to the sensor and back to the silo. The sampling from port 1 continues for the specified time and changes over to the next port automatically by closing valve 1 and opening the second valve. The gas concentration is read and stored at the end of sampling time and displayed on the monitor. Once sampling from all the four ports is completed, the instrument again enters the purging mode. During this operation, valve 5 is open to air and valve 6 is kept open to the silo for 20 seconds and then to free air to purge the sensor fully with fresh air. This completes one measurement cycle and the instrument goes into sleep mode automatically. The second and subsequent cycles starts at pre determined times.

The calibration mode can be accessed by pressing a single key in the main menu. The calibration of the instrument involves two steps- (i) Zeroing the instrument in clean air and (ii) Setting the span gas value and applying the gas of known concentration (equal to the set span gas value). If there is a mismatch between the set span gas value and the calibration gas concentration, the gain is to be adjusted such that the reading on the monitor matches with the calibration gas concentration.

CONCLUSION

During phosphine fumigation in closed enclosures, monitoring of phosphine concentration over the entire period of fumigation is necessary. Ideally, a fully automatic online monitoring system which can periodically monitor phosphine concentration, store the measured data in its

memory and also transmit it to any remote location is desirable. The present instrument fully meets that requirement and should be very useful to the fumigators.