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Laboratory Safety Apparatus for use with Methyl Bromide

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Use of methyl bromide (MB) and other toxic gases for laboratory fumigation experiments is a hazardous undertaking. This is a report of a number of safety precautions and alarm systems that have been developed in this laboratory.

KOLBEZEN and ABU-EL-HAJ (1972) designed a fumigation apparatus for MB laboratory experiments; its basic design is applicable for use with other toxic gases as well. The basic apparatus is a device whereby gaseous MB and air, both under constant pressure, are mixed to provide the concentrations desired which are fed through restrictors to the fumigation chambers. The modifications by OHR et al. (1973) included placing the fumigant supply in an incubator maintained at a constant temperature lower than the lowest room temperature. In this way, MB always remained gaseous as it entered the mixing chamber. Other modifications to enhance the safety of the apparatus are described below.

OLFACTORY ALARMS. A number of dangerous gases are odorless and commonly have a strongly odored gas mixed with them for detection of leaks. In the case of MB, the most common additive is chloropicrin (trichloronitromethane). When added as a warning agent, chloropicrin is used at 2% concentration. Because chloropicrin is also a toxicant, it can conceivably alter results when testing MB, and consequently, may have to be omitted. Other chemicals, such as the mercaptans used as warning agents in natural gas, may be useful as olfactory alarms. They should, of course, be tested to determine their effect on fumigated organisms, so that their use does not confound the data.

GAS SUPPLY. The MB supply tank is kept in a temperature controlled chamber external to the fume hood. The gas is delivered to the fumigation apparatus in the fume hood via 6.4 mm OD copper tubing. To minimize the effects of a leak occurring in the temperature chamber, the supply tank (gas cylinder containing 2.5-4.5 kg MB) is kept in a sealed chamber constructed from plastic pipe with end caps (inside diameter 21 cm, length 40 cm). The atmosphere within the pipe is vented

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to the fume hood via a 12.7 mm plastic tube. If a leak occurs at the tank or valve, the pressure of the leak forces the gas into the hood and not into the temperature controlled chamber.

In practice, the sealed chamber MB is kept on a scale so that the amount of MB in the inner cylinder may be determined without removing it from the apparatus.

ACTIVATED CHARCOAL SCRUBBERS. Delivery of gas in the apparatus is dependent solely on gas pressure in the supply tank. Thus, if the building's electricity fails, or the fume hood becomes inoperative, the gas would continue to flow and become a hazard. To avoid such a hazard, exhaust from the fumigation vessels is collected in a manifold and guided via copper tubing to a solenoid valve (Fig. 1, V-1; Robert Shaw Control Systems Division Model R 427-20). The valve is normally open when power is present, and the gas is discharged into the fume hood air stream. Upon failure of power to the solenoid, the valve closes and switches the gas to flow into a galvanized pipe (5.1 cm internal diam. x 1 m) filled with granular activated charcoal. Saturation time of the scrubber is dependent upon the volume of charcoal, the concentration of MB and speed of gas flow. In our use with the scrubber completely filled with charcoal, it removed MB from the air stream as follows: 7 days at concentration of 1.2 mL MB/L air or 6 h at concentration of 35 mL MB/L air where total flow rate was 240 mL/min.

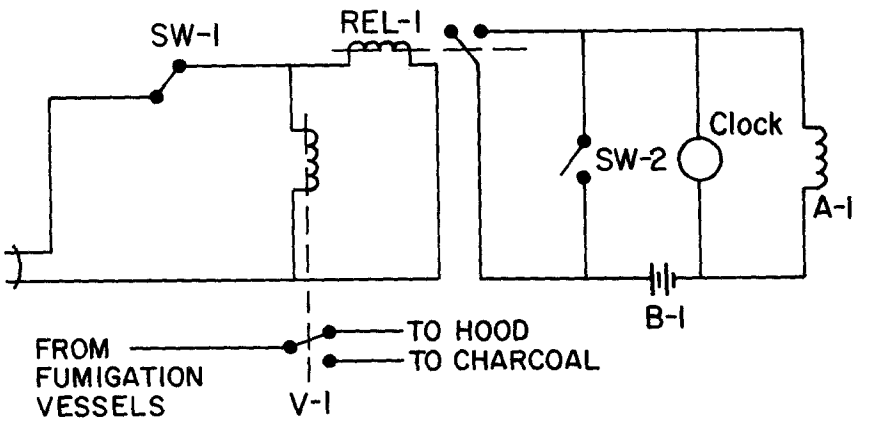

Figure 1. Schematic of safety and alarm circuits. A-1, alarm bell; B-1, battery; clock, elapsed time clock (optional); REL-1, relay; SW-1 sail switch; SW-2, press-to-test switch; V-1, solenoid valve.

SAFETY AND ALARM CIRCUITS. The alarm circuit (Fig. 1) consists of two switches (SW-1, SW-2), a relay (Rel-1), a solenoid valve (V-1), an alarm bell (A-1), and a battery (B-1). An elapsed time clock (Clock) is optional.

The operation of the circuit is as follows: SW-1 (Honeywell Model 688A-1007) is a normally closed sail switch located in the fume hood air stream. Upon failure of the venting air stream for any reason, SW-1 opens, removing power from the alarm relay (Rel-1) (normally open), which then closes, completing the battery circuit and causing the alarm (A-1) to sound, and the clock (Clock) to record the time that the circuit was closed. Switching of SW-1 also removes power from the solenoid valve (V-1), causing it to divert the fumigant exhaust stream from the fume hood air flow to the charcoal scrubbers. Failure of building power causes the same sequence of events. SW-2 is a press-to-test switch to insure that the alarm circuit is functional.

The clock is preferably an elapsed time digital readout of appropriate voltage to make it compatible with the alarm bell coil and battery. The clock is used to determine the amount of time the exhaust stream has flowed through the charcoal scrubbers. The clock is especially useful during intermittent power failures, because elapsed time is then summed, and degree of charcoal saturation can be estimated.

OTHER SAFETY EQUIPMENT. A self-contained breathing apparatus should be available outside of the laboratory in the event that leakage makes it impossible to enter the room safely. A halide detector should be available and used each morning upon entering the laboratory to determine if low level leaks are present. Safety instructions including emergency procedures, emergency phone numbers, poisoning symptoms, and other safety precautions should be prominently posted along with the location of the nearest medical facility capable of handling toxicant poisoning.

"Safety Precautions for Fumigating with Methyl Bromide," obtainable from Dow Chemical Co., U.S.A., Agricultural Products Dept., Midland, Michigan 48640 should be read by all operators and kept for quick reference.

REFERENCES

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