COMBINATION FUMIGATION METHOD
Structural Fumigations Using Heat, Carbon Dioxide, and Phosphine

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A patented process of manipulating the biological functions of a pest insect in a flour mill or food processing plant can affect mortality faster and decrease fumigation time. The combination of inert carbon dioxide at concentrations of 30,000 – 50,000 parts per million heats at a range of 30º to 35º C, with low levels of phosphine fumigant, will effectively fumigate a flour mill or food processing plant in 24 hours.

Advantages:

- A proven methyl bromide alternative
- Less shutdown time than phosphine alone
- Better worker safety than methyl bromide
- Less expense than methyl bromide fumigation

Disadvantages:

- Corrosion management is a key element
- More labor to seal and monitor the fumigation
- Carbon dioxide has special needs
- Heat equipment availability

Over seventy structural fumigations have been performed in the United States and Europe since 1995 with the Combination Fumigation Method. Most included flour mills and food processing plants looking for alternatives to methyl bromide. To date, over 100 tonnes of methyl bromide have been replaced with the Combination Fumigation Method.

Components:
Heat – used to increase insect respiration. Temperatures of 40º will increase insect's respiration by 3X (Murdoch).
Carbon dioxide- used to increase insect respiration. CO_2 levels of 3 - 5% by volume will increase insects' respiration by 50-300%. (USDA/ ARS)
Phosphine – fumigant used at low levels (<100 PPM) to minimize corrosive properties of phosphine to copper and brass.

Monitoring and Corrosion Management:
Monitoring and fumigation is crucial to the success of any fumigation. The three components of the Combination Fumigation must be maintained for the entire 24-hour exposure period to ensure control of all stages of pest insect life. Additional phosphine fumigant can be added from outside the fumigated structure using Eco2Fume Phosphine fumigant. ECO2FUME is a cylinderized phosphine fumigant that eliminates the risk of fire and allows for critical amounts of fumigant to be re-released in a structure to obtain precious concentrations high enough to effect a kill and low enough to not cause corrosion in the structure.

Efficacy:
A test on adult, larvae, and egg bioassays of *Tribolium confusum w*as conducted during a fumigation of a large Pillsbury flour mill and food warehouse in Hillsdale, Michigan in October 2000. The Combination Fumigation Method showed 100% mortality. Similar studies have been conducted with the same results. One 2002 fumigation of a flour mill in Denmark showed 100% mortality of Tribolium placed by the Danish Pest Infestation Laboratory. These two flour mill fumigations were performed in northern latitudes during a cool time of the year in a 24-hour duration. Methyl bromide under field evaluation in flour mills generally achieves 85 - 95% mortality.

Figures:
Cost Comparison with Methyl Bromide
Mortality of bioassays of mixed staged stored product insects
Phosphine Concentrations
Carbon Dioxide Concentrations
Heat Readings

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