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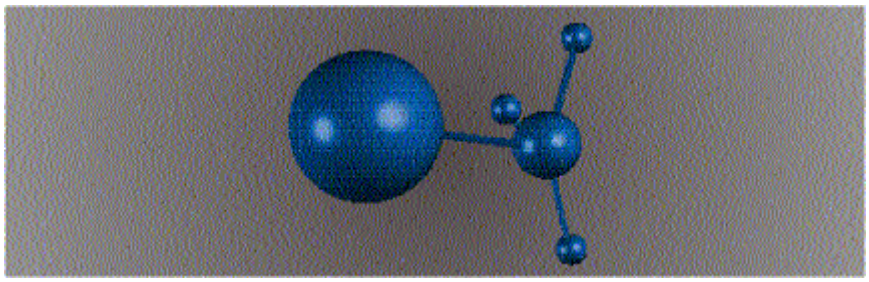

Insect Management in Food Processing Facilities with Heat and Diatomaceous Earth

With the impending loss of methyl bromide, the use of high temperature as an insect control tool in food processing facilities is being revisited. This involves heating all or part of a facility to 120–140°F (49–60°C) for 20–36 hours. Some facilities in North America have successfully used heat treatments for more than 75 years to manage insect pest populations while this is a completely new concept for most processors. Heat kills insects in two ways: denaturing proteins inside the insect's body and disrupting the waxy layers on the outside of the insect causing dehydration. All life stages of stored-product insects will die at these temperatures in less than one hour, but the additional time is required for the heat to penetrate into processing equipment and the building itself. Not all facilities are well suited for heat treatment; wooden structural elements and equipment may dry out, warp or crack during heat treatment and some plastic materials used in modern processing equipment may warp or become brittle. Additionally, without good ventilation heat is generally not well distributed within a room during a heat treatment resulting in areas that are under-heated.

A collaborative research project between the U.S. Department of Agriculture and Agriculture & AgriFood Canada is examining the use of diatomaceous earth in combination with heat for insect management in food processing facilities. Diatomaceous earth is the skeletal remains of single-celled algae, or diatoms, that formed thick layers in ancient seabeds when they died. Diatomaceous earth is comprised predominantly of silicon dioxide and is a fine, crumbly substance used in insulating materials, abrasives, ceramics, filters, as a food additive in toothpaste and as an anti-caking agent in artificial sweeteners. Diatomaceous earth has low mammalian toxicity and is registered as a feed additive and also is used as a natural insecticide. Mortality in insects is not immediate, as expected with traditional chemical insecticides, but will occur after a period of time. When diatomaceous earth is combined with heating, there can be synergism that causes insects to die more quickly and at lower temperatures than when insects are exposed to diatomaceous earth or heat alone.

Field trials of the combined treatment have been conducted in cereal processing plants in Peterborough, Ontario, and Manhattan, Kansas. The objective of both studies was to examine the combined impact of high temperature and diatomaceous earth on the mortality of adult confused flour beetles, *Tribolium confusum,* in a flour mill environment during heat treatment. The confused flour beetle was selected for the tests because of its high tolerance to diatomaceous earth and is a common pest of food processing facilities. Protect-It™ (Hedley Technologies, Mississauga, Ontario), an enhanced diatomaceous earth formulation was used in both studies and applied as a dry powder with an electric duster at a rate of about 6.5 oz/1000 ft2 (2 g/m2). The duster created a cloud of diatomaceous earth that settled to the floor in about 2 hours. Prior to the diatomaceous earth application, plastic sheets were taped to the floor to mask out the insecticidal dust in areas to serve as undusted controls. Plastic rings were glued to the floor using a removable sealant. The rings were placed on the floor to create diatomaceous earth-treated and untreated arenas. Adult confused

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flour beetles, 50 beetles per ring, were monitored at 60-minute intervals during the heat treatment and the dead insects were removed after each inspection. Steam heaters were used at both locations to reach and hold a target temperature of 122°F (50°C) for 24 hours.

Effectiveness of the diatomaceous earth and heat treatment was determined by the duration of survival during the treatment, the temperature at time of death, and the percentage of dead beetles at the end of the heat treatment. The beetles exposed to diatomaceous earth plus heat were all dead when temperatures reached 106°F (41°C) while those exposed to heat alone were dead when temperatures reached 115°F (46°C). These lower temperatures also translated into a shorter duration (13 hours) for the diatomaceous earth treatment compared to the heat alone (32 hours). The rate of heating also will impact the duration of heating and insect mortality. The researchers suspect that the insects will be more susceptible to a high rate of temperature increase that would minimize insect escape to cooler areas or adjusting to higher temperatures.

In areas that are difficult to heat to temperatures lethal to insects, an application of diatomaceous earth could be of value. Even if the insects are not killed during a combined diatomaceous earth plus heat treatment, the diatomaceous earth offers residual value for insect control if left in place after treatment. Because of the residual value and low mammalian toxicity of diatomaceous earth, it may be suitable for use in combination with heat in areas containing heat-sensitive equipment. It would also be useful in areas that are difficult to heat such as along outside walls, windows and basement floors.

Heat alone has already proven to be an effective and safe alternative to methyl bromide fumigation in facilities that can withstand the temperature requirements. Diatomaceous earth is also proven to be effective for controlling stored-product insects and can fill a niche where high temperature treatment may not be effective or practical.

Before there can be wide-spread acceptance of the combination treatment, there are four issues that need to be addressed. Resident insect populations often are in more protected locations, such as inside processing equipment, cracks and crevices in the floors and walls, and may never contact the diatomaceous earth or lethal temperatures. The researchers have demonstrated that heat penetrates quickly into flour milling equipment but currently there are no diatomaceous earth products labeled for use on food contact surfaces. Since diatomaceous earth is already used as a feed additive, approval for use in food processing equipment may be granted. Additionally, there remain questions about the abrasive characteristics of diatomaceous earth and what damage may result if used inside processing equipment. Given the low application rates, this is not likely to be a significant issue, but needs to be addressed. Finally, on a full plant basis, there are no data that conclusively prove that a combined treatment of diatomaceous earth and heat is better than either treatment individually. If the combination treatment does prove best, the question remains of how low the temperature can be dropped and still offer adequate insect control.

Depending on how these questions are answered, adopting heat treatments with diatomaceous earth for insect management will reduce the amount of traditional chemical insecticides used in the food processing industry. Additionally, it will further minimize worker safety issues associated with structural fumigation as well as the potential of toxins inadvertently contaminating food products.

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