MILLING
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Steam-Heat Economics

Permanent heaters deliver a cost-effective method of insect pest management

This article is based on a presentation by Armstrong International Inc. Heat Transfer Group (450-378-2655), to the International Association of Operative Millers (IAOM) Technical Conference in Nashville, TN, in May 2005.

By now, it is common knowledge in our industry that methyl bromide has been phased out as an approved fumigant for insect pest management in flour mills (except for critical use exemptions).

Heat treatment for insect pest management is becoming increasingly accepted as a safe and effective alternative and has been performed successfully by major food and grain-processing companies for the past 40 years.

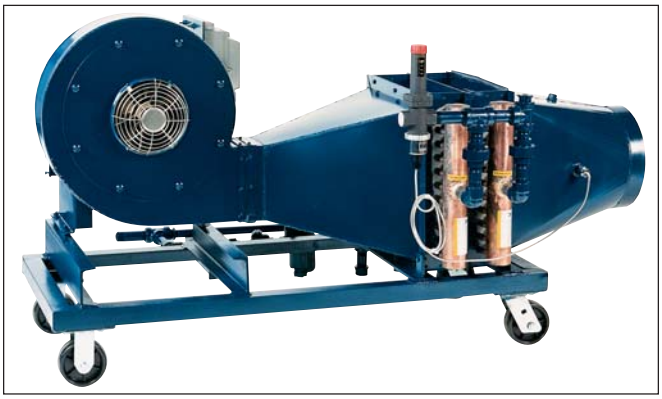
Portable heaters offer a cost-effective option for insect heat treatment. Mounted on sturdy carts, portable heaters provide on-demand spot heating in any area within a food processing facility. Photo courtesy of Armstrong International, Inc.

Process of Heat Treatment

Heat treatment is a simple three-step process: ramp up, cook, and cool down. Step one is a controlled ramp up of the flour mill's ambient temperature, usually by 10 degrees per hour to avoid potential structural expansion problems. The ramp-up time is usually four to six hours.

Once the temperature reaches 125 to 140 degrees F, it is held steady for an additional 12 to 24 hours (depending on the structure's construction), for thorough penetration into the walls and equipment.

Because insects have an external (exo)skeleton, they are affected greatly by moisture and temperature. Extensive research has shown that insects (adults, larvae, and eggs) will die if exposed to low humidity and temperatures



Heavy-duty bin heaters provide an effective way to heat bins, silos and other hard-to-access areas within a food facility. Photo courtesy of Armstrong International, Inc.

Cost of Buying and Operating Steam Heaters

Table 1

Year	Permanent Steam Heaters Only; In-house Installation	Permanent Steam Heaters With Hired Installation	Portable Rental Steam Heaters
2005	$100	$170	$70
2006	$0.05/hr	$0.05/hr	$72
2007	$0.06/hr	$0.06/hr	$80
2009	$0.09/hr	$0.09/hr	$110

in excess of 120 degrees F.

After the cook, the structure's ambient temperature is allowed to cool down back to its original condition. The cool down phase can take from four to six hours.

Heat-Generating Options

Several heat-generating options are available, including electric resistance, direct-fired natural gas or propane, and steam.

Electric-resistance (ER) heat is a viable alternative for projects that require smaller, targeted heating. An extensive ER system would require prohibitive wiring and power requirements. It also would increase the risk of fires or explosions, due to the high element temperatures. The flash point for most flour products is around 850 degrees F, which is less than the electric-element surface temperature.

Natural gas and propane direct-fired heaters introduce some of the same concerns as electric-resistance units. Along with the potential for fires or explosions, products of combustion such as carbon monoxide and moisture are introduced into the heated space. These combustion products can limit the heater's effectiveness, because both an elevated temperature and low humidity are required to kill insects.

A permanatly mounted steam heater in the sifting area of a Chicago, IL flour mill. Photo courtesy of Armstrong Intl. Inc.

Steam heaters, a third option, are becoming increasingly popular, because they provide a safe and reliable source of heat. However, one must consider whether an existing steam-generating and distribution system is available in the areas of the mill to be heat-treated. Steam heaters are available in portable units or as a system that can be mounted permanently.

The heaters, controls, piping, and electrical wiring required for a permanently mounted steam-heat treatment system can be a significant investment but one that is efficient and cost-effective for pest management. After the initial capital expenditure, the only recurring costs are maintenance and the fuel and electricity to power the heaters.

With individual temperature control at each heater and a remote temperature acquisition and monitoring system for the heated areas, the personnel requirements can potentially be reduced. Not requiring personnel in the heated space for extended periods is also an added safety benefit.

Thermal Requirements at Different Outdoor Temperatures

Table 2

Location	50°F (10°C)	65°F (18.3°C)	80°F (26.7°C)
1st Floor	14.8	14.1	12.6
2,3,4 Floors	12.6	11.8	10.3
5th Floor	12.7	11.7	9.9
AVERAGE BTU/CU. FT	13.06	12.24	10.68

Total Cost of Using Steam Heaters

Table 3

Year	Permanent Steam Heaters Only; In-house Installation	Permanent Steam Heaters Purchased and Installed	Portable Rental Steam Heaters
2005	$10,120	$17,120	$7,120
2006	$144	$144	$7,344
2007	$180	$180	$8,180
3-year Total	$10,444	$17,444	$22,644

Cost Comparison: Permanent vs. Portable

Before selecting the steam-treatment option (permanent or portable) that suits them best, milling companies must compare costs. The following three tables provide real-world data from a case study (by Armstrong Intl.) comparing the costs associated with using permanent or portable steam-heat systems in a five-story concrete and masonry construction building. The costs are in U.S. dollars per 1,000 cubic feet of heat-treated space.

In **Table 1** (page 24), data for the year 2005 includes costs associated with buying permanent steam heaters only (and performing in-house installation), buying a complete installed steam-heater system, and renting portable steam heaters. Data for permanent steam heaters in 2006 projected through 2009 reflects the average fuel (natural gas) and electric costs per hour (per 1,000 cubic feet of heat-treated space) over a single, 24-hour heat treatment per year.

The thermal requirements for selecting the heaters in Table 1 are based on an outside ambient temperature of 50 degrees F. **Table 2** (page 24) lists the requirements for this temperature, as well as for the ambient temperatures of 65 degrees F and 80 degrees F. Note that as the outside ambient temperature increases, the average btu/cu. ft. requirement decreases.

The first floor of the mill will always be the most difficult to heat, because heat naturally rises to the top floors of a building. Different building designs and construction materials also could affect the average thermal requirements.

Table 3 (above) includes a three-year total cost comparison for the three options. Costs are in U.S. dollars per 100,000 cu. ft. of heat-treated space and based on one heat treatment per year. Year 2005 includes the initial capital expenditure or rental plus the average cost of fuel (natural gas) and electricity during a 24-hour heat treatment. Years 2006 and 2007 only reflected the utility costs associated with a 24-hour heat treatment.

Comparing the costs for permanently-installed heaters with the costs for portable rental heaters is similar to comparing permanently installed heaters with fumigation, because fumigation is basically a rented service. The initial expenditure for heat treatment equipment is more expensive, yet quickly has a cost advantage after a few years of operation.

The time to begin evaluating the economics and feasibility of methyl bromide alternatives for insect pest management is now. Steam-heat treatment should be investigated as a viable option.

Jim Camillo, editor

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