KSU Heat Treatment Workshop

Researchers look at techniques for heating a mill structure.

This article is based on a presentation by Dr. Bhadriraju Subramanyam, associate professor in the Department of Grain Science and Industry at Kansas State University (KSU), Manhattan (785-532-4092/bhs@wheat.ksu.edu), and Dr. Allen Dowdy, then a researcher at the USDA Grain Marketing and Production Research Center, Manhattan. They spoke at the 2000 Association of Operative Millers Technical Conference in May in Kansas City, MO.

As the use of methyl bromide as a fumigant for mill structures continues to be phased out under international law, researchers at KSU are looking closely at the older insect control technique of heat treatment, finding ways to adapt it to modern milling practices.

During the summer of 1999, KSU researchers held two heat treatment demonstration projects at the KSU pilot mill on the Manhattan campus. They performed three-day experimental heat treatments at the pilot mill in June and the pilot flour and feed mills in August of that year.

The second of the two was held as a public workshop and it attracted quite a bit of attention. A total of 67 people took part in the workshop, including food and feed industry representatives, pest control company representatives, federal U.S. Department of Agriculture and Occupational Safety and Health Administration staffers, KSU faculty and students, and representatives from the Association of Operative Millers.

Heating Practices

One of the main goals of the August workshop was to evaluate different methods of heating the entire mill structure to a target temperature of 50 degrees C (about 122 degrees F). To that end, the researchers tested two different heating systems for the June and August heat treatments.

For the June treatment, the TempAir heating system was supplied by Rupp Industries, Burnsville, MN (800-836-7432/www.rupp-inc.com). This system heats air from outside the building and delivers it through cloth ducting. This creates positive pressure within the building that results in heated air being forced out of cracks and other openings.

A different heating system was used for the August treatment, supplied by Aggreko Inc., New Iberia, LA (800-443-2447/www.aggreko.com). This system consists of electric heaters located within the building, with

Room	Floor	Time above 50°C (hr)	Time to reach 50°C (hr)	Maximum Temperature (°C)
TABLE 1				
Cleaning house	1	27.5 ± 2.6	11.7 ± 4.2	57.9 ± 1.2
	2	23.0 ± 2.4	14.9 ± 2.1	56.6 ± 1.3
	3	21.4 ± 2.4	19.7 ± 2.3	55.4 ± 0.8
	4	17.8 ± 2.0	23.2 ± 2.5	53.8 ± 0.5
Flour mill	sub floor	13.2 ± 3.4	23.7 ± 4.4	53.3 ± 1.2
	2	22.6 ± 2.9	16.3 ± 3.3	59.1 ± 2.1
	3	28.2 ± 1.2	14.0 ± 1.0	57.7 ± 0.5
	4	22.9 ± 2.0	19.3 ± 2.0	55.3 ± 0.6
	5	22.4 ± 2.3	20.0 ± 2.0	55.1 ± 0.6

Source: KSU Department of Grain Science and Industry.

power and monitoring cables running to a control trailer outside. The Aggreko system heated air within the buildling and did not duct additional air into the structure.

Both systems use fans to facilitate air circulation during heat treatment.

To test the effectiveness of both heating methods in achieving the target temperature throughout the mill and holding it there, the researchers placed a series of electronic temperature loggers at the floor level throughout the structure in a loose grid fashion. They used 16 to 22 loggers per floor in each room of the pilot mill. The loggers were positioned in the same locations for each heat treatment.

The loggers were set to record the air temperature at 10-minute intervals during the heat treatment. Researchers used the data from these loggers to map the temperature distributions on each floor.

Table 1 above shows the amount of time it took to reach 50 degrees C, the amount of time above that level, and maximum temperature reached on each floor of the cleaning house and flour mill during the June heat treatment, when the TempAir system was used.

Table 2 on page 66 shows the same information for the August heat treatment, when the Aggreko system was used.

Heating Results

Both heating systems performed reasonably well, though neither performed perfectly.

During the June heat treatment, one logger recorded an unusually hot spot on the second floor, and it turned out that it had been located directly under a heating spout. Half of the first floor failed to reach the target temperature, and some floor-wall junctions remained relatively cool, but the TempAir system performed well in most of the rest of the structure.

In August, the Aggreko system was able to produce target temperatures and hold them through most of the structure, but it did not quite reach into some of the corners of the structure.

Both systems were effective, but the researchers concluded that additional fans would be needed to better distribute heat

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Room TABLE 2	Floor	Time above 50°C (hr)	Time to reach 50°C (hr)	Maximum Temperature (°C)
Cleaning house	1	20.5 ± 3.7	5.2 ± 2.0	53.6 ± 1.4
	2	24.3 ± 4.4	19.1 ± 3.9	54.3 ± 1.4
	3	27.1 ± 3.3	20.9 ± 4.2	53.9 ± 0.6
	4	26.0 ± 2.7	9.7 ± 1.8	53.6 ± 0.7
Flour mill	2	20.0 ± 3.0	10.0 ± 2.0	53.3 ± 1.1
	3	30.0 ± 2.2	7.7 ± 1.4	54.7 ± 0.8
	4	24.2 ± 2.9	8.7 ± 1.5	53.9 ± 1.1

Source: KSU Department of Grain Science and Industry.

throughout the structure.

Both the June and August treatments produced no discernible damage to milling equipment. As part of the experiment, the researchers placed six old computers, both PCs and MACs, inside the feed mill during the August heat treatment to see what would happen. Three were left running, and three were turned off.

All of the computers withstood the exposure to the heat, which reached as high as 140 to 157 degrees F, depending on the location in the mill, and they continued to function.

The researchers also looked into the effectiveness of the heat treatments at destroying insect infestations. They placed caged stored grain insects in various locations around the mill, both with and without food. The cages were checked two hours into the heat treatments, at 11 hours, and at 29 hours.

Only a few insects had died at the two-hour mark. However, all were dead at 11 hours, with or without food, when the temperature had reached 122 degrees F for at least two hours.

To test the long-term effectiveness of heat treatments, researchers put out insect pheromone traps around the mill and kept them out through late December.

While the heat killed insects, but it must be followed up with good sanitation practices. The traps began to indicate insect populations returning two to four weeks after the last heat treatment. Of the various insects caught, red flour beetles were the most common.

Thus, heat treatments are effective at knocking back insect populations, but they can rebound slowly over time.

Ed Zdrojewski, editor