PENETRATION OF HEAT INTO CEREAL-GRAIN PROCESSING EQUIPMENT DURING A FACILITY HEAT TREATMENT

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During a heat treatment to control insects in food processing facilities, one of the limiting factors is the amount of time necessary for the heat to penetrate into closed spaces such as processing equipment and wall voids. Insects must be directly exposed to lethal temperatures for enough time in order for mortality to occur otherwise a control failure may result. Fields (1992) reviewed literature regarding the thermal requirements necessary to kill most stored-product insects and reported that exposure to 50°C for less than one hour are more than adequate. A heat treatment with a target time and temperature of 50-60°C for 20-30 hours allows time for heat to penetrate into protected spaces that may contain insects. The objectives of this project were to study heat penetration into selected pieces of equipment commonly found in cereal-grain processing facilities.

Methods. Heat penetration into five kinds of cereal-grain processing equipment was examined during a full plant heat treatment. The equipment included large and small Carter Day aspirators (Models CXY1-X, CRK1-X and CRL1-X), Forsberg gravity tables (Models 50-V-SAN, 60-V-SAN and 90-V-SAN), Carter Day disc seperators (Models 2523A, ADR3 and ZT4) and FM Smith hullers. Access panels and covers were opened on half of each type of equipment during the heat treatment while the remaining equipment remained closed. Temperatures were monitored at 10-minute intervals using HOBO Temp temperature sensors (Onset Computer Corp., Pocasset, Massachusetts). The temperature sensors were placed inside the opened and closed equipment as well as outside and adjacent to the equipment to compare heat penetration. The maximum temperature attained and the length of time that the temperature was above 50°C are reported here. The target temperature and time combination for this particular facility was 50°C for 20 hours.

Results. A summary of the data is tabulated in Table 1. The maximum temperatures recorded outside the equipment ranged from 58.9°C to 64.3°C that indicates that the target temperature was attained in all areas monitored. The length of time that the temperature was above 50°C outside the equipment ranged from 30.6 hours to 66.2 hours indicating greater variability than observed with the maximum temperatures. The maximum temperatures recorded inside the processing equipment were similar to those recorded outside regardless of whether the equipment was opened or closed during the heat treatment. Additionally, the amount of time that the temperature in excess of 50°C inside the equipment was similar to that outside and was not dependant upon whether the equipment was opened or closed. The maximum temperature attained and the

length of time that the temperature was above 50°C tended to be slightly greater inside the closed equipment than inside the open equipment or outside. This appeared to be due to a lag in cooling after the treatment; heat was retained inside the closed equipment while the open equipment cooled at a rate similar to the temperatures outside of the equipment.

While adequate heat was applied inside the closed equipment during this heat treatment, the results may not have been so clear-cut if less heating had occurred outside the equipment. Typically, processing equipment is opened and cleaned prior to a heat treatment. To best facilitate the heating processes and minimize the potential of insects escaping lethal temperatures, it would be prudent to leave equipment open during the heat treatment. If processing equipment is not left open during the heat treatment, these data indicate that adequate heat will still probably penetrate into the equipment.

Future plans. Heat penetration into other types of processing equipment and structural components of buildings at different outside temperatures will be conducted.

Table 1. The maximum temperature attained and the length of the time that the temperature was above 50°C (± SEM) during the heat treatment conducted July 2-5, 1998.

	outside	inside	inside
	of equipment	opened equipment	closed equipment
	maximum temperature attained (°C)		
large aspirator	58.9 ± 0.2	58.2 ± 0.2	59.2 ± 0.0
small aspirator	59.7 ± 0.4	58.5 ± 0.5	60.2 ± 0.7
gravity table	63.2 ± 0.2	62.7 ± 0.2	62.5 ± 0.1
huller	64.3 ± 0.1	63.2 ± 0.3	62.7 ± 0.3
seperator	63.0 ± 0.2	62.7 ± 0.7	64.0 ± 0.4
	hours the temperature was above 50°C		
large aspirator	30.6 ± 0.7	27.5 ± 0.5	32.3 ± 0.1
small aspirator	44.7 ± 2.3	38.2 ± 6.7	47.9 ± 5.0
gravity table	62.4 ± 0.4	60.7 ± 0.5	62.1 ± 0.9
huller	59.2 ± 0.8	61.0 ± 0.5	61.4 ± 0.3
seperator	66.2 ± 0.6	66.0 ± 1.3	66.8 ± 0.8