PALLET PHYTOSANITARY PROJECT BULLETIN

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DIELETRIC HEAT TREATING OF GREEN PALLET PARTS[1]
PART 1 – HEAT TREATMENT RESULTS

This bulletin summarizes the results of the above titled research project funded under the Competitive Grants Program of the Pallet Phytosanitary Project.

INTRODUCTION

The objective of this research was to determine the potential for phytosanitary treatment of green pallet parts using high-power radio frequency heating, to meet the requirement of 56° C for 30 minutes at the core of each piece of wood packaging material (WPM) being treated. Current heat-treating methods, using existing kiln facilities or heat treatment units require relatively lengthy treatment schedules and can result in significant damage to the pallets if not conducted carefully. In either case, capital investment is an important consideration. Similarly, current radio frequency (RF) techniques for heat-treating (WPM) require even higher capital investments because of the need for creating and maintaining a vacuum.

The dielectric heating process places wood, in the form of pallet parts, in a high frequency, high voltage electric field between two plates. The aluminum plates (also referred to as electrodes) are 40 inches long, 36 inches wide and 0.1875 inches thick. The applied power of the electrodes is infinitely adjustable between 5,000 volts and 13,000 volts. The electric field between electrodes generates heat in the dielectric material. High moisture content in the material increases the conductance, which increases the heating rate. Generally, voltages of 9,000 or more volts at 18MHz are applied to cause heating of the wood. No vacuum is necessary to apply this method.

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The dielectric heating technology has previously been applied to dry yarn packages, coatings, foods, adhesives, carpet backing, and stacked wood veneer.

METHODOLOGY

Test specimens were nominal 8/4 thick by 4-inch wide pallet stringer material and 5/8 inch thick by 4-inch wide pallet deckboard material of mixed oak species. Mean moisture content of these boards was 80.3 percent. Each 80-inch piece was cut into two 40-inch pieces; one to serve as a control and the other for testing purposes. The 40-inch lumber was required to accommodate the maximum capacity of the RF heat-treating unit.

Specimens were then tight-piled stacked. Stringers were stacked 3-layers deep in 6 adjacent stacks so that 18 stringers were treated per charge. Deckboards were tight piled with 10 pieces in each of 6 stacks. Three stringer and three deckboard charges were treated. All pieces were weighed prior to and after treatment to determine any moisture loss.

Five thermocouples were inserted into specimens to monitor temperature during the heat treatment. Preliminary heat-treating tests indicated that the bottom course of boards reached the lowest temperature. Similarly, thermocouples at board centers showed the lowest temperatures following the preliminary heat-treating tests. Therefore, thermocouples were located in the bottom board and at board mid-length. This insured monitoring of specimens with the lowest temperature in order to comply with the core temperature requirement of the phytosanitary standard.

Sheets of ¼ inch thick foam insulation were placed between the bottom electrode and the lumber and on the surface of the top course of lumber, completely covering both surfaces. The insulation was a foam house insulation of 3 lbs/ft^3 weight. Gaps of 5.5 inches and 5.25-inches were maintained between the upper electrode and the top surface of the stringer test specimens and the deckboard test specimens, respectively.

Heat treatment was applied for 30 minutes, which was sufficient to heat the lumber to temperatures above 56° C. Following the heat treatment, additional foam insulation material was inserted into the device, creating a 3-dimensional rectangular box, which completely insulated the heated lumber. The lumber was then left in place following the treatment and monitored for an additional 30 minutes.

RESULTS

During the 30-minute application of heat, the final temperature attained by the lumber substantially exceeded 56°C and averaged 72.2° C over all six charges. The lowest average charge temperature was 66.8°C and the highest average charge temperature was 82.7°C. The averages are based on the monitored results of the 5 thermocouples inserted into the test specimens for each charge.

During the 30-minute period of insulated storage following the heat treatment, average final temperature of all lumber was 69.3°. The lowest average final charge temperature was 66.2°C and the highest average final temperature was 73.3°C.

During the 30-minute storage phase, it was expected that the lumber would equilibrate over this time period, so that the highest temperature would cool, while the lumber at the lowest temperature would acquire heat from hotter charge lumber. This thesis proved correct, 12 of the 30 total thermocouple readings had a temperature increase, 17 experienced a temperature decrease and one had no change in temperature.

Mean temperature change between the end of heating and that at the end of insulated storage decreased 2.9°C, indicating a rather modest loss of heat during the insulated storage phase. The largest temperature decrease for any thermocouple in the six treatment charges was 19.6, moving from 99.7°C to 80.1°C. The largest temperature increase for an individual thermocouple in the six charges was 11.1°C, moving from 63.5°C to 74.6°C.

Moisture content loss during drying was 1.25 percent, as determined from comparing total lumber charge green weight prior to heating to the weight following heating and insulated storage.

Following treatment the pallet parts were visually inspected for warp. The results showed that no warping had occurred, which is consistent with the small reduction in moisture content.

DISCUSSION

The outcome of this research indicates that it is feasible to employ high-power RF energy to heat treat green pallet parts. The 60-minute treatment period successfully encompasses heating the core of each pallet part to at least 56°C and then maintaining at least that core temperature through a 30-minute period of insulated storage, in accordance with the heat treatment requirements of ISPM 15. In addition, negligible moisture loss in the pallet parts, accompanied by the lack of warpage, was a positive outcome with respect to possible degradation of the WPM.

An additional issue related to RF heat treatment concerns the possible degradation of the boards due to the high heat. As part of the overall study, an investigation of the effect of the RF treatment on the mechanical properties of the lumber was completed. The results of that component of the study are covered in Bulletin 6 of this series.