



Wiedemeier Wood Dryers LLC Report of The HT Sanitizer Sterilization and Mold Control Testing May, 2017

Testing Background:

A potential HT Sanitizer customer engaged White & Company President Marshall (Mark) White in conjunction with the Virginia Tech Center for Packaging and Unit Load Design and the HT Sanitizer team to conduct further testing focused on pallet sterilization and mold control. A detailed report of about 20 pages was produced after the testing by White & Company and shared with our company. This document summarizes the testing activities and results.

Test Description:

A southern US pallet company manufactured and shipped, 210 green southern pine and 210 green sweet gum GMA style pallets to Waupaca, Wisconsin. The deck board thickness was 0.563 inch and stringer width 1.25 inches for all pallets. The pallets were delivered by trailer on April 26, 2017 at the HT Sanitizer customer site in Waupaca, WI. On April 27 all pallets except 30 pine (20 control pallets and 10 pallets for Initial MC) and 30 gum (same breakdown as pine) were treated.

Three stacks of 20 pallets of each species were treated, separately, for 2, 1.5, and 1 hour. A total of 180 pallets of each species were treated. The initial chamber temperature was 450F. However, the chamber temperature varied from 250F to 290F during the treatment.

Multiple calibrated temperature data loggers were placed into dummy stringer segments to collect temperatures of each cycle and species.

Small specimens, 1 inch wide, were removed from a 5.5 and 3.5 inch deck board and a 1.25 X 3.5 inch stringer from each of five pallets of each species. These were sealed in plastic bags and forwarded to the Virginia Tech, Center for Packaging and Unit Load Design at 1650 Research Center Drive, Blacksburg, Virginia. The small specimens will be dried for 48 hours at 103C and the oven dry moisture content was calculated. Ten pallets of each species in each chamber charge of 60 pallets were weighed before and after treatment. Based on the initial moisture

content and the weight of the pallets before and after treatment the average moisture content of the wood in each pallet can be determined, before and after treatment. The rate of moisture loss will also be calculated for each treatment cycle and wood species.

Ten pallets of each species in each chamber charge of 60 pallets were weighed, pallet splits and cracks were counted before and after the treatment cycles.

Unfortunately the pallets exhibited mold growth when delivered to Waupaca. The test had to proceed by comparing changes in mold on the pallets immediately after treatment with changes that occurred after shipping and storage. Since the temperatures used for treatment will sterilize the wood surfaces, the changes will reflect the efficacy of the treatment. Ten pallets of each species and treatment cycle were randomly selected and placed into each 60 pallet charge. These pallets were labeled as "VR". After treatment the VR pallets were photographed in detail, so changes in mold could be documented, after shipping and storage. Half of the pallets including the control and "VR" pallets were delivered to Blacksburg on April 29th. The remaining pallets were delivered back to the southern pallet customer. Pallets left in Blacksburg, half were placed into stacks of 5 to 10 pallets. Gum and pine were stacked together however the stacks were separated according to treatment cycle. The "VR" pallets and control pallets were stacked separately. On April 29th half of the pallet stacks were covered on top with OSB panels to simulate ventilated shed storage. The other half of pallets was covered on top and all sides in black plastic to simulate drop trailer unventilated storage. These pallets were monitored for 3-4 weeks for mold growth.

Test Results:

1. Cycle time for ISPM 15 compliance

It should be noted that the stringer segments blocks used in testing were reused and therefore, dry. A separate test was done on 5/24/2017 to understand heat up times of green versus dry dummy stringer blocks. It was determined that it only takes an average of 5 minutes longer for green blocks to come up to temperature. So when applying this additional time to each of our 4/27 treatment cycles, all treatment cycle times produced the needed wood temperatures and times to meet ISPM-15 compliance within 1 hour for each cycle.

2. Average energy consumption

The average power consumption in kilowatt (KW) hours was calculated based on voltage (V), amperes (A) and duration of treatment according to:

$$KW = (V \times A) / 1000$$

Energy consumption was recorded and the machine consumes 1.28 KW per hour.

3. Treatment effect on pallet quality

The only changes in pallet quality observed was in the number of open wood splits in the nailed connections between the deck boards and the stringers. The pine pallets were little affected by the 1, 1.5, and 2 hour. The gum pallets started to show levels of degradation in the form of an increased number of open splits at connections during the 1.5 and 2 hour cycles.

4. Drying rate

The gum and pine pallets were very green (wet) prior to treatment. The average rate of moisture loss for gum was 10.2% per hour and for pine 12.7% per hour. As expected the pine loses more moisture than the gum pallets and the longer the treatment, the more moisture is removed. When comparing the pallet weight changes as a function of location of the VR pallets in the stacks, there are no trends that would indicate significant temperature gradients and subsequent drying rates differences within the chamber. Although not

measured, it was evident that the surfaces of the wood, immediately after treatment, were very dry.

5. Mold control efficacy

The pallets in storage in Blacksburg, Virginia were monitored and inspected for 3 weeks in storage. The control, untreated pallets under the black plastic exhibited some new mold growth. No other pallets in storage showed any change in mold when compared to the pallets after sterilization treatment in Waupaca, Wisconsin. However, the average evening and daytime temperature during storage were 45 to 55F and 55 to 65F respectively.

If the treated pallets are stored, shipped, and used in very well ventilated situations, mold growth after sterilization treatment is controlled. The 1.0, 1.5, and 2.0 sterilization treatment cycles seem to be equally effective. However, because of the high average wood moisture content after sterilization treatment, re-wetting of the wood surfaces and subsequent mold growth will be difficult to control in some situations.