FUMIGATING AND HEAT-TREATING IN SERVICE HARDWOOD PALLETS

L. David Dwinell
USDA Forest Service, Southern Research Station, Athens, GA 30605

The risk of introduction of pests in wood packing material (i.e., crating, dunnage, pallets, and cable spools) is a global issue. There is a paucity of information, however, on mitigation measures to eradicate pests in wood packing material. This study reports on the possible use of methyl bromide fumigation and elevated temperature to eradicate fungi in in service hardwood pallets.

Fumigation. The poplar/gum (*Populus* spp./ *Liquidambar styraflua*) and oak (largely *Quercus rubra*) pallet stringers and deckboards were obtained from Exclusive Services and Pallet Co., in Bogart, Georgia. The material was from pallets that been in service for 2-4 years. The stringers were 33-mm-wide by 80-mm-thick by 38-cm-long. The oak deckboards were 10-mm-thick by 90-mm-wide by 45-cm-long and the poplar/gum deckboards were 10-mm-thick by 90-mm-wide by 38-cm-long. Before and after treatment, the boards were sampled for fungi. An area on one face of the board (about 100 cm^2) was sprayed with 95 percent ethyl alcohol that was lit with a flame (flame-sterilized). Using a flame-sterilized bit on a variable speed drill, the board was drilled to the core. Samples of the resultant borings were then plated on malt extract agar. The plates were read for fungi ten days later. The wood moisture content of the pallet material was determined by drying stringer and deckboard samples at 105^{o}C for 24 hours.

The fumigation was done outdoors in three tents (replicates) constructed of plastic pipe and covered with a polyethylene sheet. Each tent had a volume of 5.69 m^3 and was on a concrete pad. The edges of the polyethylene sheets were sealed prior to fumigation. Each load (replicate) consisted of 10 poplar/gum stringers, 10 oak stringers, 10 poplar/gum deckboards and 10 oak deckboards. The pallet wood was fumigated for 24 hours beginning 28 November 2001 at 10:40 am at a rate of 80 g/m^3. This is equivalent to APHIS T404 schedule for wood products for 4 - 20^{o}C. The nonfumigated controls run was begun 4 December 2001 at 10:30 am and concluded 24 hours later. The ambient and chamber temperatures were monitored by Hobo dataloggers (Onset Computer Corp.). In each chamber, a type-J thermocouple was inserted into the geometric center of two stringers and two deckboards. A Campbell Scientific 21X datalogger was used to record the core wood temperature data.

Heat-treatment. The hardwood pallet material used in this experiment was the same as for the fumigation study. The oak and poplar/gum deckboards were 10-mm-thick by 90-mm-wide by 102-mm-long. The oak stringers were 33-mm-thick by 80-mm-wide by 114-mm-long. The wood was heat-treated in water baths with the water adjusted to 57, 62, 67, 72, 77 and 82^{o}C (1^{o}C higher than the target core wood temperature). For each temperature run, three baths were calibrated to the desired temperature (replicates). Ten deckboards or stringers were placed in two ziplock polyethylene bags (5 samples/bag) and submerged in the water bath. One of the deckboards or stringers in each bag had a type-J thermocouple inserted to its geometric center

from the side. A Campbell Scientific CR10X datalogger was used to record the core wood temperatures. When the core wood temperature reached 56, 61, 66, 71, 76, or 81°C, the samples were removed from the water baths. The control samples were held at 25°C in an incubator. The procedure used to isolate the fungi from the wood was the same as for the fumigation study.

Results and Discussion. In the fumigation run, the ambient temperature was fairly mild (Table 1). Although the maximum chamber temperature of 29°C exceeded 20°C, the minimum and mean temperatures of 14 and 19°C, respectively, were within the parameters of the T404 schedule. The nonfumigation run was during a cold wave, so the temperatures were somewhat lower than those for the fumigation run. The maximum core wood temperature of the test material, however, did reach 26.9°C. In both runs, the core wood temperature of the pallet components paralleled the chamber temperature.

The effects of methyl bromide on fungi in pallet wood that had been in service for several years and had dried to its equilibrium wood moisture content (8 – 10 percent on dry weight basis) were mixed (Table 2). Prior to fumigation, fungi were isolated from all of the boards. The lack of diversity of fungi isolated from the pallet components is significant. The fungi most frequently isolated were the cosmopolitan *Trichoderma* spp. (probably *T. harzianum*), *Paecilomyces variottii* and *Aureobasidium pullulans*. On average, the incidence of fungi in the hardwood stringers and deckboards after fumigation was 73 and 12 percent, respectively. After fumigation, *Trichoderma* spp. was rarely isolated from the wood. *Paecilomyces variottii* and *A. pullulans* were able to survive fumigation in a dry state (desiccated) in wood at the equilibrium moisture content.

As with the fumigation study, the most commonly isolated fungi from the heat-treated wood were *Trichoderma* spp., *P. variottii* and *A. pullulans.* The frequency of isolation of fungi did not vary significantly by wood species (oak vs. poplar/gum) or pallet component (stringers vs. deckboards) (Table 3). The frequency of isolation of *Trichoderma* spp. declined when the core wood temperature exceeded 66°C. *Paecilomyces variottii* and *A. pullulans* appear to be highly resistant to exposures to temperatures as high as 81°C. In general, the frequency of fungi isolated from heat-treated wood did not significantly decline until the wood temperature was 71°C or higher.

Conclusions. The need to treat pallets that have been in service for more than one year is problematic. During the years 1985 through 1998, USDA APHIS reported that crating, dunnage, and pallets accounted for 45, 33, and 6 percent, respectively, of their interceptions of exotic insects with wood articles. As a general rule, insects exit the wood by the time the pallet components are one-year-old. In coniferous wood, the pinewood nematode (*Bursaphelenchus xylophilus*) cannot survive in wood that has reach the equilibrium moisture content (10-12 percent for southern pines). Fungi do not grow in wood in which the moisture content is below the fiber saturation point. As shown here, some saprophytic fungi in hardwood pallets, which survive in a desiccated state at the equilibrium moisture content of the wood, are resistant to methyl bromide fumigation and elevated temperatures. These fungi, however, do not cause tree diseases and are not a risk to native forests. The most cost efficient way to insure that wood packing material used in international trade is not a pest risk is to use seasoned, pest-free lumber at the time of their manufacture.

Table 1. Summary of temperature data for methyl bromide fumigation study.

Treatment	Temperature (°C)		
	Ambient[a]	Chamber	Core wood
	Mean, Max., Min.	Mean, Max., Min.	Mean, Max., Min.
Fumigated	17.5, 23.6, 14.5	19.2, 29.0, 14.6	19.3, 30.0, 14.4
Nonfumigated	12.4, 21.2, 6.2	12.7, 27.3, 6.0	12.4, 26.9, 6.0

[a]The temperature outside of the chambers.

Table 2. Isolation of fungi from hardwood stringers and deckboards before and after treatment.

Pallet material and component	WMC (%)[a]	Fumigated		Nonfumigated	
		Pre-fumigation	Post-fumigation	Pre-treatment	Post-treatment
		Fungi (%)[b]	Fungi (%)[b]	Fungi (%)[b]	Fungi (%)[b]
Poplar/gum stringers	8.5	100	73	100	100
Oak stringers	9.6	100	73	100	100
Poplar/gum deckboards	8.1	100	17	100	100
Oak deckboards	8.4	100	7	100	100

[a] Expressed on a dry weight basis.
[b] Mean of three replicates (10 boards per replicate).

Table 3. Isolation of fungi from heat-treated oak stringers and deckboards, and poplar/gum deckboards.

Temperatures (°C)	Oak deckboards (%)[a]	Oak stringers (%)[a]	Poplar/gum deckboards (%)[a]
25	100	100	80
56	74	100	70
61	83	80	90
66	87	100	70
71	67	60	80
76	60	-	50
81	53	-	50

[a] Mean of three replicates (10 boards per replicate).