PALLET PHYTOSANITARY PROJECT BULLETIN

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COMMERCIAL FEASIBILITY OF VACUUM TO CONTROL INSECTS IN RAW WOOD PACKAGING MATERIALS[1]

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 demonstrate the commercial feasibility of a low-pressure vacuum method for insects and nematodes in wood packaging material (WPM). This was accomplished as a commercial scale test conducted in a laboratory environment, as an intermediate step in the development of the process and the final step prior to a commercial demonstration with an industry partner.

The vacuum process in this research utilizes a flexible container, that is applicable for use with both lumber and pallet parts. The same principle can then be extended, if feasible, to treat assembled pallets in a rigid chamber. For example, existing preservative treatment cylinders could be used to create vacuums adequate to kill insects.

Advantages of a low-pressure vacuum sterilization system are that it consumes little energy, eliminates the need for a heating system, does not release ozone-depleting chemicals, and maintains the original color and strength of the treated wood.

METHODOLOGY

Technical feasibility of the vacuum method for commercial scale treatment was tested on two types of pests: the Longhorned Beetle and Pinewood Nematode.

[1] The researchers on this project were Zhangjing Chen and Marshall White (Virginia Tech) and W. H. Robinson (Urban Pest Control Research and Consulting).

Longhorned Beetle

The vacuum process was tested with two species of the longhorned beetle: the ribbed pine borer (*Stenocoruis lineatus)* and the sawyer beetle *Momochamus spp):* and pinewood nematodes. The equipment used in the study included a vacuum pump, condensing system, vacuum controlling system, and one flexible container. The 5.68 m^3 (1500 gallons) flexible container consisted of high tenacity woven fibers, coated and impregnated with specialty synthetic rubber compounds. All corners and openings were fabricated with heat and pressure seams and heavy duty flange connections and reinforcements.

Test pressure was 20 mm Hg and temperature 20° C. Wood test specimens were southern yellow pine (15.24 cm x 15.24 cm x 243.84 cm) at a range of moisture contents, from 9 percent to 42 percent. The test specimens were packed tightly to a size of 91.33 cm x 152.4 cm x 243.84 cm and inserted into the flexible container.

Larvae and pupae of the old house borer and sawyer beetle, weighing 100-500 mg, were placed into holes (1 cm in diameter and 6 cm deep) drilled into the center of test specimens, plugged with a dowel, placed at various locations inside the wood stack, and treated within 1 hour of placing the larvae.

Pinewood Nematode

Nematodes (Bursaphelenchus xylophilus) were raised on a culture of *Botrytis* fungus in agar and then inserted in a groove (7.92 mm wide by 38.1 mm deep) cut at the center of the southern pine test specimens. Moisture content of the wood was 53.8 percent. A vacuum of 20 mm Hg was applied to the test specimens for 24 hours.

RESULTS

Longhorned Beetle

The larvae and pupae were subjected to three heat treatment periods. At 90 hours and 24 hours all larvae and pupae were killed. At 12 hours all the pupae were killed, but nearly half the larvae were still alive. As a result, the researchers concluded that a 12-hour treatment was not sufficient to kill the beetle larvae and pupae, although the lethal time for pupae is shorter than for larvae.

From a comparative standpoint, the low pressure vacuum method with a 24 hour cycle at 20 mm Hg is comparable to the typical methyl bromide fumigation cycle time, but longer than the 3 to 5 hour cycle time for heat treatment.

Pinewood Nematode

Following the 24 hour treatment period, no nematodes were found alive. However, the nematodes in agar that were inserted into the wood had little direct interaction with the wood. Therefore, the experiments were repeated using wood chips and wood flakes infested with pinewood nematodes. Moisture content of the chips and flakes were 49 and 42 percent, respectively. It was found during experimentation that the chips and flakes lost about 90 percent of their moisture during the vacuum treatment, virtually assuring nematode fatality. Additional experiments, with moisture content maintained by wrapping in a wet towel, showed that a 24-hour treatment cycle was sufficient to kill all the nematodes. The final moisture content of the chips and flakes was 35.4 percent.

ECONOMIC FEASIBILITY

The researchers conducted an economic feasibility analysis for a proposed production plant that is assumed to treat 1000 pallets per day, 250 days per year. Each pallet is assumed to contain 16 board feet, with a 5 percent allowance for waste, translating to 16.8 board feet of furnish for each pallet or 16,800 board feet per day. The number of vacuum containers needed to handle the production (assuming the 24 hour treatment period for each charge) is 10, with each container measuring 1.22m x 1.22m x 3.05m (4' x 4' x 10').

The physical footprint of the facility will require one acre of land, including a small office, and a covered storage shed for finished products. Land and site preparation is estimated at $10,000 and construction of the office and covered storage is estimated at $100,000.

Production equipment includes: two vacuum pumps (one to serve as a backup) at $10,000 each for a total of $20,000; 15 flexible vacuum containers (10 production and 5 for backup) at $2,000 each for a total of $30,000; a condenser and vapor trap at $2,000; a forklift at $15,000; hand power and maintenance tools at $1,000; office equipment at $1,500; and a 5 percent allow on total cost to cover engineering, installation, and contingency funds.

The researchers assumed a commercial loan of $200,000 for a term of 15 years at an interest rate of 4.875%, yielding an annual payment of $18,822 for principal and interest.

Labor includes a facility manager at $40,000 per year plus 30% fringe costs for a total of $52,000 per year; two production laborers at $10 per hour and a 30% fringe rate for a total of $52,000 for both.

Energy costs to run the vacuum pump is estimate at $1,225 per year. Other energy costs including heat, light, and liquid propane for the forklift is estimated at $2,800 per year.

Raw material cost, assuming $0.4536 per board foot and an annual raw material requirement of 4,200 mbf, translates to a cost of $1,905,120.

Revenue will be based on the market pricing of heat-treating and/or fumigated products. Current pricing indicates an additional $1.00 to $2.00 per treated pallet. With the cost of raw material for each pallet at $7.62 the estimated premium for the vacuum treatment translate to a price range of $8.62 to $9.62 per pallet.

With annual gross revenue of between $2,155,000 ($8.62 per pallet * 1,000 pallets per day * 250 days per year) and $2,405,000 ($9.62 per pallet * 1,000 pallets per day * 250 days per year) and annual costs of $2,078,869, return on sales ranges from 3.6% to 13.6% and return on investment ranges from 40.2% to 172.0%.

The authors conclude that from both a technical and economic feasibility standpoint, the low vacuum pressure system for eradicating pests from WPM is a viable alternative to the current available options: heat treatment and methyl bromide fumigation.