

EFFICACY OF VACUUM/STEAM TREATMENT OF MOLD FUNGI IN COTTON BALES

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Summary. The efficacy was assessed for using vacuum/steam technology to kill mold fungi growing on the cotton. The five species of mold fungi tested were *Aureobasidium pullulans*, *Aspergillus niger*, *Chaetomium globosum*, *Gliocladium virens* and *Penicillium pinophilum*. Cotton samples were inoculated with mold fungi. Inoculated cotton samples were inserted into the center and mid-center and attached to the surface of bales. The bales with inoculated cotton samples were vacuum/steam treated using the Xorella chamber. The five-cycle vacuum/steam treating schedule was applied in all the tests. The efficacy was determined using three methods, i.e. microscopy examination, sample culturing and fungal colony formation unit to evaluate the viability of fungi. All mold fungi were killed during steam/vacuum treatment using five-cycle treating schedule.

Objective. The objective of this research was to measure the efficacy of vacuum/steam treatment for controlling mold fungi in cotton bales using a vacuum/steam treating equipment supplied by XORELLA AG, a subsidiary of Fong's Industries Co., LTD.

Experimental equipment. Xorella equipment consists of a vacuum pump, vacuum gauge, and vacuum chamber, steam generating system and air compressor. This treatment system can create and regulate vacuum in the container. At the same time the system produces the steam and maintains the saturation state in the container.

Vacuum/steam treatment schedule. A five-cycle treatment schedule was used. During the first cycle, the system reduces the pressure to 150 mbar and steaming lasts for 5 minutes. During the second cycle, the system reduces the pressure to 170 mbar, and steaming lasts for 5 minutes. The third and fourth cycles are the same. The system reduces pressure in the container to 180 mbar and steaming lasts for 10 minute to increase temperature. During the final cycle, at 180 mbar, steam is injected periodically to control the temperature at 70°C for 60 minutes. Total time including vacuum and steaming was about 120 minutes for each test using five-cycle vacuum/steam treating schedule.

Fungal Inoculums. Five fungal inoculums and procedures used are described in ASTM D4300-1. The fungal inoculums were grown in a nutrient medium, and a

spore suspension at a concentration of 1×10^6 spores/ml was produced from each fungus. The spore suspensions were uniformly sprayed on the cotton products.

Vacuum/steam treatment of inoculated bales. During the test, the inoculated samples were placed at the three locations in the minibales (28×30.5×45.7 cm), i.e. center of bale, middle distance between the center and the surface of the bale and surface of bale. The fifteen inoculated cotton samples (three samples for each fungi species) were vacuum/steam treated at one time. Three replicate tests were performed.

Inoculated non - treated control samples. The control samples of the five mold fungi were prepared. The control bales were not be treated and placed near the treating facility. These were used to verify treatment effects.

Vacuum/steam test of bale without inoculation. This test was performed to check the integrity of the cotton bale after five-cycle vacuum/steam treatment. At the same time, the temperatures at center, halfway and surface were recorded. One bale was treated.

Non - treated and not inoculated control bale. This bale was observed to see whether mold spores from environment would germinate in the cotton bale and influence test results. One bale was used.

Result and Discussion. Total time including vacuum and steaming was about 120 minutes for each test using five-cycle vacuum/steam treating schedule. The temperature profiles within the cotton bales are shown in Figure 1. The inoculated cotton samples and other cotton samples were analyzed at Forintek laboratory, the Canada's Wood Products Research Institute to determine the morbidity of mold. The analysis by Forintek confirmed that mold fungi were killed after the vacuum/steam treatment. In this process, temperature, low pressure and time are essential parameters to maintain. This treatment condition may also be lethal to insects such as boll weevil. Many insect life cycle states can be quickly killed at 65°C. Also, 56°C and 30 min treatment is the standard for the control of insects in solid wood packaging according to ISPM 15 2002. This implies the Xorella vacuum/steam would be fatal to boll weevil of any life cycle stage.

Conclusion. The results confirm that mold fungi are killed after the vacuum/steam treatment using Xorella process.

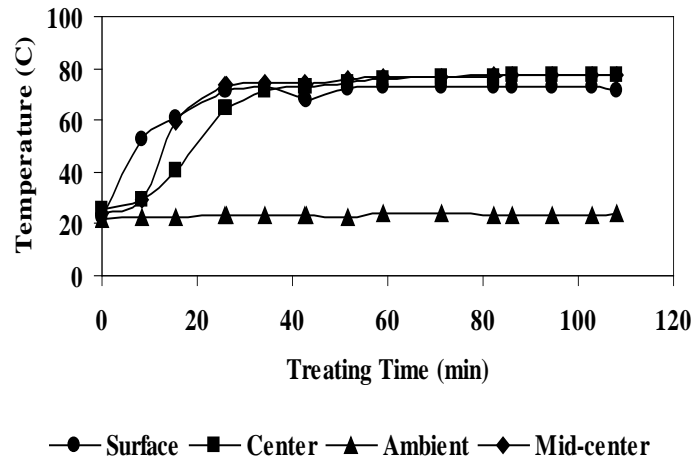


Figure1. Temperature profiles within minibale of cotton during the vacuum/steam test