

Use of high intensity ultrasonic for killing wood pests

Technology tested on fungi, mold and termites

Documentation of research internship at University of Tennessee

for

Marshall Plan Scholarship Programm

written by

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Abstract

The internship dealt with five different experiments concerning high-intensity ultrasonic treatments of wood: Woodblocks infected with different fungi and mold species or infected with termites were treated as well as the moisture contents of treated samples and control samples were compared.

The results showed that high-intensity ultrasonic is not a suitable technique to clean pest-infected wood.

Keywords:

High-intensity ultrasonic

Wood pests

Mold

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1 Introduction

In today's industry, high intensity ultrasonic technique is used for different fields of application. For instance, it enables extraction of plant oils, colors and other plant extracts as well as defoaming liquids used in food and beverage manufacture. After cutting white oak samples (1 inch x 1 inch x 1 inch) out of staves of used white and red wine barrels, and treating them with high intensity ultrasonic technology in order to clean, sanitize and enhance the life span of a wine barrel, it turned out that the Australian company "Cavitus" already uses this technology in an economic and industrial way. (www.cavitus.com, 2008)

The aims of this project had to be changed and the focus was put on sanitation of wood with high intensity ultrasonic dealing with typical wood pests like mold, wood fungi and termites. Since no test standards exist for ultrasonic treatment in this field, different experiments and settings had to be arranged.

Possible fields of application of ultrasonic technology could be palette or fruit box industry where fresh cut wood is used for production. The sanitation of produced palettes and boxes is assured by kiln-dryers which need a lot of energy. The use of ultrasonic technology would save a lot of energy and costs.

The objectives of this project were to determine if ultrasound technology is able to penetrate into wood in order to kill wood pests like insects, fungi and mold, which not only attack the wood surface but also the inner tissues.

2 Material and methods

2.1 Material

A high intensity ultrasonic device with micro tip was used for all tests. It was a "Misonix sonicator 3000" device and samples were treated in a glass beaker in deionized water, which was cooled by crushed ice.



fig. 1: High intensity ultrasonic device „Sonicator 3000“ of Misonix (Perchermeier, 2010)

The "sonicator 3000" converts electrical energy into mechanical vibration due to a piezoelectric crystal. The sonotrode emits those vibrations in a longitudinal direction and causes cavitation in liquids (*Misonix, operation manual, year unknown*).

Cavitation is a very quick alternating high-pressure and low pressure cycle causing small vacuum bubbles which implode. The implosion of those bubbles releases very high pressures and temperatures in the local surrounding and liquid jets of up to 280m/s velocity can occur (www.hielscher.com, 2007).

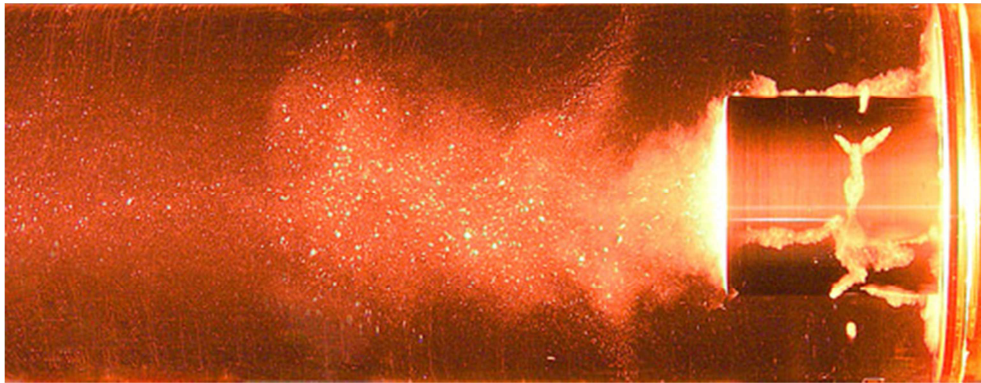


fig. 2: Ultrasonic cavitation (www.hielscher.com, 2007)

2.1.1 Ultrasonic treatment of fungi infected wood samples

Seasoned poplar panels were cut into cubes (dimension: 1inch x 1inch x 1inch), sanitized and were given into sterile jars filled with moist soil. The fungus species "trametes versicolor" was inoculated under sterile conditions and all jars were given into an incubator in order to let the fungus grow on the samples which had a moisture content of 45%.

Fresh cut Hickory, which was already infected with several fungi species, was also cut into cubes (dimension: 1inch x 1inch x 1inch) for the ultrasonic treatment.



fig. 3: fresh cut Hickory infected with fungi (Perchermeier, 2010)

2.1.2 Ultrasonic treatment of mold infected pine sapwood

Fresh cut pine sapwood was cut into cubes (dimension: 1inch x 1inch x 1inch) and sanitized. Five different mold species (*Aureobasidium pullulans*, *Aspergillus niger*, *Penicillium chrysogenum*, *Penicillium fellutanum* and *Trichoderma viride*) were grown in petri dishes.

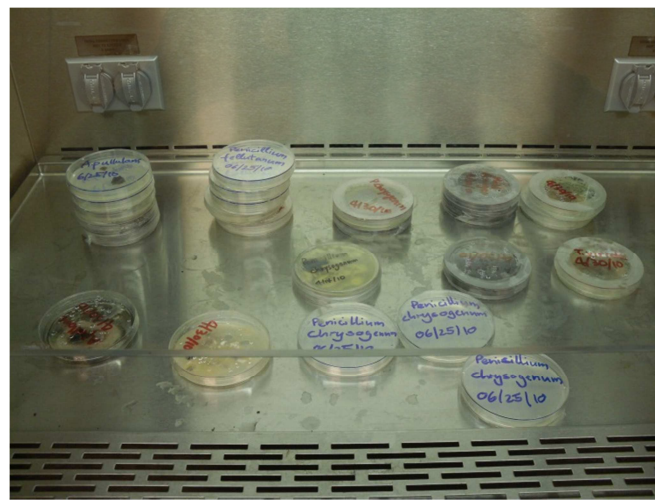


fig. 4: mold species in agar plates used for test (Perchermeier, 2010)

Afterwards the species were mixed into deionized water, filtered to remove mycelia and the suspension was sprayed onto all pine samples under sterile conditions prior to giving the samples into sterile jars filled with malt extract in order to let the mold grow for at least three days.



fig. 5: Suspension of mold and water before filtering (Perchermeier, 2010)

2.1.3 Ultrasonic treatment of termite infected poplar samples

Seasoned poplar was cut into blocks (dimension: 1inch x 1inch x 1inch) prior to drilling a hole into each sample. A living termite was given into each hole before the sample was closed tightly with a wooden plug.

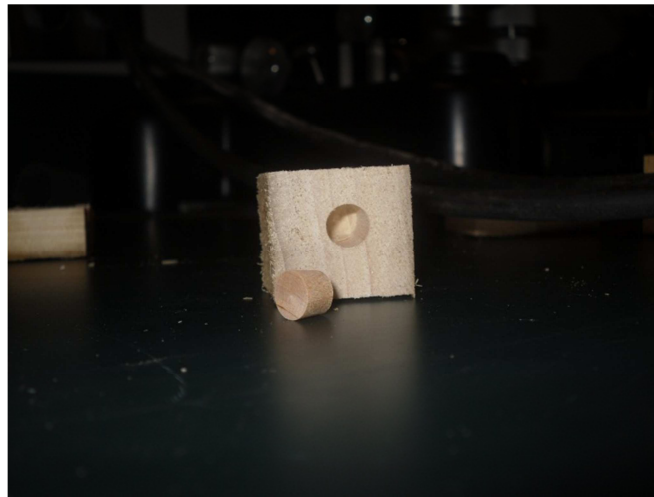


fig. 6: Sample for termite-test (Perchermeier, 2010)



fig. 7: living termites used for testing (Perchermeier, 2010)

2.2 Methods

2.2.1 Ultrasonic treatment of fungi infected wood samples

The specimen were mounted onto an aluminium plate to assure a fixed position in the beaker and to keep the sample under the water surface which can be seen as a schematically description in fig. 8.

A few drops of ethanol were added to reduce the surface tension of water which enhanced the effect of cavitation. The sonotrode was adjusted in a distance of 5 mm. All samples were treated with different parameters, as table 1 shows.

Since the treatment should be tested on every stage of fungi growth, the samples were treated every 2 to 3 days. The ultrasonic intensity was on highest rate in every run (≈ 1500 V rms) and the water temperature did not exceed 35°C to assure that the temperature did not kill the fungi but only the high intensity ultrasonic.

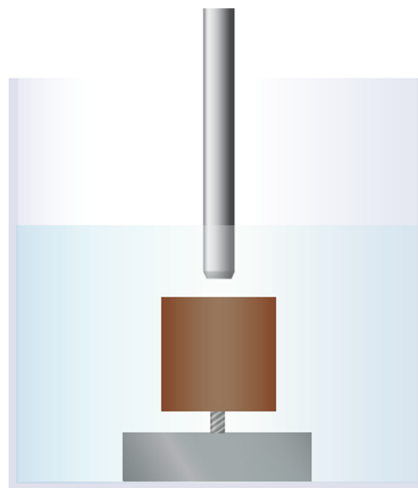


fig. 8: a schematically description of the experiment's settings (Perchermeier, 2010)

Table 1: Parameter of high intensity ultrasonic treatment tested on poplar and Hickory samples (Perchermeier, 2010)

	Total treatment time [min]	Impulse [sec. on/sec. off]	samples/run [-]
Poplar	30, 40, 45, 60	30/30, 40/20, 120/40, 180/40, 600/120	1
Hickory	30, 40, 45, 60	30/30, 40/20, 120/40, 600/120	1, 3

After the ultrasonic treatment every sample was dipped into ethanol and flamed in order to kill spores which could contaminate the surface of a treated specimen after the cleaning procedure. Subsequently the sterile sample was given into a sanitized jar filled with malt extract. All jars were put into an incubator which had the perfect climate for possibly surviving fungi spores.

2.2.2 Ultrasonic treatment of mold infected pine sapwood

The settings in this experiment were similar to those in chapter 2.2.1, except of the complete ultrasonic treatment took place under sterile conditions as well as the parameters “total treatment time” and “impulse” were changed. The impulse was set on 10 minutes on/2 minutes off for all runs and the total treatment time was changed to 30 minutes.

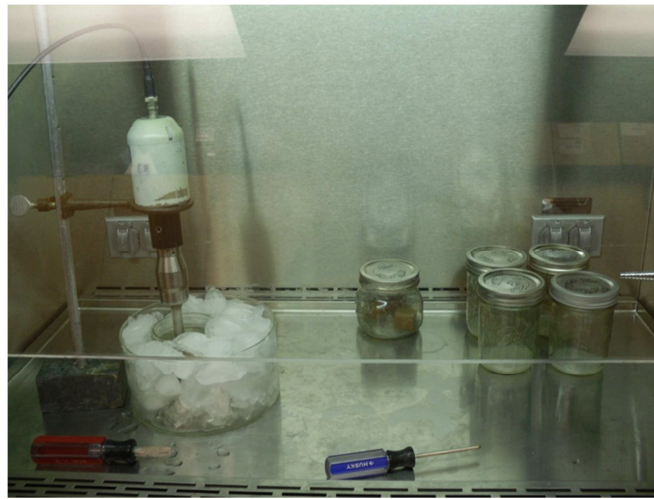


fig. 9: Experiment settings under a sterile hood (Perchermeier, 2010)

In this experiment, every specimen was as well dipped into ethanol, flamed and was given into a sterile jar filled with malt extract. All jars were stored in an incubator providing the appropriate climate for a possibly regrowth of mold.

2.2.3 Ultrasonic treatment of termite infected poplar samples

The prepared samples were treated with different parameters which can be seen in the following table:

Table 2: Parameters of ultrasonic treatment of termite infected wood (Perchermeier, 2010)

sample #	Impulse (min. on/min. off)	total treatment time (min.)
1-3	5/1	30
4-6	10/2	30
7-9	15/3	30
10-12	20/4	40
13-15	30/0	30

After treating a sample, it was carefully opened with a chisel in order to check if the termite had survived.

2.2.4 Moisture content tests of ultrasonic treated wood

In this experiment seasoned poplar was cut in blocks with 1 inch edge length. Prior to treating each sample with ultrasound and different parameters, its mass was determined. Control samples were given into a beaker filled with water and were kept under the water surface. A schematically description of the experiment's settings can be seen on fig. 10 and fig. 11 .

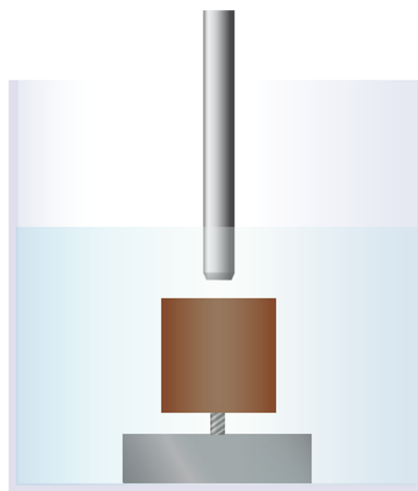


fig. 10: Schematically description of experiment's settings for ultrasonic treatment of wood (Perchermeier, 2010)

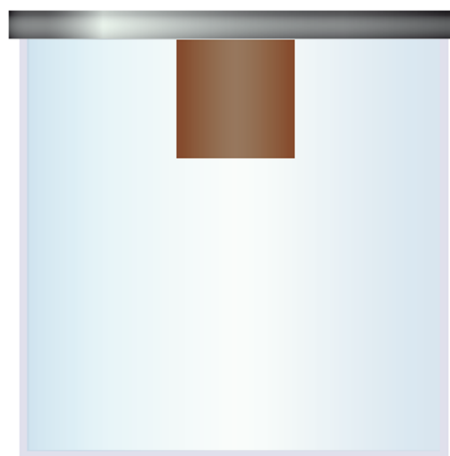


fig. 11: Schematically description of experiment's settings for control samples (Perchermeier, 2010)

The impulse parameters were 10, 15 and 20 minutes on and 2, 2 and 4 minutes off. The total treatment time varied with 30 and 40 minutes, the time of control samples staying under the water surface changed from 34 to 32 and 44 minutes.

Afterwards the moisture content of all samples was determined according to standard EN 322.

3 Results

3.1 Ultrasonic treatment of fungi infected wood samples

53 samples and 26 control samples were treated in total. After 2 to 5 days a regrowth of fungi could be seen on all samples.



fig. 12: Hickory sample, 3 days after ultrasonic treatment (Perchermeier, 2010)

The fact that the fungi regrowth started quicker and more intense on the treated samples in comparison to the control samples, was a striking observation and can also be seen on fig. 13:

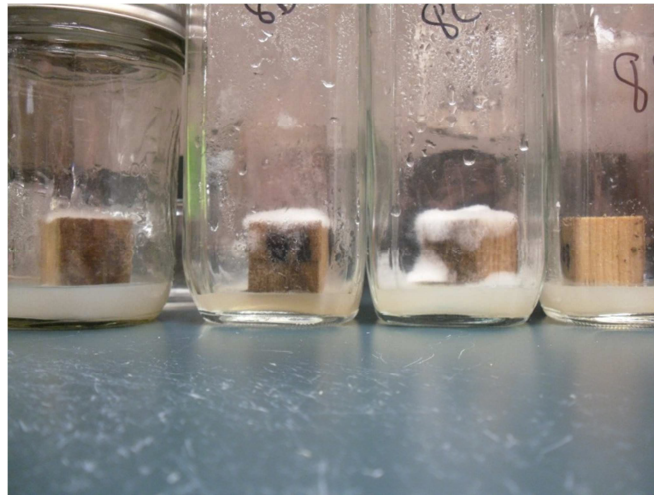


fig. 13: Poplar samples, 3 days after treatment, control sample on the right side (Perchermeier, 2010)

3.3 Ultrasonic treatment of termite infected poplar samples

Table 4: Treatment parameters and survival rate of termites (Perchermeier, 2010)

Sample#	parameters	termites	
		dead	alive
1	5min/1min impulse; 30min total		
2			
3			
4	10min/2min impulse;30min total		
5			
6			
7	15min/3min impulse;30min total		
8			
9			
10	20min/4min impulse;40min total		
11			
12			
13	30min/0min impulse; 30min total		
14			
15			

Though different parameters were tested on the samples, most of the termites survived the ultrasonic treatment. One termite was killed but this was not caused by ultrasonic treatment but by opening the poplar sample not carefully enough.

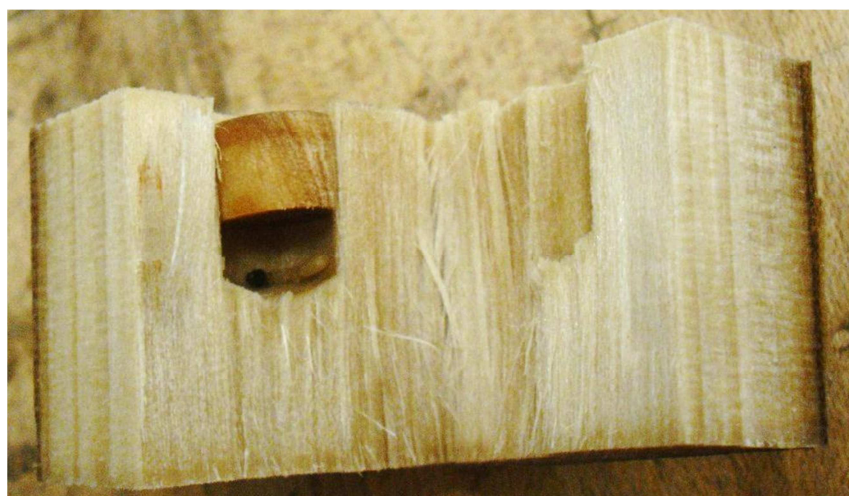


fig. 14: sample opened after treatment with living termite (Perchermeier, 2010)

3.4 Moisture content tests of ultrasonic treated wood

The treated samples had moisture contents between 37% and 55%, the control samples between 27% and 30%. Though the standard deviations of the moisture contents of treated samples are with 3.16, 7.10 and 2.37 quite high and varying, it is obvious that high intensity ultrasonic treatment increases the moisture content in an enormous rate.

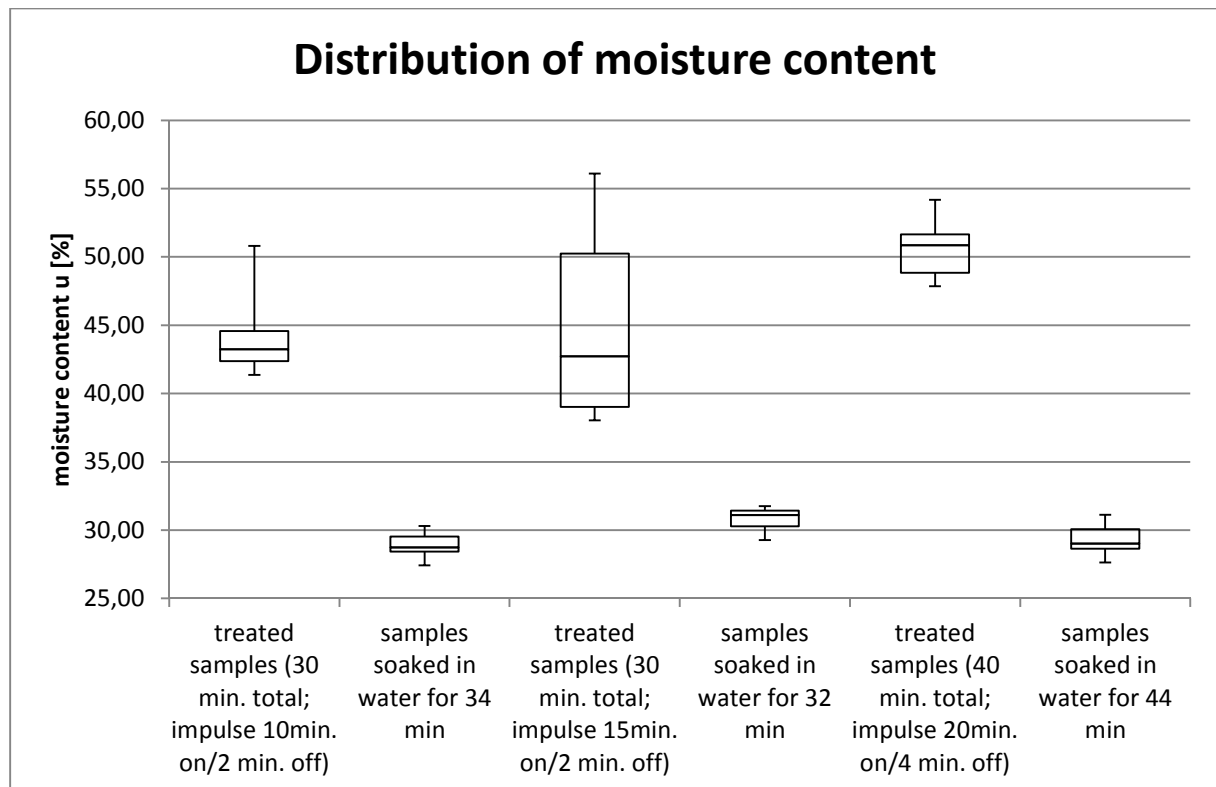


chart 1: Distribution of moisture contents of ultrasonic treated poplar blocks and control samples (Perchermeier, 2010)

4 Discussion

The results of all experiments show that high intensity ultrasonic technology is not an appropriate mean to sanitize wood from pests like wood fungi, mold and insects.

The moisture content test explains why mold and wood fungi regrew faster and stronger on treated specimen in comparison to control samples. Due to the treatment a perfect environment for surviving spores is provided and facilitates them to regrow easily.

5 Picture references

- fig. 1: High intensity ultrasonic device „Sonicator 3000“ of Misonix (Perchermeier, 2010)
- fig. 2: Hielscher Ultrasonics GmbH (2007), " Ultrasonic cavitation",
<http://www.hielscher.com/ultraschall/technolo.htm>, last call on 2010/12/20
- fig. 3: fresh cut Hickory infected with fungi (Perchermeier, 2010)
- fig. 4: mold species in agar plates used for test (Perchermeier, 2010)
- fig. 5: Suspension of mold and water before filtering (Perchermeier, 2010)
- fig. 6: Sample for termite-test (Perchermeier, 2010)
- fig. 7: living termites used for testing (Perchermeier, 2010)
- fig. 8: a schematically description of the experiment's settings (Perchermeier, 2010)
- fig. 9: Experiment settings under a sterile hood (Perchermeier, 2010)
- fig. 10: Schematically description of experiment's settings for ultrasonic treatment of wood (Perchermeier, 2010)
- fig. 11: Schematically description of experiment's settings for control samples (Perchermeier, 2010)
- fig. 12: Hickory sample, 3 days after ultrasonic treatment (Perchermeier, 2010)
- fig. 13: Poplar samples, 3 days after treatment, control sample on the right side (Perchermeier, 2010)
- fig. 14: sample opened after treatment with living termite (Perchermeier, 2010)

6 Chart and table references

chart 1: Distribution of moisture contents of ultrasonic treated poplar blocks and control samples (Perchermeier, 2010)

Table 1: Parameter of high intensity ultrasonic treatment tested on poplar and Hickory samples (Perchermeier, 2010)

Table 2: Parameters of ultrasonic treatment of termite infected wood (Perchermeier, 2010)

Table 3: development and intensity of mold regrowth on ultrasonic treated pine sapwood (Perchermeier, 2010)

Table 4: Treatment parameters and survival rate of termites (Perchermeier, 2010)

7 Literature References

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