THE USE OF JOULE HEATING AS A PHYTOSANITARY TREATMENT – A POTENTIAL ALTERNATIVE TO METHYL BROMIDE FUMIGATION

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The ISPM 15 phytosanitary standard for wood packaging [1] provides the heating parameters for using conventional heating methods (e.g. steam or kiln drying, dielectric heating) required internationally to ensure quarantine security. Specifically, the wood packaging must be heated to 56°C for a minimum duration of 30 continuous minutes.

Research in New Zealand demonstrated that forest insects [viz., *Hylurgus ligniperda* (F.), *Hylastes ater* (Paykull), *Arhopalus ferus* (Mulsant), and *Prionoplus reticularis* (White)] do not penetrate further than 32 mm into pine, *Pinus radiata* D. Don, logs [2].

Thermotolerance studies with these forest insects showed that the most thermotolerant species and life stage was killed by heating to 56ºC and maintaining that temperature for 30 minutes [3]. Hence, the most thermotolerant species and life stage is controlled by the heating parameters required by ISPM 15.

Joule heating[1] is the process by which electrical current flowing through a conductor which has electrical resistance causes power dissipation, generating heat.

Joule heating was found to be a viable method for heating pine logs to kill any forest insect life stages and, potentially, pathogens that may be present [4]. This heating method is being developed as a phytosanitary treatment for pine logs. Experimental equipment was used to heat pine logs to achieve a temperature of at least 56°C for 30 minutes to a depth >32 mm beneath the cambium, thereby meeting ISPM 15 requirements. The research has confirmed that the Joule heating process can be modified to obtain selected temperature profiles within a log, which gives this heating method the flexibility to control insects and pathogens that may become an issue in the future.

By characterizing the thermal and electrical properties of pine logs [5, 6] as a function of temperature, a computer model was developed to control the injection of electrical energy into the log and predict the resulting temperature rise. Because almost all the electrical energy is converted to heat within the log, Joule heating is more efficient than radio frequency or microwave heating. Moreover, the computer modelling and processing equipment needed for the Joule heating process is much simpler and less costly [7]. The Joule heating process is very fast, allowing logs to be heated in minutes rather than the hours or days required using steam, water baths or kilns.

[1] Also known as Ohmic heating

Laboratory scale results

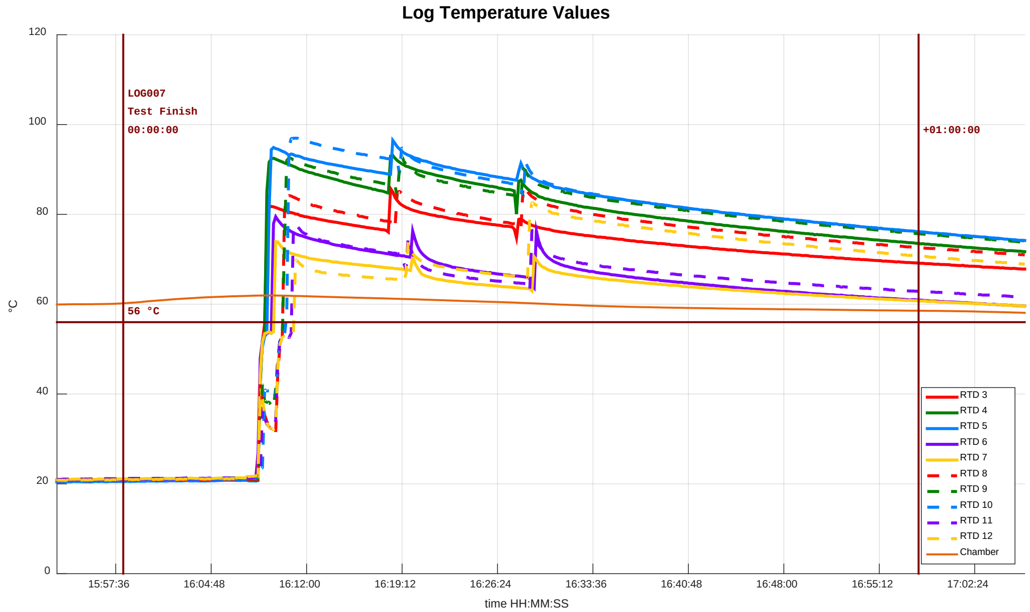

Figure 1. Temperature measurements after Joule heating of a typical log shows the temperatures measured at 30 locations (3 sets of 10 locations, each 32mm below cambium), in the hour following Joule heating of a typical test log. [Note: to gather preliminary data, logs were infested with golden haired bark beetle, *Hylurgus ligniperda* (F.) (Coleoptera: Bostrichidae). No survivors were found in the treated logs.]

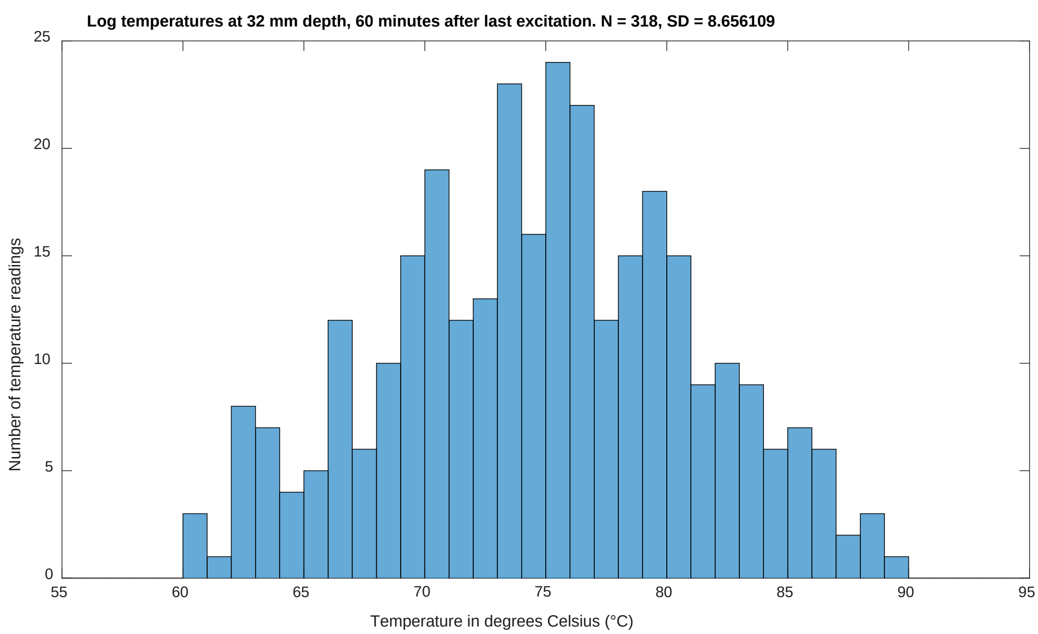

Figure 2. Histogram of temperatures measured after Joule heating of multiple logs shows the full range of temperatures measured at the final 10 locations (as per Figure 1) of 32 logs. [Note: 2 measurements are missing, due to equipment failure. All 318 measured temperatures meet ISPM 15 criteria.]

Currently, feasibility studies are underway to support the development of Joule heating as a possible commercial phytosanitary process for pine logs exported from New Zealand.

References

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