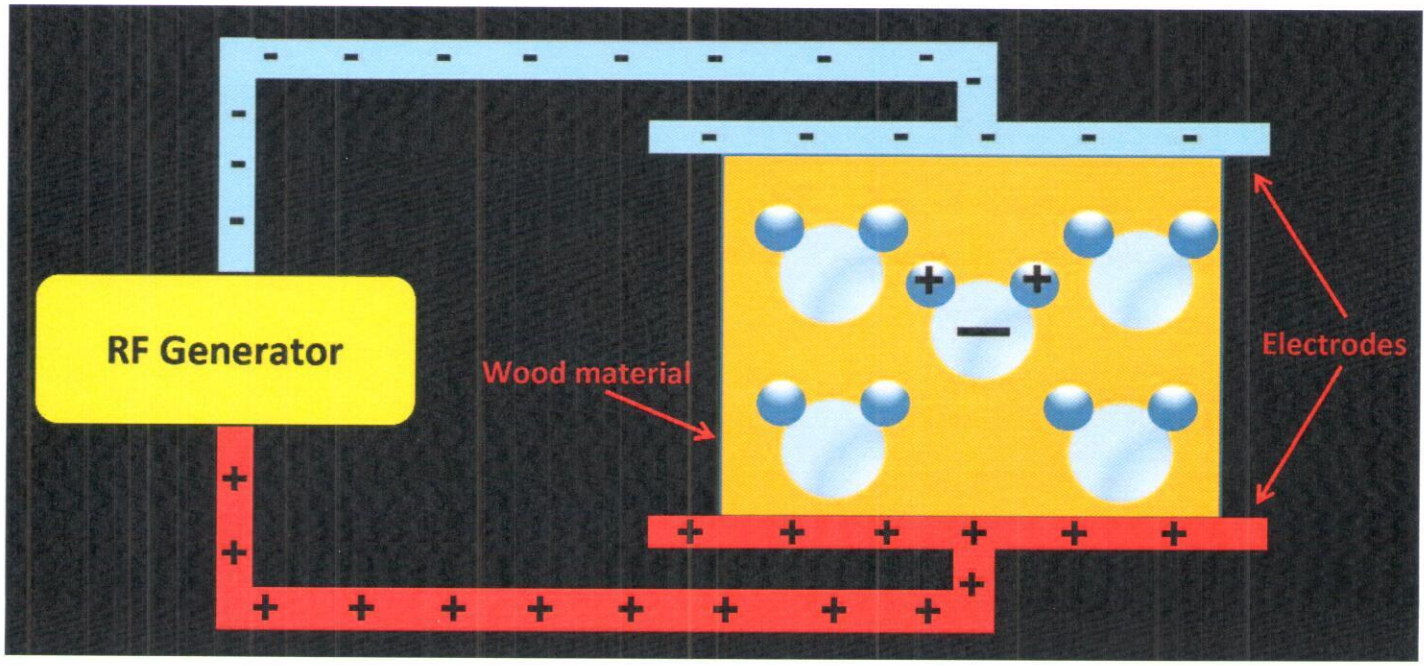
MANUFACTURER UPDATE

Radio Frequency Dielectric Heating for Pallet Sanitization

By Mark Gagnon, Karolina Szymona, John Janowiak, Kelli Hoover, Ronald Mack and Mark Hamelin

Many of us often use a microwave to heat up lunch or refresh a hot beverage. Now imagine using a related technology, Radio Frequency (RF) dielectric heating, to heat wood from within to destroy invasive pests. Our team, composed of researchers at Penn State, USDA-APHIS and RF Kiln Tech Ltd. have taken on the challenge of bringing RF heat treatment technology to pallet manufacturers. Thanks to support from NWPCA and select members, our recent research suggests that for a 5600 bdft commercial trial, ISPM 15-compliant treatment can be effectively applied at a cost of five cents per standard 48x40 Grocery Manufacturers Association (GMA) shipping pallet. This dielectric treatment cost is potentially well below current pallet heat treatment practices.

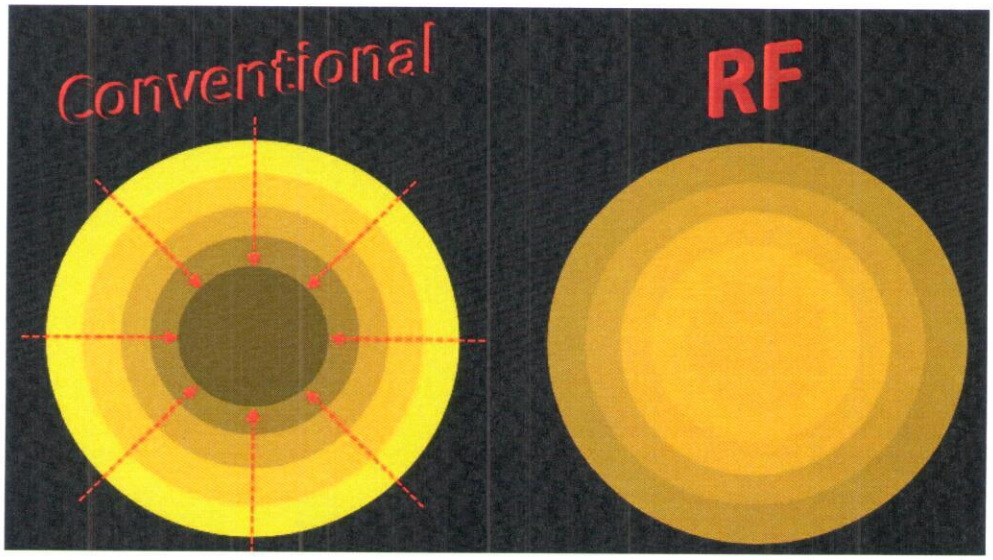
RF refers to a certain frequency and wave length of corresponding electromagnetic energy (we are using 6.78 MHz) to effectively create the heat. Heating of wood occurs through the continuous change of the RF field from positive to negative that affects water molecules in wood fiber. Water being a highly dipolar molecule (one end is positively charged and the other



negative) will move and vibrate as fast as the RF field is shifting, causing friction-based heat. The 6.78 MHz frequency means that the electric field will alternate and rotate water molecules 6.78 million times per second; imagine how much friction it creates! Similar to your microwave, RF efficiently heats material from the inside. However, unlike microwaves, RF penetrates at a greater depth allowing for packs of wood, and larger dimensional material such as dunnage, to be heat treated more effectively.

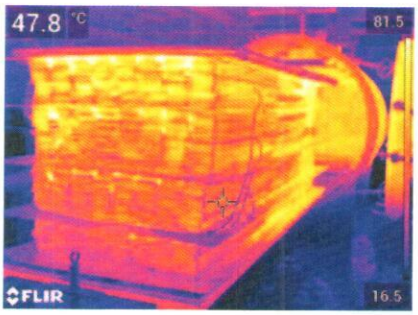
Just like heating dinner in a microwave, RF is much faster and more energy efficient than heating using a conventional kitchen oven. RF Kilns are considered to be direct heating so when power is applied the wood begins to heat instantly throughout the whole volume. Conventional kilns are considered to be indirect heating which requires large volumes of heated air to transfer heat to the wood slowly from the outside to the core. Estimates show that conventional kiln systems are only about 10% efficient because they lose most of their energy from heating the wood from the exterior inward, whereas RF technology which heats from the core out provides approximately 70-80% energy use efficiency.

Conventional kiln heat treating costs range from $1.25 to $0.25-0.50 per GMA pallet. Dry kiln energy costs alone fluctuate between $0.11-0.25 per GMA pallet depending on fossil fuel prices. Other approaches, such as methyl bromide (MeBr) fumigation have environmental implications, can be even more costly or are difficult to access. RF heating offers a potential alternative method for facilities to gain ISPM 15 treatment compliance.



RF technology is not new to the wood industry. It is currently used in high value applications such as drying large timbers or valuable hardwoods. However, applying RF for the phytosanitary heat treatment of wood is considered to be a new application for this technology. Over the last 15 years our team of scientists have systematically developed a commercially viable RF system beginning with limited bench testing and then moving to a 1200 board foot pilot scale chamber on site at Penn State University's Forest Research Lab. Recently we completed full scale commercial trials with similar successful outcomes. The research team has conducted over 50 heating trials with a variety of commercial wood species and dimensions that are common in pallet manufacturing. Heat treatment schedules are being developed as a result of these trials which will lead to easier pallet manufacturer adoption of RF technology to comply with ISPM 15 standards.

Current testing with feedback from several cooperating NWPCA manufacturers indicates significant savings for phytosanitation treatment. Savings are due to lower energy costs (~$0.05 for RF treatment vs conventional heat treatment at $0.11 -0.25/GMA pallet) and potential labor savings since inline placement of an RF cylinder is an option. In addition, RF chamber life is estimated to be 20 years, which is approximately twice as long as many standard dry kilns. Commercial scale RF heat treatment units are available at 8000 bdft capacity for an approximate installation cost of $281K. Typical dry kilns can cost from $90 to $150K depending on capacity and features. RF kilns have the ability to heat treat enough material in one charge to produce ~590 GMA pallets



and could potentially run up to 10 cycles or 5,900 GMA pallets per day. An automated tram system for the RF chamber facilitates faster loading and unloading that appears to be less than typical dry kiln loading/unloading times of 1 to 1.5 hours.

Thanks to continuing pallet industry support and funding from the USDA NIFA, our team is working to adopt IPPC-approved dielectric standards for sanitized shipping pallets starting with a U.S./Canada bilateral agreement. This includes the formalization of third-party inspection protocols so the RF technology can be mill ready as soon as possible. Our clear goal is to facilitate commercial scale RF adoption with innovative pallet manufacturers in both the U.S. and Canada and to help these producers save money and become successful RF phytosanitation treatment adopters.

Our team is part of The International Forestry Quarantine Research Group (IFQRG) that helps to develop international standards and protocols to mitigate the spread of invasive species in wood pallets and packaging material used for international trade. The development and implementation of RF treatment (approved under ISPM 15) will be another helpful technology in the fight against invasive insects in wood pallets and packaging. Moreover, the significant decrease in energy demand in comparison to the conventional heat treatment method will allow for a lower carbon footprint and reduced impact on the environment. This makes RF treatment a viable technology for the near future.

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We are still looking to perform more feasibility studies on other facilities. For more information about the project and how your company can get involved contact: Mark Gagnon, Penn State, mag199@psu.edu, 814.865.0469. For technical information contact: Karolina Szymona, Penn State, kss29@psu.edu. **PC**

The article is a collaborative effort from staff members at Penn State University and the Animal and Plant Health Inspection Service (APHIS), an agency of the USDA Department of Agriculture. For more information, Mark Gagnon, PhD, Penn State, mag199@psu.edu; for technical information contact: Karolina Szymona, Penn State, kss29@psu.edu.