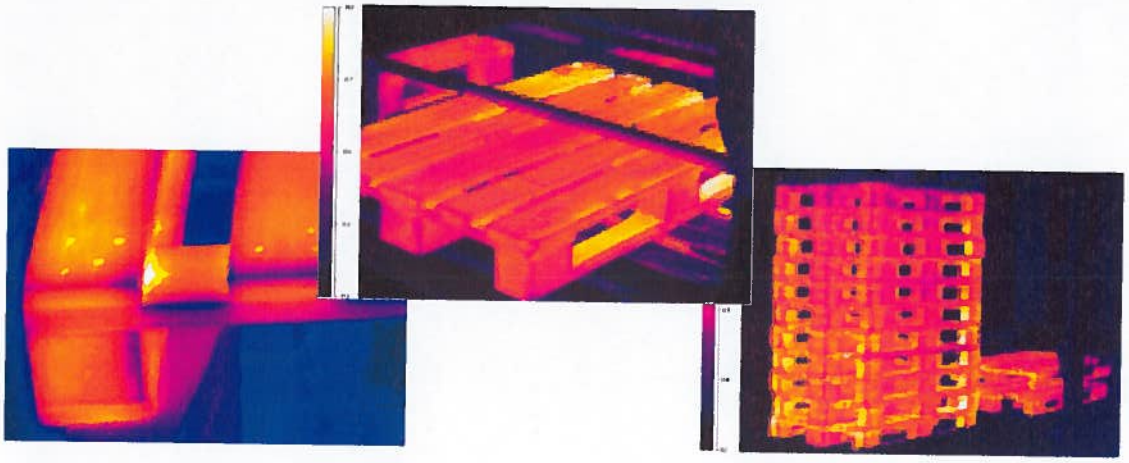
"DIELECTRIC HEATING"

EMitech®
ELECTRO MAGNETIC innovative technologies

FEF PEB



SPECIAL THANKS TO THE FEFPEB ORGANIZATION FOR THE KIND HOSPITALITY

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"DIELECTRIC HEATING"

DH is the new phytosanitary measure for the biological disinfestation of Wood Packaging Materials (WPM) proposed as alternative to the thermal treatment and also to the Methyl Bromide (MB) treatment before and after its phase-out.

DH is a Technical and Scientific proposal submitted to FAO by EMitech in 2004 through the coordination of:

- MIPAAF - *(Italian Ministry of Agriculture, Food and Forestry Policies)*
- IFQRG/FAO - International Forestry Quarantine Research Group / Food and Agriculture Organization

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"EMITECH COMPANY PROFILE"

EMitech is certified by TÜV in compliance with the standards ISO 9001 and ISO 14001

EMitech boasts a special know-how in:

- Electromagnetic shieldings for civil and military scopes
- Electromagnetic energy industrial applications
- Planning and development of electromagnetic energy systems
- Microwave shielded and reverberation chambers

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"APPLICATION FIELDS"

EMitech's innovative technology is a patented method employed in various application fields :

- *Art*

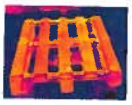
Preservation of cultural heritage and archival assets

- *Agro-food*

Foodstuff disinfestation, drying

- *Packaging*

Pallets drying, disinfestation



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"APPLICATION FIELDS"

Art and Cultural Heritage

Microwave device for the biological disinfestation of objects in wood, paper and cloth Patent No. 01282818

Microwave device for the biological disinfestation of immovable structures like wooden beams, parquet and other wooden structural and/or decorative elements Patent No. 0001371880

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"APPLICATION FIELDS"

Food Safety

Microwave device and method for drying and biological disinfestation of corn, rice, legumes, dried fruits in the post-harvest phase. Method replacing the use of chemical substances.

Patent No. 03425243.7

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"RESEARCH ACTIVITIES"

Alternative energies

Microwave assisted process for biodiesel extraction from oil-plant seeds.

WORK in Progress

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"APPLICATION FIELDS"

Packaging

Device and method for disinfestation and drying of wooden packaging materials.
EMitech Submission to FAO in 2004.

Patent No. EPO 1600172

"FAO - ISPM 15 HISTORY IN BRIEF"

FAO-ISPM-15 is the international standard for phytosanitary measures to be applied to *wood packaging materials* used in international trade whose scope is reducing the spread of quarantine orgnisms.

Wood Packaging Materials are a potential path for the diffusion of exotic organisms. The introduction of these organisms in some continents provoke serious ecological and social-economic problems.

"FAO - ISPM 15 HISTORY IN BRIEF"

ISPM-15 (FAO 2002) reports two globally approved phytosanitary measures:
- Heat Treatment HT (56°C for 30 continuous minutes)
- Methyl Bromide Fumigation MB (the use of this substance provokes damages to the ozone stratum) – is being phased out

IPPC/FAO mark

IT – 123
HT

"DIELECTRIC HEATING"

What is DH?

The expression "dielectric heating" identifies the technologies used to heat materials that are not good heat conductors.
These technologies achieve the heating with electromagnetic energy rather than with heat transfer.

Volumetric
- ⇒ it involves at the same time the whole volume of the sample
- ⇒ it does not depend on the thermal conducibility of the irradiated material

It moves from the interior to the exterior ⇒ The surrounding environment remains "cold". All the MW energy is transformed into heat in the material

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"DIELECTRIC HEATING"

How does it occur?

The use of microwaves as treatment method involves the exposure of wood to the electromagnetic radiation which makes rise temperatures in materials containing water.
When these materials are irradiated by microwaves, it is possible to observe heating and consequently drying of wood provoked by rotation and friction of polar molecules, mostly water molecules contained in wood and in insects infesting it.

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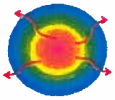
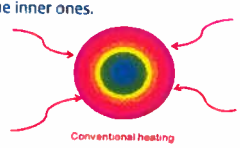
"DIELECTRIC HEATING"

What does it ensure?

This heating method is completely different from the conventional one: in the case of wooden materials, the core heats more rapidly with respect to the external stratum which is less humid.
On the contrary, in a conventional HT electric oven (these ovens work mostly with methane gas!) the heat can pass through irradiation and conduction exclusively from the outer strata to the inner ones.



Dielectric heating



Conventional heating

Studies by EMitech (2004) have suggested that microwave treatment can be a highly versatile method of disinfesting both solid wood packaging and raw wooden materials (such as round wood) from insects and nematodes in all life stages.

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"HEATING TREATMENT VS DIELECTRIC HEATING"

Methodes comparison through experimental tests

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"HEATING TREATMENT VS DIELECTRIC HEATING"

Conventional method (HT):

Forced convention treatment of pallet blocks in a laboratory stove

Materials and equipment:
- N. 2 wooden blocks 75 x 100 x 145 mm, weight 600 g
- Laboratory stove set at 90°C

Temperatures were recorded at 20 and 40 mm depth by means of a fiber optic thermometer.

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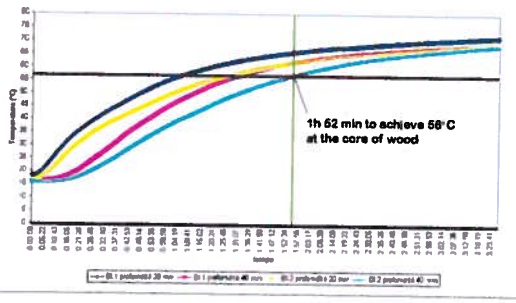
"HEATING TREATMENT VS DIELECTRIC HEATING"

Conventional method (HT):

Heating cinetics monitored through fiber optics



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"HEATING TREATMENT VS DIELECTRIC HEATING"

Dielectric heating (DH):

Treatment of pallet blocks in microwave device

Materials and equipment:
- N. 2 wooden blocks
75 x 100 x 145 mm, weight 600 g;
- EMitech's microwave device;

Temperatures were recorded at 20 and 40 mm depth by means of a fiber optic thermometer.

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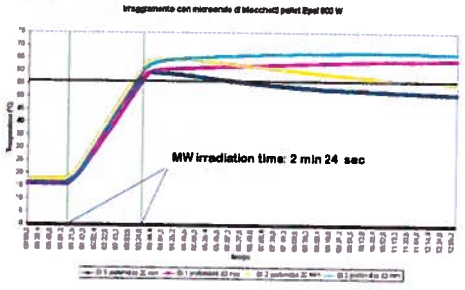
"HEATING TREATMENT VS DIELECTRIC HEATING"

Dielectric heating (DH):

Heating cinetics monitored through fiber optics



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"HEATING TREATMENT VS DIELECTRIC HEATING"

Energetic balance – laboratory tests

	Stove (HT)	Microwave (DH)
Achieved temperature(°C)	56	56
Delivered power (kW)	1,6	1,6
Chamber pre-heating time	12 min 27 s	0
Time to achieve 56 °C	1 h 52 min	2 min 24 s
Energetic consumption(kWh)	0,929	0,064
Costs (€)	0,11148	0,00768*

*** Note: DH treatment costs represent less than 1% of HT costs**

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"HEATING TREATMENT VS DIELECTRIC HEATING"

Energetic balance – tests with industrial system

Tests carried out on an industrial system installed at the premises of the company SCAR SERVICE srl, provided definite results as regards the complessive energetic expense relative to the DH treatment.

System characteristics:

- Productive capacity: 100 pallets/h = 1 pallet/36 sec;
- Treatment costs: 0.10/0.13 €/pallet (it depends on the initial temperature of pallets considering the energetic cost equal to 0.11€/kWh);
- Installed electric power: 80 kW;
- Available MW power: 60 kW_{MW};
- η= 0.75

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"HEATING TREATMENT VS DIELECTRIC HEATING"

Energetic balance – tests with industrial systems

	HT Plant	Microwave System
Daily Production	800 pallet/8h	800 pallet/8h
Energy cost*/pallet	0,20 €	0,13 €
Handling costs	0,15 €	None Automated line
Yearly production – 300 days – 8 h	240.000 pallet	240.000 pallet
Equipment cost	33.000/48.000 €	120.000/140.000 €
Production yearly cost	84.000 €	31.200** €

* Costs calculated for ΔT = 35°C

** In case of DH the saving is about 62%

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"HEATING TREATMENT VS DIELECTRIC HEATING"

Conclusive notes of tests

These tests show that:

- Wood is a bad heat conductor: it is clearly evident if we observe the handle of an old iron;
- HT needs much energy and long times and depends on the thermal conducibility of the material which is very low in wood;
- At the end of the cycle, thermal energy produced in the HT oven is dispersed in the environment.

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"HEATING TREATMENT VS DIELECTRIC HEATING"

DH Advantages

- Efficacy on wood with and without bark.

- Impacts to operators and to the environment. For instance, electromagnetic energy is completely confined within a microwave shielded chamber during treatment. Irradiated electromagnetic energy is totally converted into heat and absorbed by wood so that there are no losses in the surrounding environment.

- In respect to conventional heating, dielectric heating allows much quicker turnover, wich may imply an economic advantage.

- Temperatures higher than those required for heat treatment (minimum 56°C) can be reached and maintained inside wood using much lower amounts of energy.

"HEATING TREATMENT VS DIELECTRIC HEATING"

DH Advantages

- Rapid heating – the irradiated electromagnetic is converted into heat in the treated pallets which achieve the target temperature in a few minutes;

- Selective treatment – the whole irradiated energy is exclusively absorbed by the pallets under treatment, without the consequent heating of the treatment chamber;

- Energetic saving – short treatment times and selectivity are synonimous of energetic costs reduction;

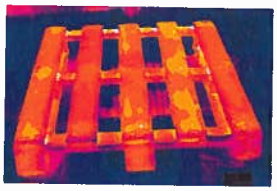
- Use flexibility – a DH system allows also the treatment of little volumes of pallets;

"TECHNOLOGICAL SOLUTIONS FOR DH"

EMitech technological proposals:

- Microwaves Tunnel in line
- Microwaves Tunnel out of line (stand-alone)
- Microwaves in ISO-STD container (20'-40')
- Microwaves Custom: to be realized on the installation site:
  - For this solution it is possible to use pallet conveyors pre-existing at the customer's premises if they are compatible with the microwave shielding needs

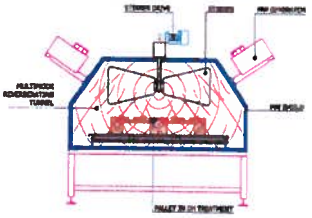
"EMITECH SYSTEMS: TUNNEL"



- EMitech's system for the treatment of wood packaging materials against all nematodes and xylophagous insects according to the requirements of FAO ISPM No.15
- Pallets undergo a continuous treatment

"EMITECH SYSTEMS: TUNNEL"

Heating uniformity is ensured thanks to a multimodal reverberation chamber endowed with stirrers. The stirrer helps the random propagation of electromagnetic energy so that the object under treatment is irradiated from all directions – in other words it works like the rotating dish into domestic MW ovens.



"FAQ: EMITECH ANSWERS"

How do microwaves differ from conventional systems?

- In the conventional heating the process takes place through conduction of heat which is diffused from the outer strata of an object to the core.
- This process implies:
  - Long treatment times;
  - Expensive, COMPLEX and intricate handling;
  - Energy waste between a treatment cycle and the following one.

"FAQ: EMITECH ANSWERS"

How do microwaves differ from conventional systems?

- With microwaves the thermal transfer occurs electromagnetically.
- "Ready to use" technology: machines do not need pre-heating.

This process allows a better heating uniformity. Time is reduced by 1% with respect to the conventional method.

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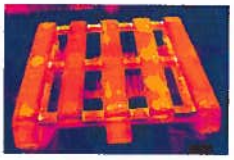
"FAQ: EMITECH ANSWERS"

What adavantages do microwaves introduce?

- The irradiation uniformity achieved through the use of opportune devices, allows to obtain a homogeneous heating even in the case of objects which are heterogeneous in shapes and wood types, as in the specific case of pallets;



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"FAQ: EMITECH ANSWERS"

What does occur at the end of irradiation?

- Temperatures in pallets continue to grow by some grades even after the irradiation - "standing time" effect

Microwaves cause water molecules to vibrate 2.5 billion times per second, producing heat. After the irradiation is off or material is removed from the device, the molecules continue to generate heat as they come to a standstill.

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"FAQ: EMITECH ANSWERS"

Does DH offer improvements in the use?

YES

Possible use of "Just in Time"

It can be turned on and off according to the productive needs, without pre-heating at the beginning of the cycle or heat waste at the end of the cycle.

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"FAQ: EMITECH ANSWERS"

Does a DH system installation need any authorization?

NO

- MW devices do not need the use of gas or other combustibles. This makes the authorization process much easier in terms of safety in the workplace.

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"FAQ: EMITECH ANSWERS"

What adavantages do microwaves introduce?

- Possibility to install the system in line with the machinery pre-existing in the plant
- Complete automation of the system without the need of workers employed for that specific task
- Easy and smart software to be customized
- Re-use of the thermal energy deriving from the cooling water of generators

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"FAQ: EMITECH ANSWERS"

What are the disadvantages of microwaves?

- Increase of power availability and costs for electric lines adjustment
- Dedicated electric line
- Necessity of very long treatment lines in case of productive needs exceeding 300 pallets/h
- High running costs in case of productive needs exceeding 300 pallets/h
- Necessity of maintaining the cooling water of magnetrons below 40°C

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"FAQ: EMITECH ANSWERS"

What about workers' safety?

- Total confinement of electromagnetic energy in the workplace
- Compliance with EC standards concerning electromagnetic compatibility and protection of workers against non ionizing radiations
- Compliance with EC standards concerning electric safety and Machinery Directive
- In case of electromagnetic energy leakage, the system process is immediately interrupted through the electromagnetic field sensors present in the workplace

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"FAQ: CONCLUSIONS"

- EMitech submitted this method as alternative to Methyl Bromide for the phytosanitary treatment of wood packaging materials already in 2004;
- Experimental and industrial tests carried out so far have proven the cheapness of the DH treatment with respect to HT;
- Moreover, the technology which is already available, represents an efficient eco-innovation in the packaging sector;
- "DH" treatment is the new measure approved in compliance with ISPM 15 and will be in force in ??

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"TECHNOLOGY FOR DH"

Programme Europe 2020

This programme was proposed by the European Commission last year in March and consists in several measures such as:

✓ A resource-efficient Europe: to support the shift towards a resource-efficient, low-carbon economy, Europe should not neglect its targets for 2020 in terms of energy production, efficiency and consumption. This would allow to reduce gas and oil importations by 60 thousands million Euros.

✓ An industrial policy for a sustainable growth: supporting businesses to be competitive in the post-crisis period, supporting entrepreneurship and developing new competences. This would create millions of new jobs.

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"TECHNOLOGY FOR DH"

European Strategy about Sustainability

The DH treatment is in harmony with the new economic strategy of EU. Moreover it is in harmony with the thematic strategy concerning the sustainable use of natural resources.

This strategy defines the orientations of the European Union's action for the coming 25 years, in order to have a more effective and sustainable use of natural resources during their life cycle.

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"TECHNOLOGY FOR DH"

European Strategy about Sustainability

The Strategy aims at reducing the negative environmental impacts deriving from the use of natural resources (exhaustion of resources and pollution) in harmony with the targets established by the European Council of Lisbon as regards the economic growth and occupation. It is addressed to all sectors in order to improve the resouces efficiency, to reduce their impacts on the environment and to replace the polluant ones with alternative solutions.

This approach, which will be adopted for all environmental policies in the future, is already present in some initiatives like the thematic strategy concerning waste. Some actions like the integrated policy of products or the action plan for ecotechnologies, are complementary to such approach.

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"TECHNOLOGY FOR DH"

DH and sustainability

The new dielectric treatment is compliant with and anticipates the EU strategies and goals in terms of economic and environmental sustainability

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"CONCLUSIONS"

Finally we are proud for having achieved the new IPPC/FAO mark

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"COORDINATES"

Thanks again for your attention

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