Thawing of food products by radiofrequency

Identification

Key words
Thawing, tempering, defrosting, radiofrequency, electromagnetic radiation, heat transfer, meat, pork, beef, fish, seafood, vegetal-type products, ready meals

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How does it work?

Primary objective
Rapid thawing of meat and seafood products enhancing the product freshness quality.

Working principle
Radiofrequency (RF) is a form of dielectric heating, and implies heating foods by dipole rotation and ionic polarisation. Compared to Microwave heating, RF has been proposed to be more suitable for industrial heating of meats because of its greater penetration depths (1).

In conventional thawing methods used in the meat industry the product is placed in contact with air or water at controlled temperatures, with air being the predominant method used. This is time consuming.

By radiofrequency treatment, thawing meat blocks to within a target temperature range of -1 to +5°C is feasible. A 85 fold reduction in thawing time (3) and a 30 fold reduction in tempering time (2) has been reported when compared to conventional methods. Leaner blends and higher power treatments produced the most efficient RF tempering process (4).

The most common methods used in seafood industry are air based or water systems, using either immersion in tanks or spraying with water. Water systems have several problems i.e. under-thawed product and yield losses, or over-thawed product involving problems with texture loss and decreased freshness as well as excessive water consumption.

Using radiofrequency 5cm blocks of fish can be thawed in 15 to 45 minutes. For final temperatures near the thawing point of seafood (typically -1°C), the two frequencies offered by microwave processing (2450 MHz and 915 MHz) are no longer adequate as they can create uneven temperature distributions and result in poor quality products. At the lower frequencies of RF, penetration of the RF energy into foods is much greater and enables the temperature of blocks to increase from -20° C to -2 or 0°C. As a result, the thawing process can be shortened.

Images

Additional effects
• Thawing meat by RF decreases drip losses, as compared to air thawing (6)
• The greater penetration depth associated with RF thawing should help to minimize the problem of runaway heating
• Minimal drip loss in case of seafood products

Important process parameters
frequency, power level, distance between electrodes, application time

Important product parameters
degree of comminution, composition (lean/fat ratio), geometry (preferably cutted in blocks), dielectric constants
What can it be used for?

**Products**
- Meat and meat products
- Processed, semi-processed and whole fish products i.e. hoki fillets, barracuda fillets, tuna fillets, whole sardines, raw shrimp, prawn, frozen mackerel or squids
- MAP seafood (scallop, mussels, calamari) and individually quick frozen (IQF) cooked and peeled shrimps (Pandalus borealis)
- Vegetal-type products (f.e. IQF carrots, spinachs or onions)
- Soft cheese
- Butter
- Ready meals

**Operations**
thawing, tempering, defrosting, heating

**Solutions for shortcomings**
- Rapid thawing of meat blocks, with penetration distance of 20 to 50 cm depending on the frequency
- Avoiding product quality losses
- Obtaining the product at the correct temperature needed for the next processing stage, without interrupting the cold chain, even directly inside its original packaging
- Water savings (compared to conventional water systems)

What can it NOT be used for?

**Products**
- Conductive materials (i.e metals) and insulating material, mostly plastic or carton packaging with a low loss factor
- Non homogenous meat products (in shape or composition)
- High-fat meat products may have processing limitations (3)

**Operations**
- Heating can be uneven

**Other limitations**
- With conventional air thawing the temperatures obtained within the block of meat were very uniform, more even than those obtained with the best of the RF treatments (3). On the other hand, another study reported than defrosting meat with RF heating can result in similarly uniform end point temperature distribution profiles compared to conventional air tempering (2)
- For seafood products: lower level of controlliability compared to air blast systems

**Risks or hazards**
- Due to potential electric hazard, electrodes size is restricted, for example for a 27 MHz equipment, they should not be larger than 1,4 m
- In case not optimized process or not enough homogeneous product, there is a risk of overheating, thus cooking and microbial growth

Implementation

**Maturity**
RF is a mature technology and industrial applications are known since the 80’s. Industrial application for thawing is still not wide spread. Bottlenecks for a wider spreading of industrial application of RF for seafood thawing are high capital costs and personnel maintanence-related costs (8).

**Modularity/Implementation**
Batch and continuous RF thawing methods can be adapted to an existing line. Depending on the application, various radiofrequency modules can be implemented.

For seafood products: batch RF systems operate from 40 to 350 kg/hour whilst continuous RF systems can operate from 900 to 3000 kg/hour (8).

**Consumer aspects**
No information available. No problems expected.
Legal aspects
• ISM bands
• Regulation BS EN 55011:2009 (Industrial, scientific and medical equipment. Radio-frequency disturbance characteristics. Limits and methods of measurement)
• CE marking
• Radio frequency equipment had to full fit international regulation on electromagnetic leakage

Environmental aspects
• Energy saving compared to MW thawing systems (8)
• Water and effluent saving compared to ad-hoc water systems (8)

Facilities that might be interesting for you

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<th>Title</th>
<th>Institute/company</th>
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<tr>
<td>Continuous microwave heating system with conveyor - SP</td>
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<td>Continuous tubular microwave heating system - SP</td>
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<tr>
<td>HIGH STATIC ELECTRIC FIELD FREEZER</td>
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<td>Microwave heating labscale IRTA</td>
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<td>Microwave heating pilot and industrial scale IRTA</td>
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<td>Microwave system 915 MHz FBR</td>
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<td>Radio Frequency heat treatment pilot system - KEKI</td>
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<td>Radiofrequency heating semi-industrial scale IRTA</td>
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<td>Shockwave - DIL</td>
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Further Information

Institutes
- IRTA, SP, Wageningen UR - FBR, Nofima, Matís

Companies
- Sairem, Stalam, Petrie Technology, Keam Holdem Associates, NSG Environmental - NIS

References
Source: