Ohmic heating

Identification

Key words  ohmic heating, solid particle, electrical conductivity, Joule effect
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How does it work?

Primary objective  sterilization, pasteurization, heating, electroporation

Working principle

The working principle is based on the Joule – effect: ohmic heating occurs when an electric current is passed through food, resulting in a temperature rise in the product due to the conversion of the electric energy into heat. The main difference between ohmic heating and other electrical heating methods (such as dielectric heating, microwave...) is that electrical energy is directly dissipated into the product [2,9,10].

There are two advantages in homogenous liquid, pasty or food with sufficient water: the volumetric heating (conventional thermal process depending on conductive, convective and radiative heat transfer), and the possibility of a high-temperature, short time process, even for solid foods (because it is a heating process requiring no temperature-transfer ). Under these circumstances, this technology makes it possible to use high temperature short time on suspended materials. This results in an increase of the quality in the final product. A critical parameter in inhomogeneous material is the relation between the conductivities of particles and the solution around them. The heating rate in inhomogeneous food with solid and particles depends on the relative volume of both phase and on the conductivity of both phase [3, 5, 8].

Ohmic heating has effects on quality parameters of food materials, such as inactivation of microorganisms and enzymes or decomposition of heat-sensitive compounds, should be investigated. Some reports deal with ohmic heating and its comparison to the effects of conventional pasteurization. The short heating time is the base of preservation of heat-sensitive compounds. The principle of inactivation by ohmic heating is only the thermal effect [8].

Images

Additional effects

Inactivation of enzymes and microorganisms (also spores by an effect of high temperatures), without heavy effects on the flavour or vitamins
Minimisation of thermal load Heating of food with large particles, in a short time could be possible The shelf-life of ohmically processed foods is comparable to that of canned and sterile, aseptically processed products.

Important process parameters  electrical field, treatment-time, applied voltage, system geometry

Important product parameters

• electrical conductivities of all particles and fluids in the food
The resistance of the food material controls the heating rate. The heating rate is affected by: electrical conductivities of particles and fluid, particle size, specific heat, shape and concentration and particle orientation in the electric field [8]. The most important key impact is the electrical conductivity. Electrical conductivity increases with temperature and salt addition and decreases with an increase of particle size and concentration.
What can it be used for?

**Products**
Solid food in a solution of an electrically conductive fluid, or a fluid food, is applied between electrodes to cause an electric current to pass through the solution or the solid. The ohmic heater assembly can be incorporated into a complete product sterilization or cooking process. Among the advantages claimed for this technology are uniformity of heating and improvements in quality with minimal structural, nutritional or organoleptic changes.

Liquid or solid food with sufficient conductivity (between 0.1 - 1.0 S/m)
Heterogeneous food with comparable conductivity.

**Operations**
heating, cooking and inactivation (pasteurisation and sterilisation)
dehydration, fermentation blanching, thawing, on-line detection of starch gelatinization, fermentation, peeling, dehydration, and extraction

**Solutions for short comings**
Preservation of heat sensitive products, reduction of processing time.

What can it NOT be used for?

**Products**
Not for products consisting of phases with significant differences in conductivity and dielectric constant; not applicable in combination with non-conductive packaging material for packaged food

**Operations**
Only for aqueous systems (not for non-aqueous food)

**Other limitations**
Fouling of heat sensitive components on electrodes.
Food-systems with a white range of different conductivity

**Risks or hazards**
Inhomogeneous heat transfer in heterogenic food for example meat [2, 3], may cause insufficient inactivation, overheating at electrodes and surfaces

Implementation

**Maturity**
Industrial equipment, for low-acid particulate products available

**Modularity /Implementation**
Short processing times allow a simple implementation of the technique. It has to be combined with aseptic filling systems at the end of the line.
Rapid and uniform treatment of liquid and solid phases with minimal heat damages and nutrient losses, reduced fouling when compared to conventional heating and reducing costs for OH systems.

**Consumer aspects**
The acceptance of consumers is difficult, especially when the procedure is not named. Due to the higher content of vitamins and the native taste in comparison to conventional cooking, the acceptance can be increased

**Legal aspects**
No legal requirements necessary if an equivalence can be ensured to the already available food products.

**Environmental aspects**
Energy efficient, short processing time, no emission
## Facilities that might be interesting for you

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<thead>
<tr>
<th>Title</th>
<th>Institute/company</th>
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<tbody>
<tr>
<td>Continuous microwave heating system with conveyor - SP</td>
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<tr>
<td>Continuous tubular microwave heating system - SP</td>
<td>SP</td>
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<tr>
<td>HIGH STATIC ELECTRIC FIELD FREEZER</td>
<td>ONIRIS-GEPEA</td>
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<td>Microwave heating labscale IRTA</td>
<td>IRTA</td>
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<td>Microwave heating pilot and industrial scale IRTA</td>
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<td>Microwave system 2450 MHz FBR</td>
<td>Wageningen UR - FBR</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**

DIL, TU Berlin, CTCPA, University of Minho, Slovak University of Technology, Harbin Commerce University

**Companies**

DIL, Wild Indag, APV
References


Dock, Guillaume (Caumont sur Durance, FR), 2008, Ohmic heating systems with circulation by worm.U.S. patent 2008017623