Vacuum cooling of foods

Identification

Key words vacuum, cooling, mass transfer, heat transfer
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How does it work?

Primary objective Rapid cooling of food
Working principle Principle of this method is that the heat is removed from the food volume due to the evaporation of water vapour from the food pores under vacuum. The “boiling off” of water under reduced pressures is what lowers the product temperatures. This boiled off water changes phase into vapor. End cooling temperature depends on the pressure in the vacuum chamber and the quality of the vapour condenser [1, 2]. Vacuum cooling is very rapid but there is mass loss of cooled product, because of water evaporation. Better is to combine this method with air blast cooling, by firstly using vacuum cooling (to 20 – 35°C) and after that by cooling down using air blast cooling to 4°C (smaller mass loss, shorter time of cooling) [3]. Reverse order of operations is not convenient because vacuum cooling below 10°C requires very tight vacuum chamber and high capacity vacuum pump. Another method is immersion vacuum cooling when the food is cooled in water. Cooked pork ham had about 50% smaller mass loss compared to vacuum cooling without water. It depends also on the size of the cooled part of food [4]. Efficient is also vacuum cooling of cooked beef meat together with salted water in which the meat was previously cooked [5].

Images

Additional effects Other advantage of vacuum cooling, because of the fast temperature drop, is to disable the potential growth of spores and spore forming pathogenic microorganisms after only gentle cooking. Quick cooling is very important for cooked products determined for preparing chilled or frozen ready meals. Great risk of microbial growth exists especially between 30 °C and 40 °C [6, 7, 8].

Important process parameters Pressure, volume, temperature, area of condenser, flow rate, mass transfer coefficient and mass transfer surface
There exist many mathematical models of the vacuum cooling process [2, 9]. Very important are mass transfer parameters (mass transfer coefficient and mass transfer surface). Measurement of these parameters for some food is listed at [10].

Important product parameters porosity, mass, temperature

What can it be used for?

Products e.g. cooked meat, vegetable, fruit, mussels, liquid food ...
Operations cooling
Solutions for shortcomings

Rapid cooling of foods to overcome quickly the optimum temperature ranges for microbial growth

What can it NOT be used for?

Products
It is not suitable for dry foods without pores

Operations
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Other limitations
Loss of mass during vacuum cooling. Quality properties changes and higher yield losses occurring during cooling have a huge economic importance for the meat industry and probably for other products too. Vacuum cooling can have an effect on sensory properties. The products are drier after cooling (non immersion vacuum cooling).
Batch process

Risks or hazards
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Implementation

Maturity
Vacuum cooling is widely used in food industry. There can be a problem with leakages for bigger appliances.
In economic terms, increased loss of yield is detrimental to the implementation and acceptance of this technology.

Modularity/Implementation
This technology can be normally included in the production line but it has to be considered that this is a batch process

Consumer aspects
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Legal aspects
cooked meat industry regulation and guidelines on safety in cooling of meats after cooking

Environmental aspects
It is more energy efficient than conventional cooling processes [2]

Facilities that might be interesting for you

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<tr>
<td>Freezing lab-scale equipment KU Leuven</td>
<td>KU Leuven LFT</td>
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<td>Ungermann Microtec Chamber - TTZ</td>
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Further Information

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<th>Institutes</th>
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<td>FRIP, University College Dublin - refrig</td>
<td>STEPHAN, The Food Machinery Company Ltd</td>
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References
