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A simple Steam Cell for the Sanitation of Wooden Boards used in the Maturation of Cheese

Author
René Imhof, in collaboration with
Patrizia Riva Scettrini, Ufficio consulenza lattiera TI

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Steam cells – what for?

A steam cell serves to sanitize wooden boards as well as other temperature resistant working tools by elimination of pathogenic bacteria. The boards are exposed unpressurized to saturated steam reaching temperatures of 75°C to 85°C on the surface as well as in the core.

Due to its porous structure, wood cannot be sanitized using conventional techniques as scrubbing with detergents, short term submersion in hot water or the application of disinfectants.

The most reliable technique against unwanted bacteria is the exposition to heat over a sufficient period of time. Due to pasteurization, a substantial reduction of unwanted microorganisms in milk and other food products can be achieved thus leading to longer shelf life. The standard conditions for the pasteurization of milk lie at 72°C for an exposure period of 15 seconds.

During the process of sanitizing, wooden boards inside a steam cell, the boards are exposed to temperatures of 75 to 85°C for a minimal timespan of 20 minutes. The saturated wet steam thereby permeates the porous structure up into the core and transfers its heat energy with high efficiency on the wood structure as well as on microorganisms and, in doing so, destroys the vegetative cells of bacteria and molds.

The sanitizing of wooden boards and other temperature resistant working tools is very efficient in eliminating cross contaminations within production sites.

Impressum

Editor:	Agroscope, www.agroscope.ch
Information:	René Imhof Agroscope, Schwarzenburgstrasse 161 3003 Bern, Schweiz Telefon: +41 (0)58 463 84 18 bestellung@agroscope.admin.ch
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Problems with Listeria

As ubiquitary microorganisms Listeria are present almost in every ecological niche. Only one species is pathogenic for humans: *Listeria monocytogenes*, the agent of Listeriosis.
This disease is rather rarely reported in humans, generally in Switzerland 6 to 10 cases out of 1 million inhabitants occur per year.
Listeria are opportunistic germs, meaning that normally only people with enfeebled immunosystem (e.g. due to a chronical disease, convalescence or pregnancy) will develop Listeriosis. Infections with *Listeria monocytogenes* can successfully be treated with antibiotics – nevertheless up to 17 % of the infected people die

Listeria are present widespread in nature. They can survive and prosper in soil, on plant surfaces, in sewage, in silage but also in excrements of humans and animals.
According to this, the risk of introducing Listeria into a production site via persons, materials or products is high. It is impossible to guarantee absolute absence of Listeria in production areas.

Table 1: Characteristics of *L. monocytogenes*

Parameter	**Value**	**Observations**
Temperature (growth)	-1 to 45°C (optimal 30-37°C)	Minimal temperature in milk - 0,4°C
Generation time (milk)	4°C: 29 - 40 h / 8°C: 9 -14 h	
pH	pH 4,4 - 9,4	optimal 7,0
Water activity (a_w)	≥ 0,92	growth at up to 10 % NaCl
Oxygene needs	facultative anerobe (microaerophilic)	Endures elevated concentrations of CO_2 (> 30%)
Heat resistance milk / meat	*D values at 65°C: 28-93 s. *D Values at 71,7°C: 4,1-12 s. (*conditions for elimination of 90%)	In consequence: a heat treatment of milk at 65°C/15 s only eliminates 30-70% of the bacterial population
Drought resistance	long time survival possible	
Disinfectants	In general feeble resistance against disinfectants	Be aware: Up to 10% of the strains show resistance against quats (quaternary ammonium cations)

Steam cells in function

During clean up processes of dairy operations producers developed prototypes of steam cells to have an in-house process near at hand. Two examples of steam cells illustrating the broad spectrum of types are shown in the following.

The upper picture line shows a stainless steel steam cell for heat sanitation at slightly elevated pressure (water temperature for steam production 103°C ≈ 1.12 bar), capacity per run up to 150 boards, in function since the clean-up in 2005. Steam is produced by a single immersion heater in an open water quench in the rear part (red marking).

The lower picture line shows a very simple system consisting in a carrier for the wooden boards which is wrapped with a tailored tarpaulin of that type normally used to cover truck loadings. Steam is injected by means of a U-tube fixed in an open slot of the board fixation, heat exposition > 70°C for 25 to 30 minutes, capacity per run up to 112 boards.

In both dairy operations the hygienic monitoring of indicator samples did not show any positive results of *L.monocytogenes* since the clean-up ten years ago.

Steam cell as assembly kit

The description is intended to serve as an instruction manual to an assembly kit, enabling dairy technical staff to construct and validate their own device. All the parts described in the following are commercial off-the-shelf products and not otherwise specified with regard to brands or producers. You will find a list of parts and an outline at the rear section of this flyer

The core device is assembled from a plastic palette (1200 x 800 x 140mm) serving as baseplate, covered with two elements of uncoated rigid polyurethane foam (800 x 600 x 50mm) as insulation layer.

The outer shell of the steam cell consists out of elements of rigid polyurethane foam coated with a food safe polymer as used in the construction of cooling cells: 2 sidewalls, 1 back wall, 1 front wall and 2 closure elements as cap. This framework is fastened by bolt secured, hinge hasps.

On a stainless steel rack for the maturation of soft cheese (510 x 630 x 100mm), two landscape rake replacement heads (16 to 20 tines, 30mm rake width, stainless steel or plastic) are fixed with cable binders, serving as slots and fixation of the wooden boards.

Fixed on and integrated in this rack is also the tubing for steam allocation: cast iron tubes, normally used for water lines, scattering the incoming steam flow as much as possible to result in an equal heat distribution within the steam cell. Steam is produced by a steam cleaner (z.B. Karcher SC 5.800 C) at 220 Volt.

Once the wooden boards have been loaded, the boards are stabilized top down by two further landscape rake replacement heads. This ensures a standardized distance between the boards and enables free steam flow in the interspaces.

The entire rack then is covered and enclosed in an 800 liter polyethylene bag (heavy duty garbage bag), which is loosely sealed near the steam inlet to omit buildup of pressure. A second polyethylene bag just covers the system from top to bottom. These two bags serve as barrier to minimize the volume of the heating zone of the steam cell. The whole device is now wrapped with three temperature reflective windshield pads, two at the sides and one on top, acting as primary heat insulation.

The outer shell is capped by the two closure elements and the steam production is started.

The steam generator heats the system up to the target temperature value (critical temperature), measured at the lowest point 3 cm below the rack with the wooden boards. On reaching this temperature, steam production is shut down and the system is held sealed for at least 20 minutes before being opened, cooled down and unloaded. This procedure ensures an exposure of the boards to a temperature > 70°C for at least 20 minutes. The heat sanitized boards are stored in an applicable compartment to cool down and dry overnight before reuse within the next days.

The system has to be tested and standardized by validation runs before use (see next page). The resulting and device specific process criterions are deduced out of the validation data.

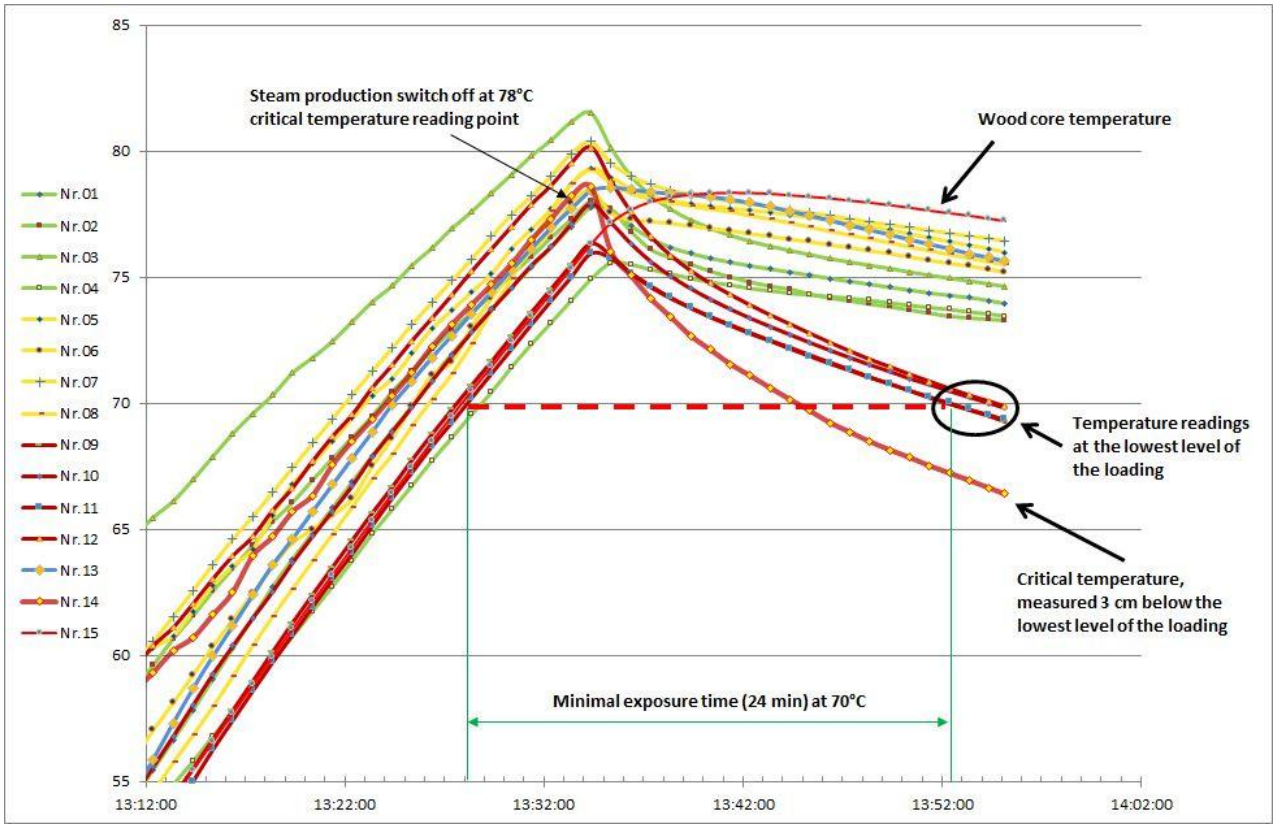
Validation

Heat distribution and the finding of the systems coldest spot has been determined in validation runs by a multi-channel data acquisition system. Temperatures were measured simultaneously at 15 points in 5 different levels with resistance-based Pt100 temperature sensors.

Based on these data the critical temperature, the holding time after steam production shut down and the repeatability of the process is evaluated.

Thus the thermal sensor for the external temperature reading is mounted 3 cm below the wooden boards.

The diagram also reveals that the lowest edge of the wooden boards were exposed for 24 minutes at temperatures higher than 70°C past switch off of steam production at 78°C.



The temperature distribution in the cell during the heating process is shown in diagram 1. After steam production switch off, the temperature measurements at the lowest level show a faster decent rate than the upper levels, including the wood core temperature. From this follows that the critical temperature is situated directly below the wooden boards.

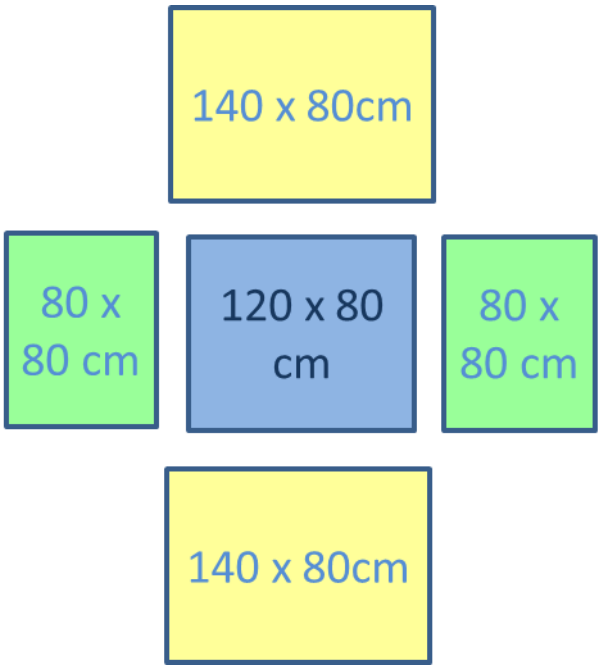
More information about construction and validation of steam cells is available from:

Agroscope,
Institute for Food Sciences IFS
René Imhof, Tel. +41 58 463 8188
rene.imhof@.agroscope.admin.ch

List of parts – assembly kit

Important:

Check the temperature resistance of the materials you use.



Side walls, front- and back wall as well as the closure elements are cut out of remnants of wall elements for cooling cells

Outer shell:
2 side walls (1400 x 820 x 100mm)
1 back wall (1080 x 820 x 100mm)
1 front wall (880 x 820 x 100mm)
2 closure elements (880 x 700 x 50 mm)
8 bolt secured, hinge hasps

1 plastic palette (1200 x 800 x 140mm)
2 elements of uncoated rigid polyurethane foam (800 x 600 x 50mm)
stainless steel rack (510 x 630 x 100mm)
4 landscape rake replacement heads
(16 to 20 tines, 30mm rake width, stainless steel or plastic)
tubing for steam allocation: cast iron tubes, normally used for water lines

2 polyethylene bags, 800 liter
(heavy duty garbage bag)
3 temperature reflecting windshield pads

Steam is produced by a commercial steam cleaner
(for instance Kärcher SC 5.800 C, 220-240 V AC, 50 HZ, heater power 1800 W)