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Sanitation of surfaces using hypochloric water




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Background

Demands on safety and shelf life of food products continuously increasing

- Food industry to reduce the micro-load in products
- Equipment desinfection
- Packaging and filling
- GMP re. whole production facility

} gaining importance

Options for improved sanitation and hygiene:

- Hygienic design and plant layout
- Clean room technology increasingly found in the food industry
- Maintaining a low micro-load on technical surfaces or on floor surfaces prior to and during production by means of desinfection agents

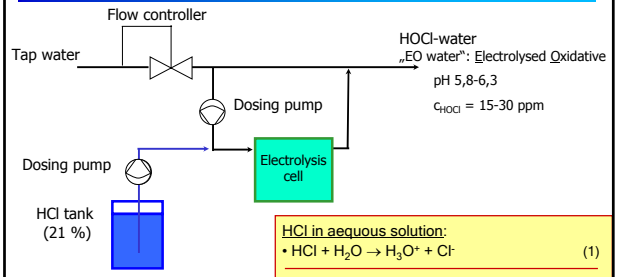
Methods for surface treatment in general

- **Inactivation methods**
  - **Physical treatment**
    - **Irradiation**
      - UV-light
      - γ-beams
    - **Heat**
      - **Dry Heat**
        - Hot air
        - IR-light
      - **Humid Heat**
        - Saturated steam
        - Humid hot air
  - **Chemical methods**
    - Hydrogen peroxide
    - Acids
    - **Chlorine** (Cl_2, HOCl)

Open issues/options

- New way to produce the active agent continuously
- How to steer the chemical equilibrium on its highest level of effectiveness
- Effects within a natural environments

Continuous HOCl-generation (System „Purester®")



HCl in aequous solution:

- $HCl + H_2O \rightarrow H_3O^+ + Cl^-$ (1)

Redox equilibrium:

- Anode: $2\ Cl^- \rightarrow Cl_2 + 2\ e^-$ (2)
- Cathode: $2\ H_3O^+ + 2\ e^- \rightarrow H_2 + 2\ H_2O$ (3)

$2\ Cl^- + 2\ H_3O^+ \rightarrow Cl_2 + H_2 + 2\ H_2O$

Cl_2 in aequous solution:

$Cl_2 + H_2O \leftrightarrow HOCl + HCl$ [= f(pH)] (4)

Continuous HOCl-generation system („Purester®")

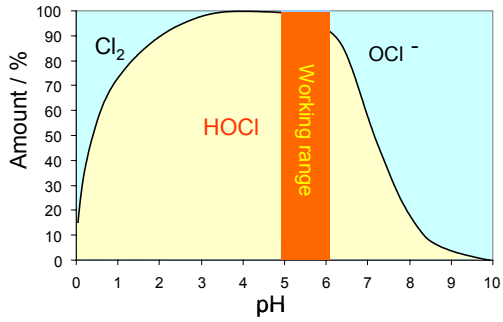
Claimed Properties/Advantages:

- Simple procedure (on/off operation possible)
- Desinfecting agent only consists of tap water and HOCl ⇒ no other residues to be considered
- pH in neutral or low acid range ⇒ low corrosive agressiveness
- No smell issues like with Cl_2
- Operating costs: 0.16 € per 1 m^3

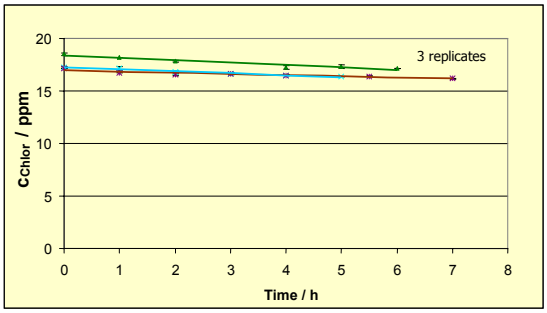
Disadvantage/(Advantage):

- Chlorine reacts with oxidizable substances to form Cl^- ⇒ no further reactivity as a desinfection agent

pH effect on the dominating forms of chlorine in water



Stability of HOCl in water over time



⇒ EO water can be produced on stock or continuously fresh

Investigations on microorganisms …

Prevailing
- In suspension
- On technical surfaces (steel, tiles)
- On particulate food surfaces (shell egg, salad leafs)

Represented by
- Vegetative germs (*E. coli spp.*)
- Bacterial spores (*B. atrophaeus*)
- Mould spores (*A. niger*)
- Natural or inoculated flora (TVC or *S. enteritidis*)

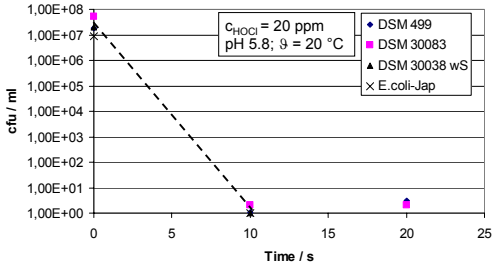
Varying
- Concentration
- Treatment time
- Temperature
- Mechanical support

Microbiological and chemical methods

Inactivation kinetics in solution
- Microorganisms (Spores or cells) cleaned by washing them after centrifugation
- Cell suspension treated with HOCl-water
- Concentration of free chlorine measured by iodometric titration
- After certain times samples are taken and reaction stopped using $Na_2S_2O_3$
- cfu determination according to standard methods

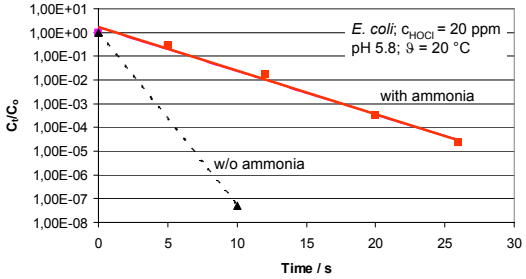
Inactivation of spores on solid surfaces
- 50 µl spore suspension distributed on the test object and dried upon it
- Treatment with HOCl-water
- Test object is transferred over into sterile washing water (containing $Na_2S_2O_3$)
- Removal of spores by means of ultrasound
- cfu determination

Inactivation of vegetative bacteria (*E. coli)* in aequous suspension



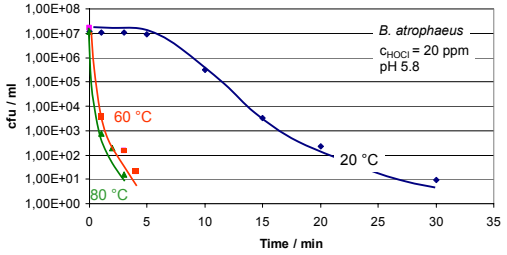
⇒ **7-8 log** reduction **within seconds**

Effect of chlorine binding substances



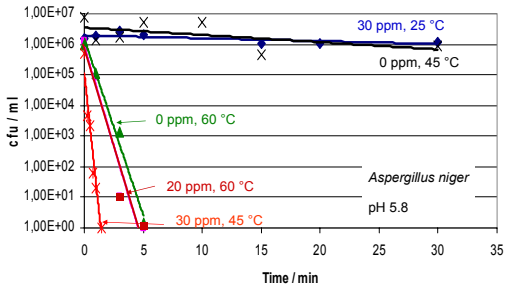
⇒ Effect of organic material (other than microorganisms, i.e. dirt) difficult to overcome

Inactivation of bacterial spores in suspension



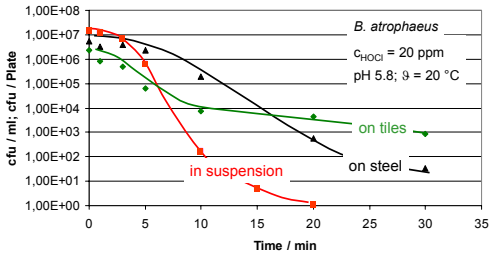
⇒ **6 log** reduction **within minutes,**
temperature with a strong supportive effect

Inactivation of mould spores in suspension



⇒ **6 log** reduction **within minutes**, temperature with a strong supportive effect

Inactivation of spores on technical surfaces



⇒ **7 log** reduction in suspension , **3-4 log** on solid surfaces

Inactivation of microorganisms on shell eggs

Natural flora on shell eggs

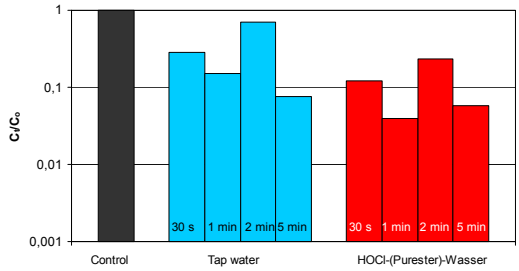
- Eggs were treated with tap water or HOCl-water
  - Dipping method
  - Mechanical method
- Wiping of the entire surface area suspends the germs into the washing solution
- Cfu determination

Inoculated *Salmonella*-flora on shell eggs

- Eggs were inoculated with human-pathogenic *Salmonella* (10^6 cfu/egg)
- Treatment
- Eggs were broken and the content disposed off
- Egg shells were homogenised and the germs suspended
- Cfu assessment on selective media

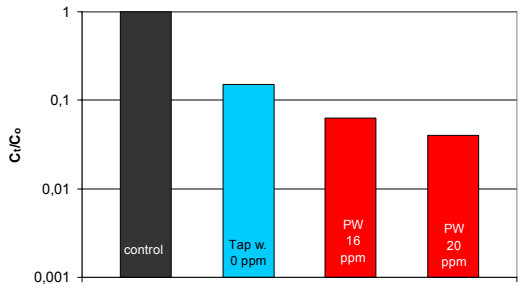
Inactivation of the natural flora on shell eggs

Dipping method in tap water and HOCl-water
(20 ppm, pH 5,8; ϑ = 20 °C); $C_0 = 10^5$ per egg



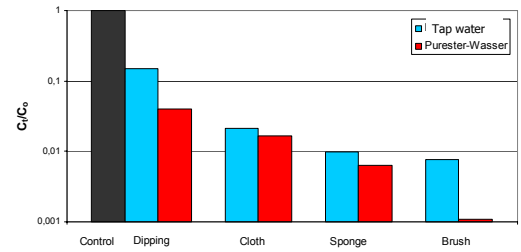
Inactivation of the natural flora on shell eggs

Dipping method in tap water and HOCl-water (PW); (1 min, pH 5,8; ϑ = 20 °C)



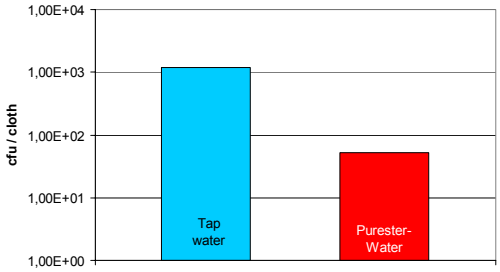
Inactivation of the natural flora on shell eggs

Mechanically supported method in tap water and HOCl-water (1 min, pH 5.8; 20 °C) in comparison to the rinsing/dipping method and control



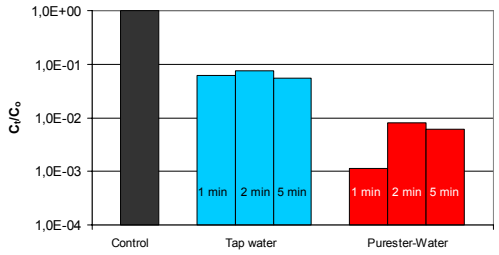
Inactivation of the natural flora on shell eggs

Cfu *on cloth* after washing of one single egg in tap water or HOCl-water

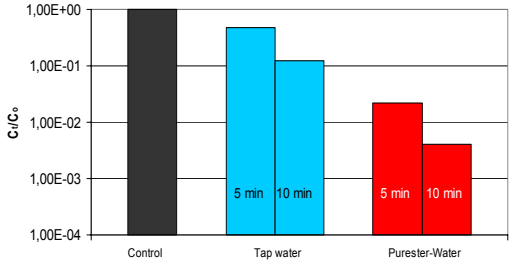


Inactivation of *Salmonella* on shell eggs

Dipping method: Eggs in tap- and HOCl-water (20 ppm, pH 5.8; 20 °C)

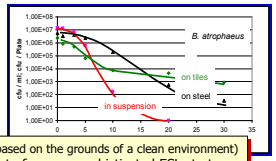


Reduction of microorganisms (TVC) on salad leafs

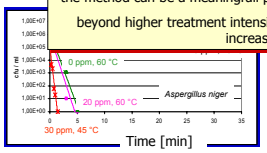


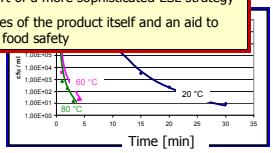
HOCl-water: A way to sanitise (reasonably clean) technical surfaces

- **Suspended vegetative germs:** 8 log reduction within **seconds**
- **Suspended mould spores:** 6 log reduction within **minutes**, depending on temperature
- **Bacterial spores:** 6 or 3-4 log reduction within **minutes**, depending on temp.ture and



By maintaining hygienic conditions (based on the grounds of a clean environment) the method can be a meaningfull part of a more sophisticated ESL strategy beyond higher treatment intensities of the product itself and an aid to increase food safety





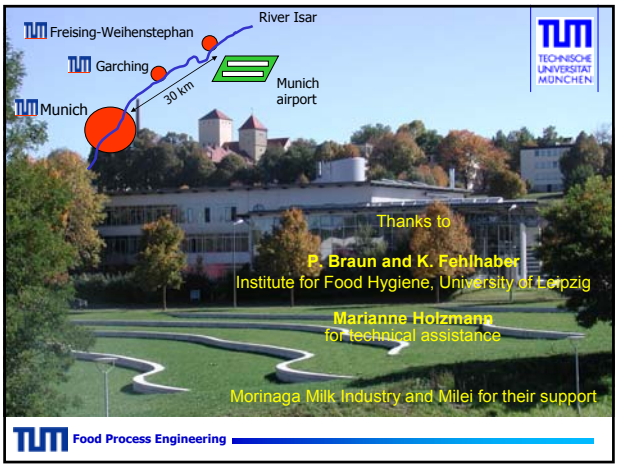
HOCl-Water: An alternative way to sanitise particulate food surfaces and overall Conclusions

- **Salmonella/TVC:** 2 log reduction within **minutes**
  - Egg surfaces
    + with differences between natural flora and inocculated test flora;
    + this possibly being an effect of surface load and
    + surface characteristics, depending on mechanical action
    + protective waxy layer as well as
    + natural variations in resistance/sensitivity against chemicals
- Methods is reported to work well in industrial practise:
  - Cheese forms
  - Technical surfaces on steel plants, floor tiles and walls
  - UF membrane units
  - Particulate food in some countries

Can be part of an alternative ESL strategy beyond higher treatment intensities of the product itself and an aid to increase food safety

Open questions/Issues for clarification

- General trend away from chlorine (in Germany at least)
- Food material in some countries only allowed to be treated with potable water (while even within the EU the situation is inconsistent with regard to using chemical agents in washing water)
- Assessment of the formation of chloroform was raised as a need by experts in the field (which does not take place)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