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# Intérêt et rôle de la fermentation en atmosphère saturée pour conserver la croustillance

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# CRISPNESS RETENTION

-**CRUST PERMEABILITY:**

-Crispness is linked to water activity

-Crispness retention : linked to crust structure

- ↗ permeability ↗ crispness retention

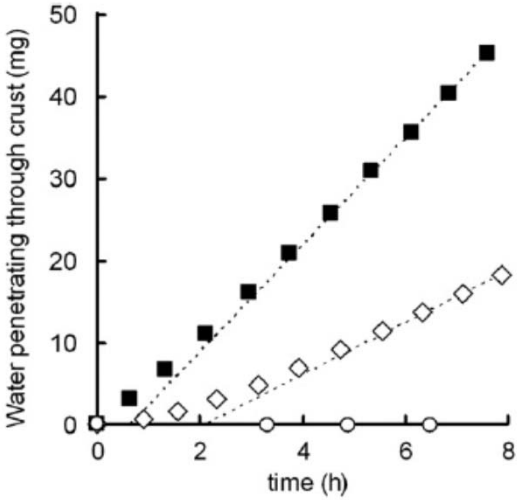



**Fig. 3.** Water vapor penetrating through a metal plate (○), a control crust (◇), and punctured crust (■) as a function of time. Water migrated from a cup (RH = 0.4) to the climate chamber (RH = 0.85). From the two crust samples, the lag phase was calculated by extrapolating the tangent at the linear part of the curve back to the *x*-intercept (dotted lines).

A.Hirte etal.
Journal of Cereal Science (2010) 1-7

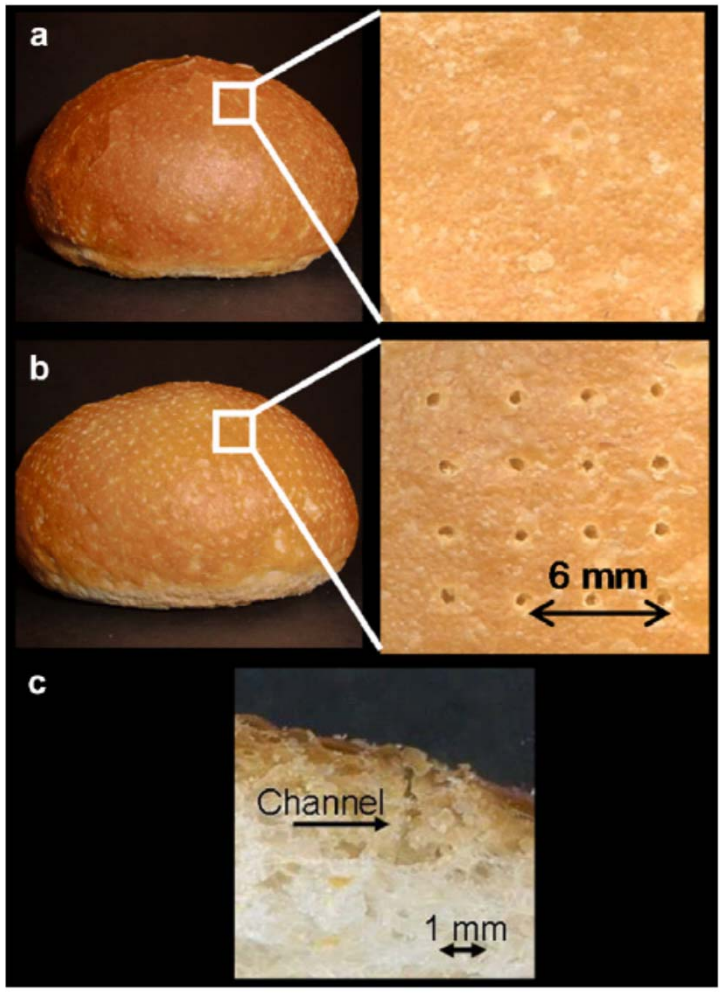


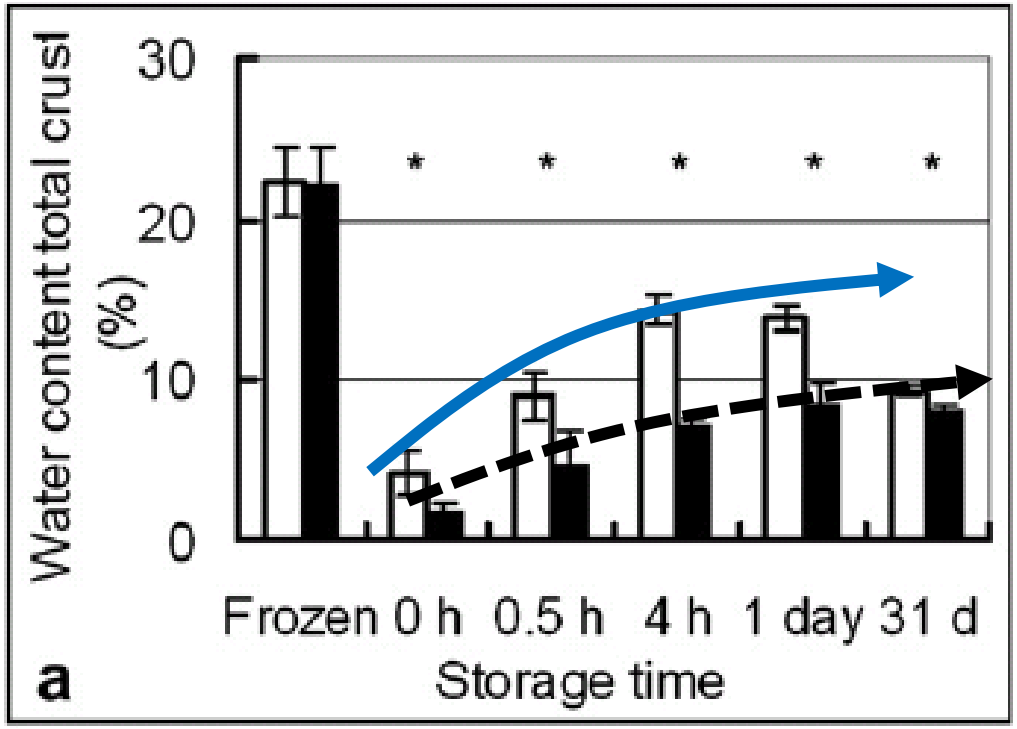

**Fig. 2.** Control roll (a) and punctured roll (b) after baking off. Standard rolls were prepared as described in Section 2.2. Half of the frozen rolls were punctured with a device containing needles. The figure shows the full roll and a detail of the crust for both rolls. (c) A cross section of the punctured crust.

# CRUST – 70 g Crispy Roll

-**PERMEABLE CRUST:**

-Less moisture trapping

-Better Crispness retention




CONTROL

POROUS CRUST

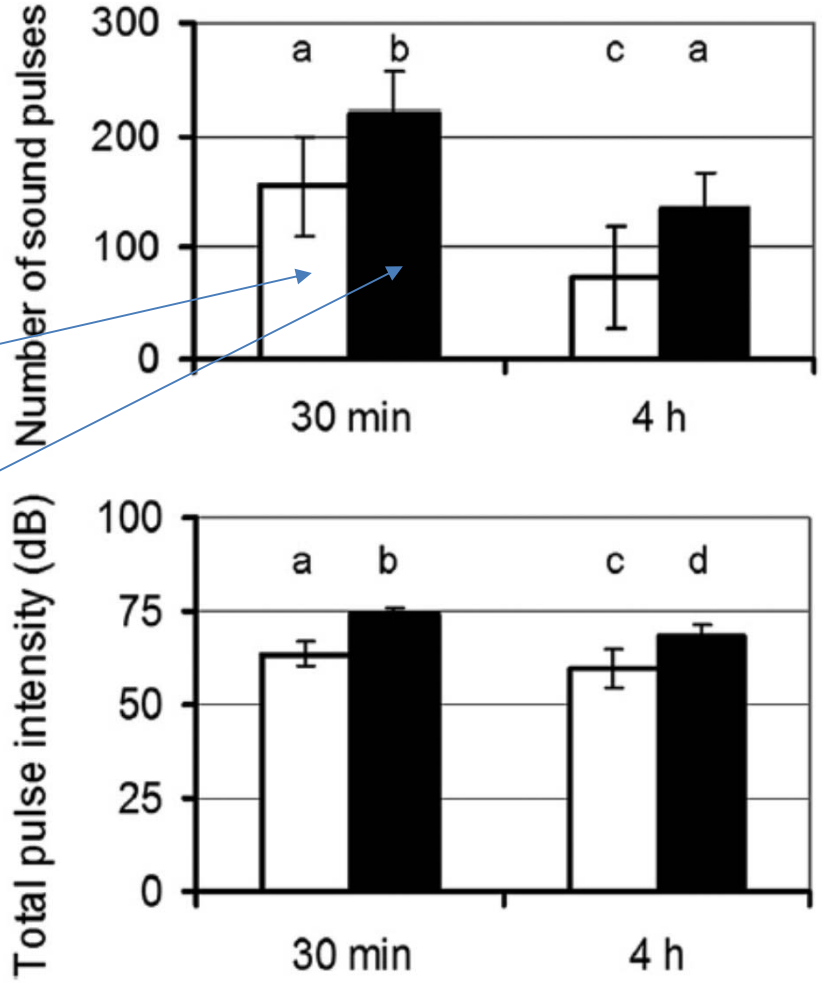
A.Hirte etal.
Journal of Cereal Science (2010)

# CRUST – 70 g Crispy Roll

-**PERMEABLE CRUST:**
-More Sound pulses
-Higher sound intensity

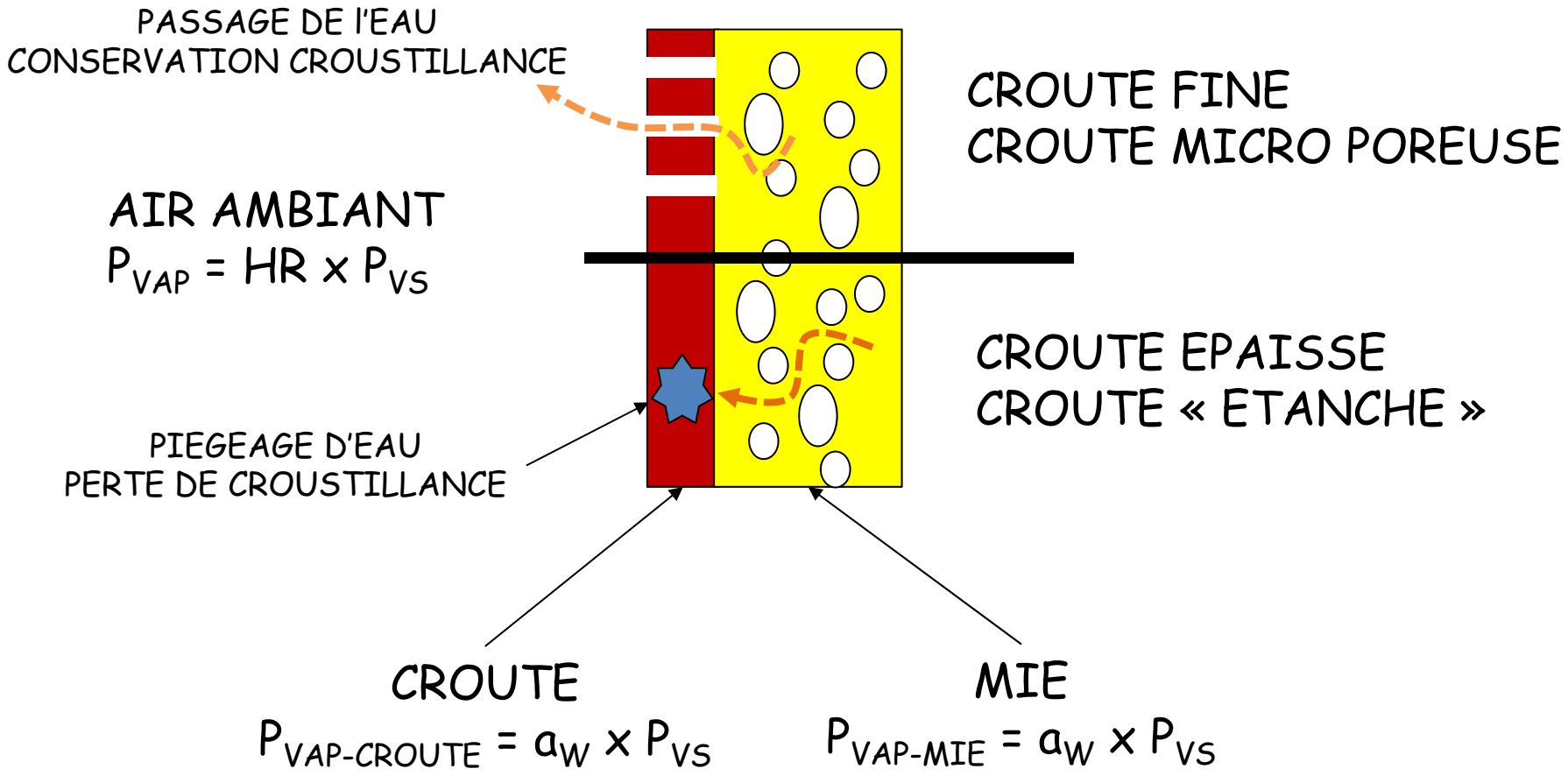
CONTROL

POROUS CRUST

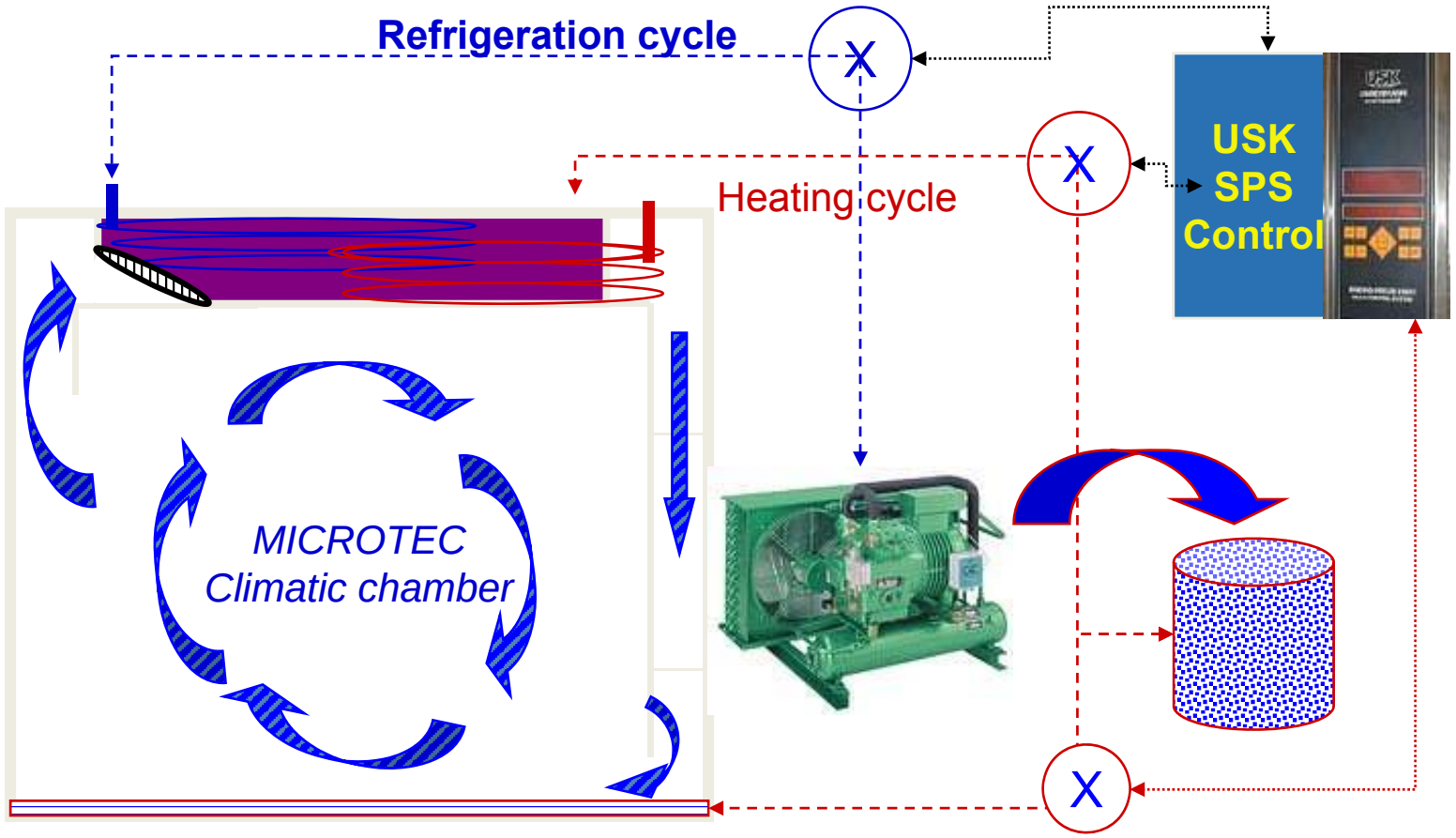



A.Hirte etal.
Journal of Cereal Science (2010)

# BREAD CRUST, STRUCTURE & GLASS TRANSITION



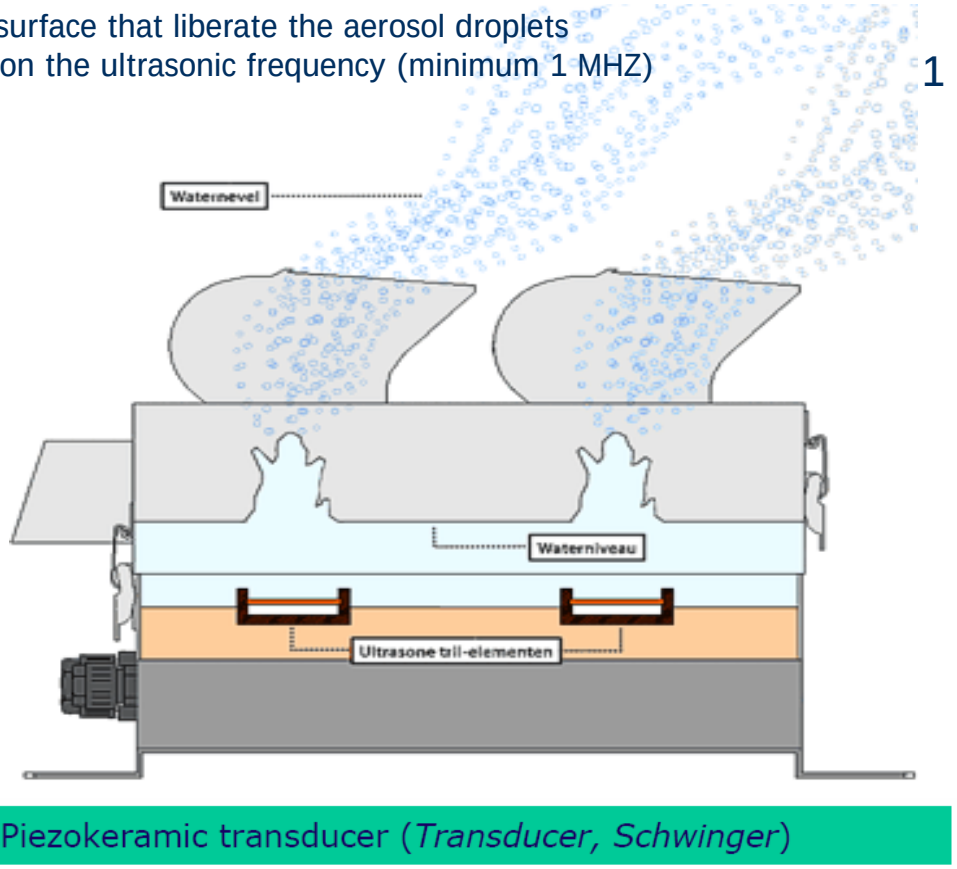
# MICROTEC CLIMATIC CHAMBER : A DIFFERENT HUMIDITY...



# Ultrasonic technology principle

- Mechanical oscillations of the water surface that liberate the aerosol droplets
- Size of the water droplets dependet on the ultrasonic frequency (minimum 1 MHZ)
- Mass-output, energetically attractive

1 / 5 µm droplets




Piezokeramic transducer (*Transducer, Schwinger*)

Fig: Aerosols are delivered by the air flow in the humidifier and mix themselves very fast with the ambient air. They have a very small diameter (~ 0,001 – 0,005 mm) thus forming a freely floating fog.

# Droplets size and sedimentation rate

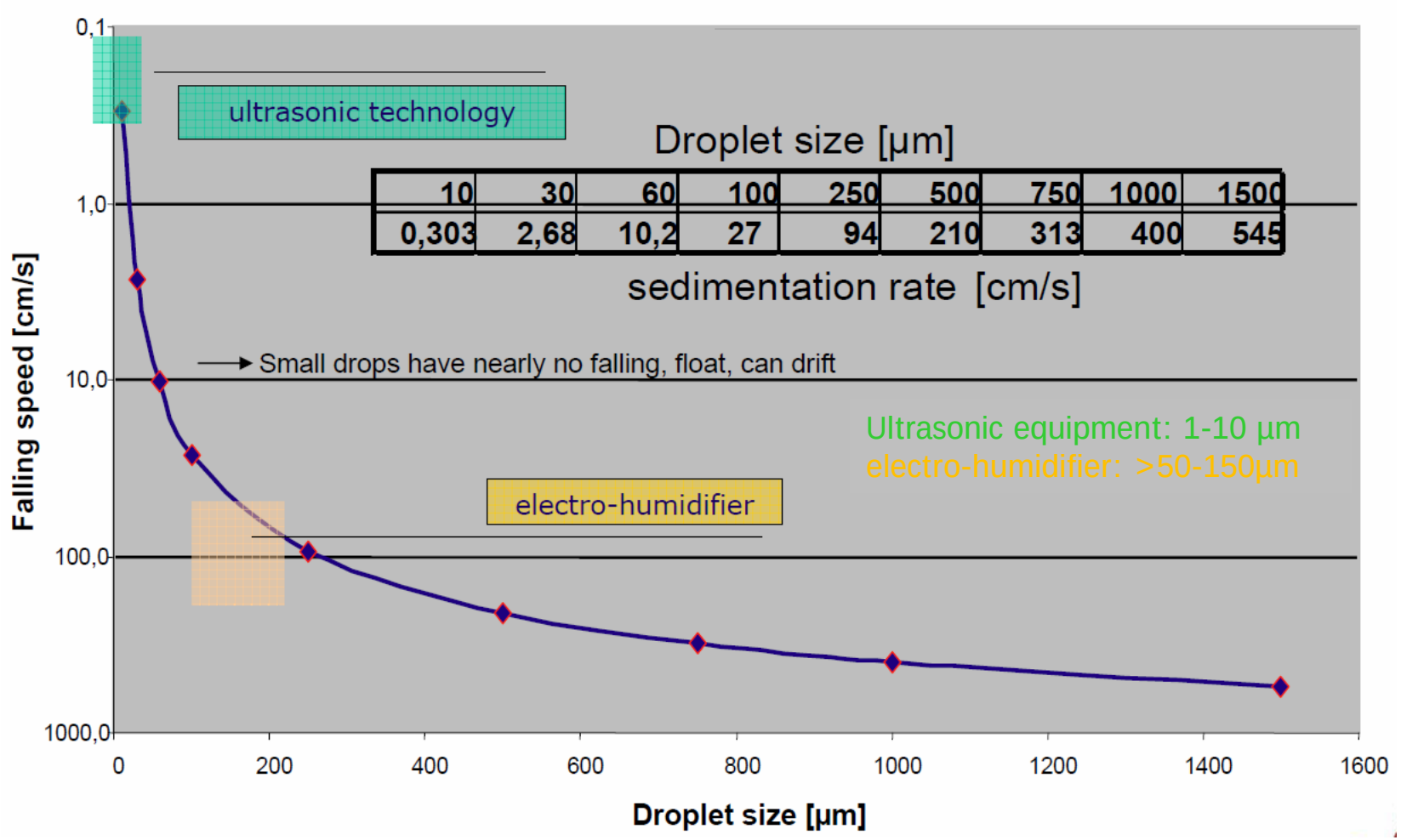



Fig: Influence of the droplet size on the sedimentation rate with water

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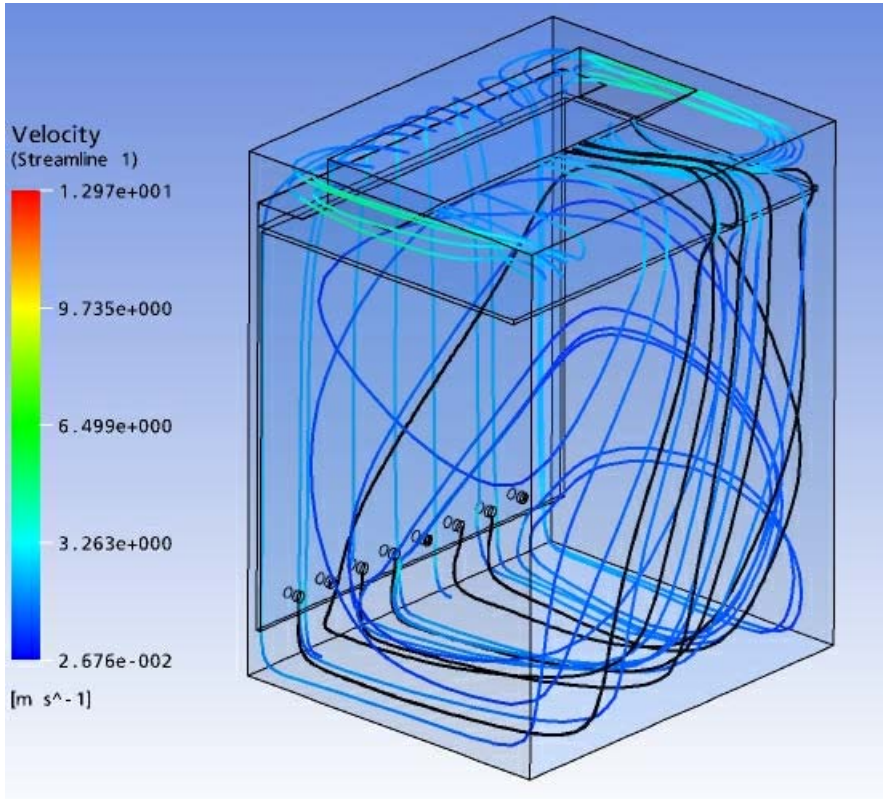
# Humidity simulation in a ripening chamber




**humidity simulation in a ripening chamber with ultrasonic technology**

**ripening chamber with ultrasonic technology**

Fig.: Optimized humidifying conditions of cold fog in a ripening chamber

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# Measurement of the relative humidity

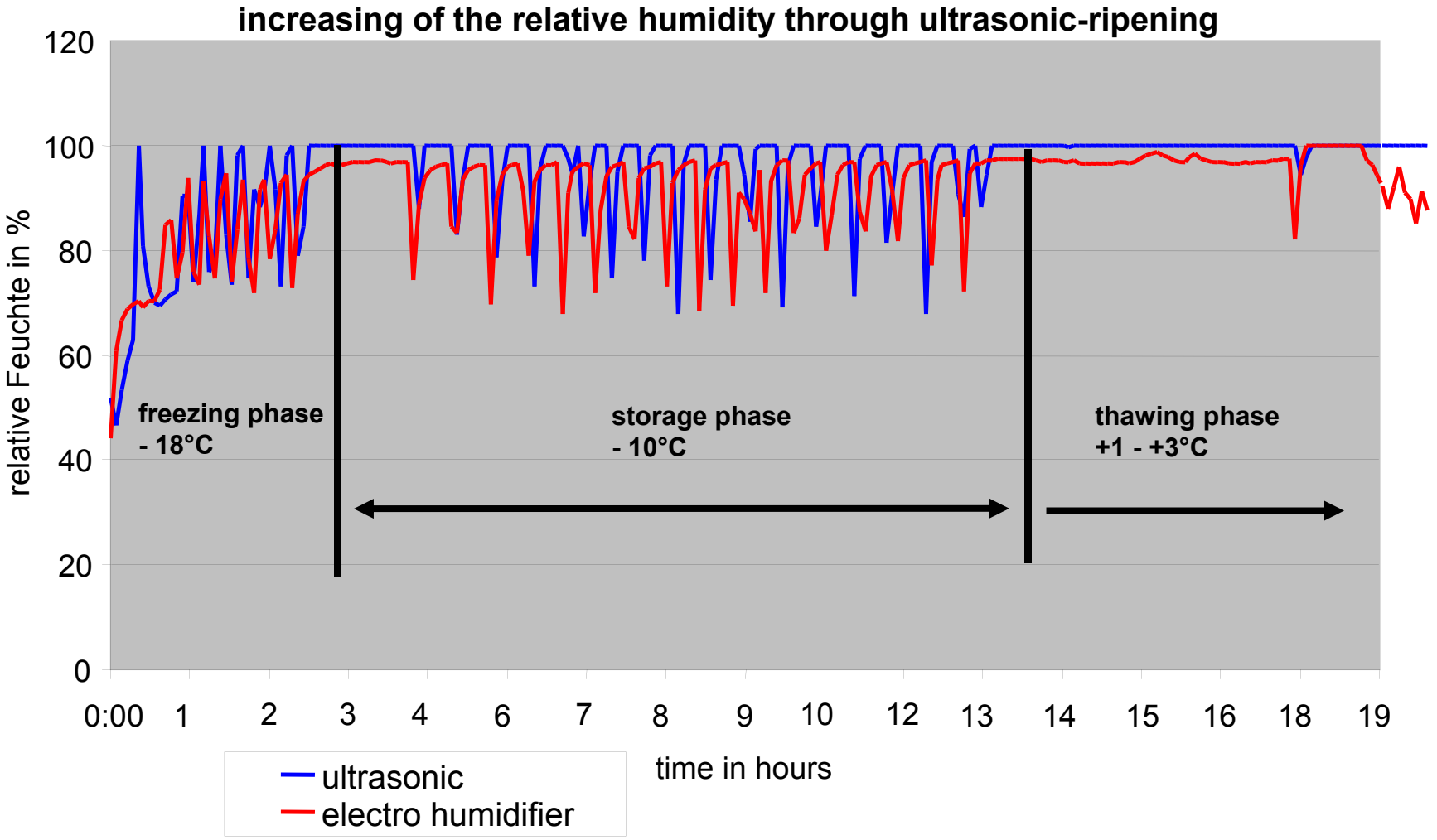
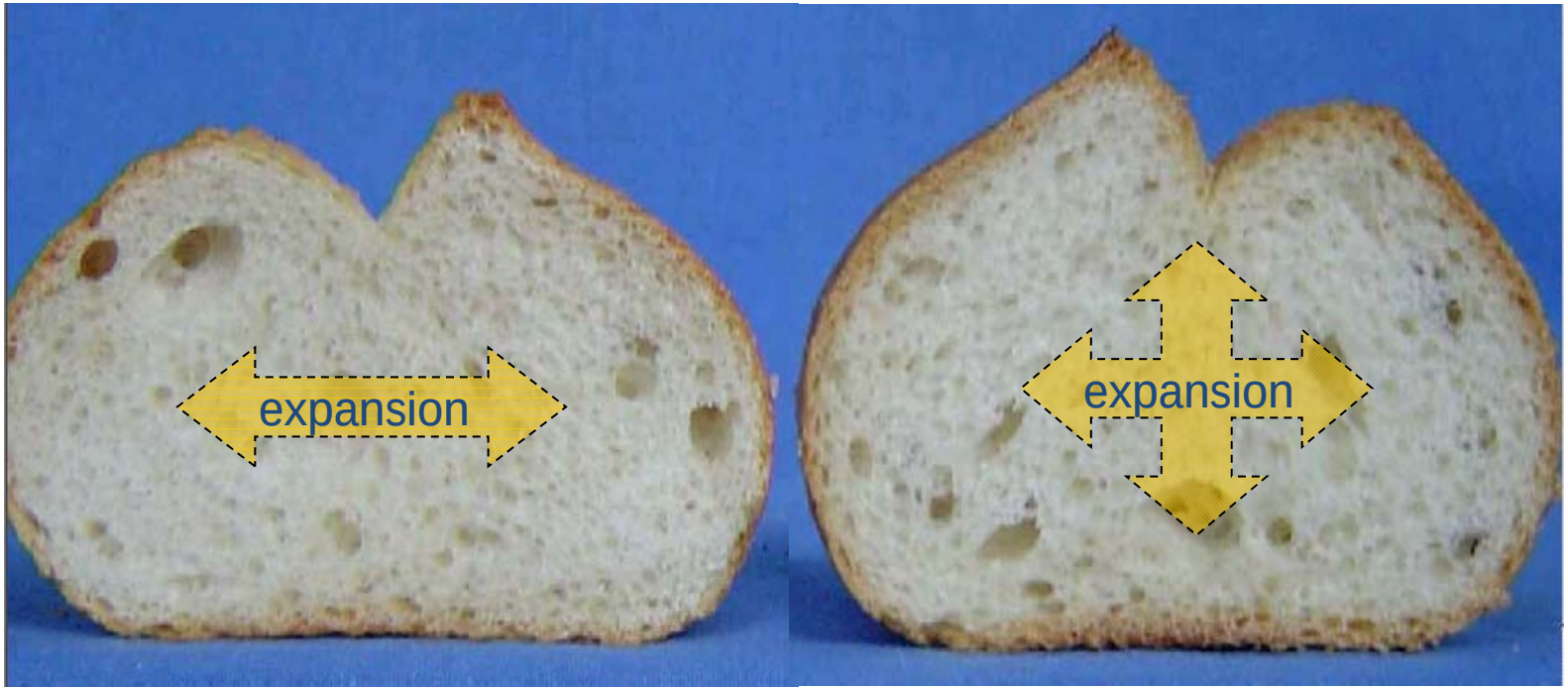



Fig.: Influence of the humidity and/or an ultrasonic ripening on rel. humidity during a freezing and a thawing phase (interrupting procedure)

# Optimized humidity in interrupted dough pieces by improved thermal conductivity



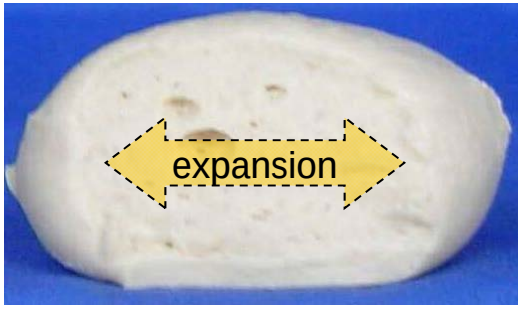

**electro-humidifier** **ultrasonic**

Fig.: Influence of cold fog on the quality of baked goods obtained through retarding processes (20 hours)

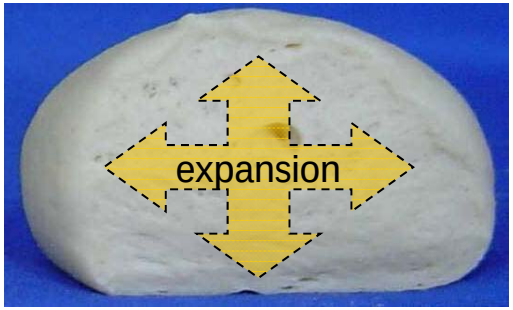
# Stabilization of dough pieces during an ultrasonic-controlled ripening process

**humidifier**
features:
gluey, wet and rough surface

**ultrasonic technology**
features:
humid and even surface
better ripening




**Electro-humidifier**
features: wet and non stable

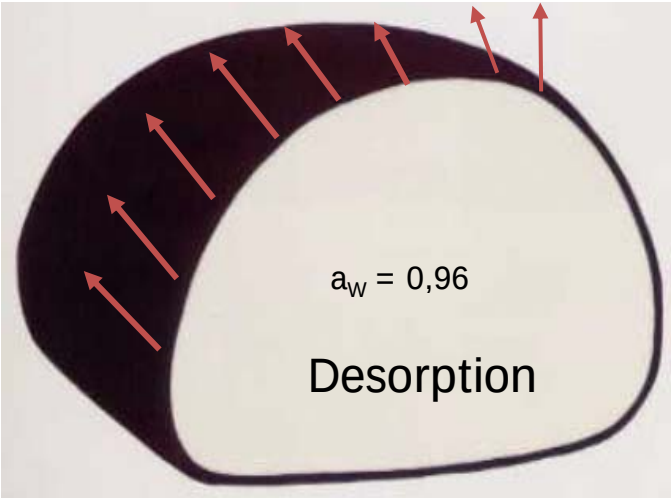



**Ultrasonic technology**
features:
moist and robust

# Water migration

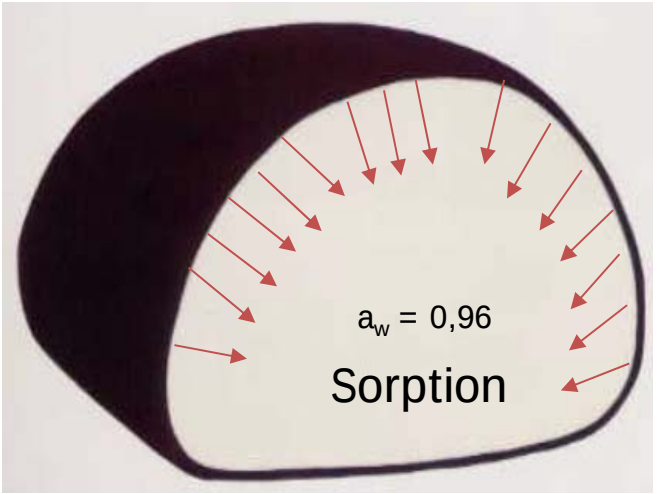
**Desorption and sorption of the bread surface during an interrupting process**

**electro humidifier**
Rel. Ambience H.= ~ 80-90 %




Humidity does not penetrate into the dough piece, the are droplets too large 50 -150 µm

**ultrasonic tech.**
Rel. Ambience H.= ~ 99 %




Humidity penetrates into the dough piece, as droplets are very small< 10 µm

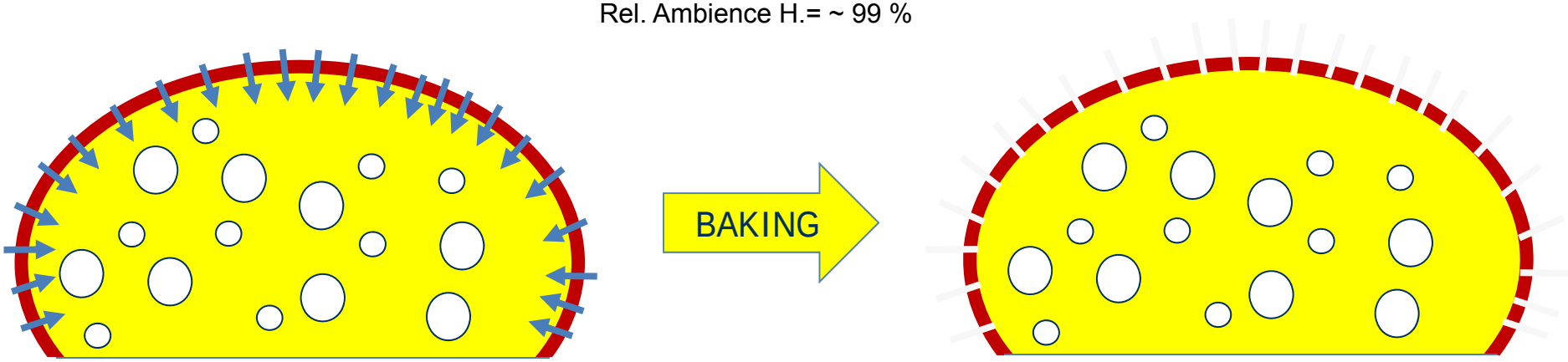
Fig.: Influence of the droplet size and the water vapor pressure on the sorption and desorption by dough pieces during a retarding and interrupting process (schematically description)

# Water migration

**Creation of a micro porosity**
- **Water intake by the dough during fermentation**
- **Micro chanel at surface of the fermented loaf**

**ultrasonic tech.**

Rel. Ambience H.= ~ 99 %



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# Optimized products quality / crispness

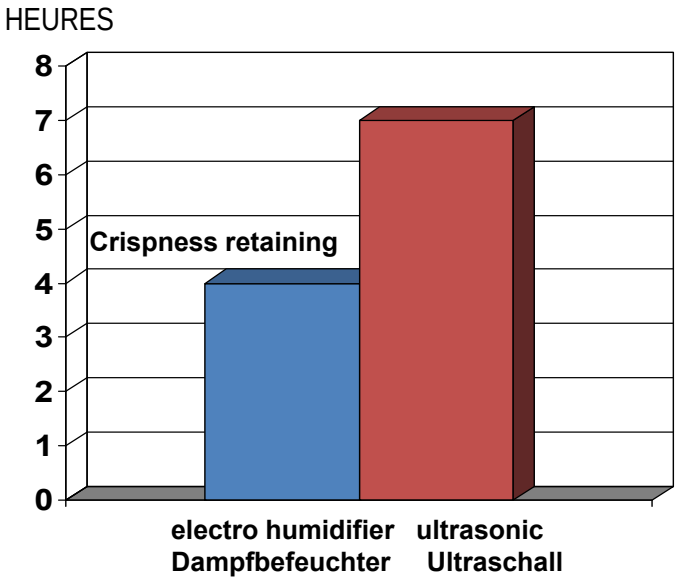
MICROTEC

conventional

**Case study**: retarded process using cold fog leads to better color, better windowing (brittle material properties, better heat conductivity and more)

# Porous structure and cripyness keeping

crispness after 7 hours



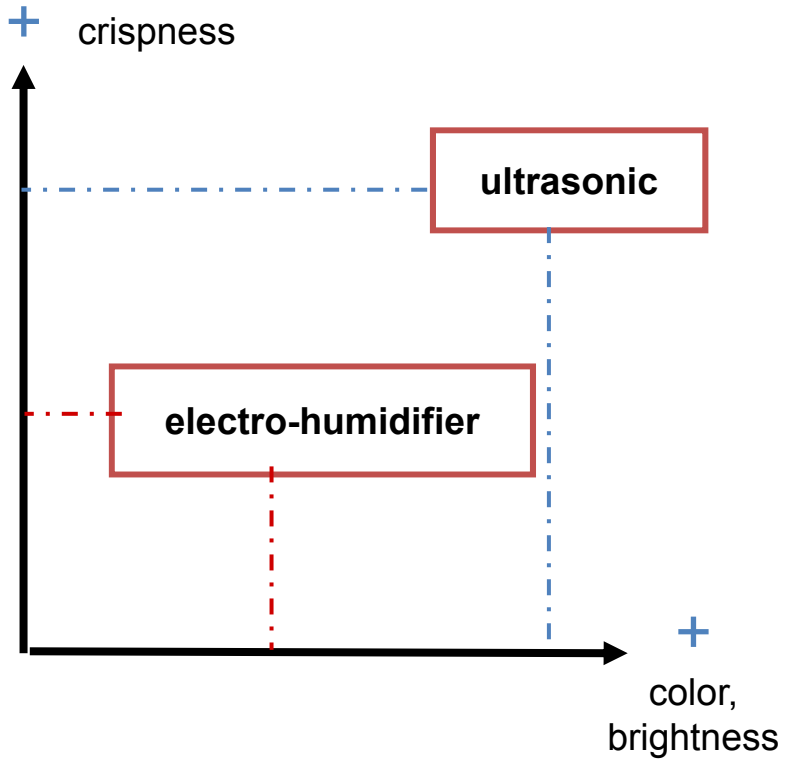




Fig.: Influence of the droplet size / cold fog on the crispness of rolls.

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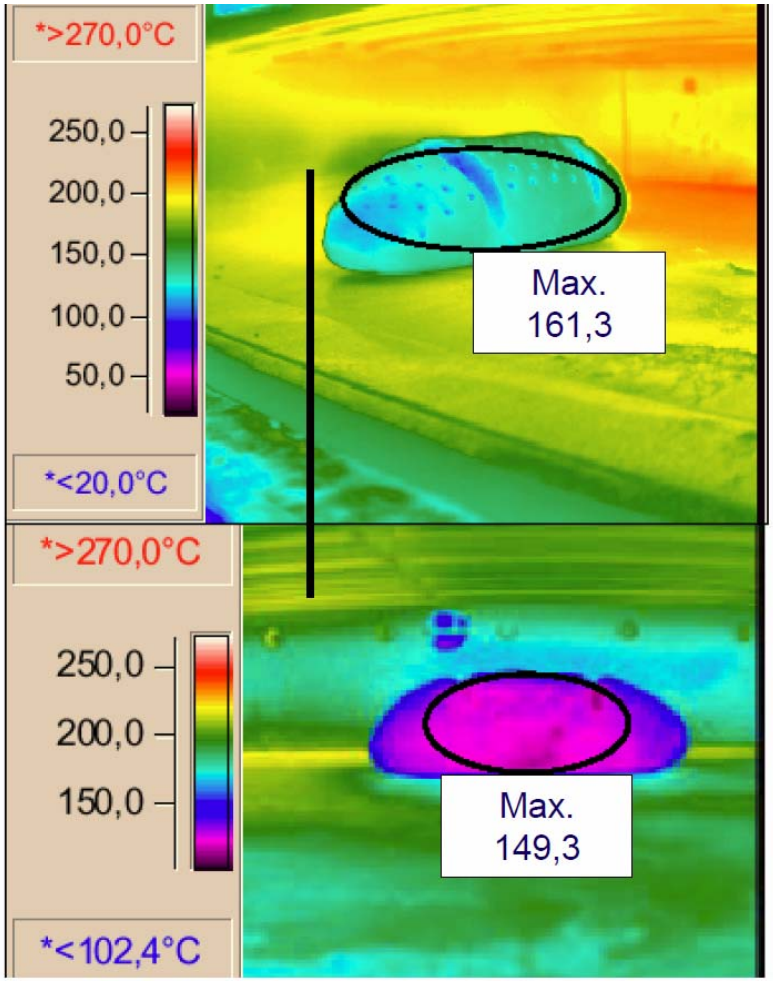
# Improvement of heat transfer




**MICROTEC**

High conductivity

Better heat transfer

Spare of energy

**Conventional**

Attenuated conductivity

Not optimal heat transfer

High energy consumption

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# Skin forming and concequences

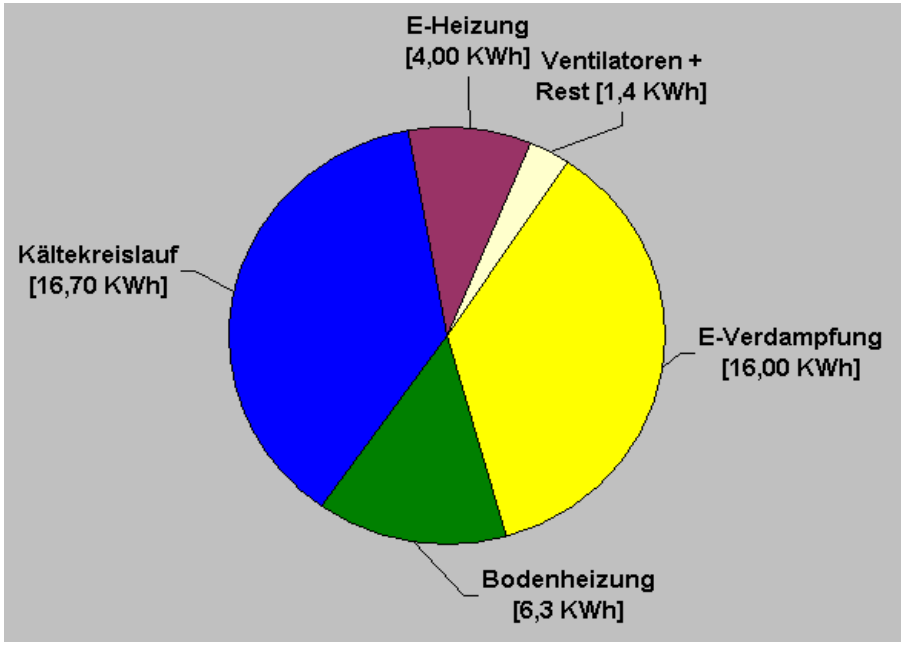
## Chemical effects:

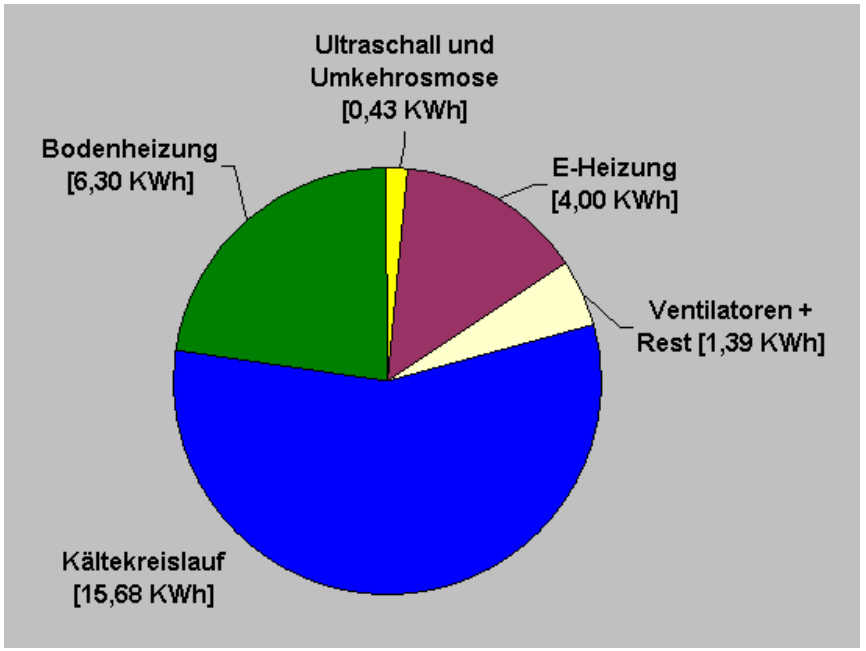
- **Water-loss** leads to an increase in concentration of starch, gluten, minerals etc.; dry mass increases in general
- **Rehydration** is more difficult ; skin forming is more or less irreversible
- **Kinetics of chemical and biochemical reactions** slows down: caramelisation, Maillard – reaction, enzyme activities, yeast activity , other

## Physical effects:

- **Redarded diffusion, higher viscosity** etc.
- **Retarded heat – and mass transport – phenomena**
- **Expansion of  gases (bubbles) is hindert** (effect: fine porous structure)
- **Heat-conductivity is decreased** a lot , more energy is needed like longer baking or cooling time...

# Energy balance




**Conventional Electro-humidifier**

**Total energy consumption = 44,40 KWh**

**MICROTEC ultrasonic system**

**Total energy consumption = 27,80 KWh**

Case study: interrupted process (20 hours)

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# Conclusions

- Fermentation en cellule utilisant de la vapeur d'eau micronisée: 1 à 5µm diam.
- Humidité atteinte 100% sans ruissellement;
- $a_W$ air humide > $a_W$ pâte : prise en eau de la périphérie pâton
- Création de microporosité dans la peau du pâton (croute plus tard….)
- Action des levures est effective dans la peau des pâtons

- Cuisson: pâton meilleur conducteur de la chaleur -> Economies d'énergie

- Pain plus croustillant et meilleure conservation de la croustillance

# Thank you for your attention!

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Bäckerei- und Getreidetechnologie

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