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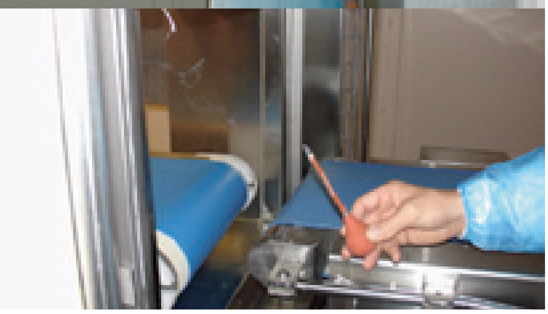
Highest food protection in Milk processing

Safe and easy



Visualization of air velocity flows .

Hygienic control of the ceiling of the refrigerator room (drops of condensate as risk factor for contamination).

An actually study concerning enhanced food safety (extension shelf life) at milk processing done by the German Just in Air Hygienefachinstitut, shows new ways of hygienisation meeting economical aspects.

For doing this first the causers for quality losses during the production process were metrological-analytical located in various production areas (Yellow & White) and then a new hygienisation method was audited under the following criteria.

- Effectiveness (application time & concentration)
- Versatility (food regulatory & hygiene - toxicological)
- Process compatibility (technical adaption on process engineering)
- Profitability (Extension shelf life & process costs savings)

The hygienic results of the test series as well as pictures of the technique are presented in the following abstract.

For reaching sustainable food safety, besides production technique also the process settings equipment like no-frost refrigerators, ventilators and so on, as part of the general air management play an important role. Therefore, an air management in the process area matching the demands is an important requirement for hygienic safety. The construction of the optimal process settings equipment must be adapted for the product and can, as the following sample shows, safe and easily metrological-analytical determined. This is done by visualization of air germ loads, surface germ loads, air velocity flows as risks for spreading as well as by the localisation of inner charges or emission sources (e.g. moisture, heat, dusts).

The existing air management of ventilation engineering and air-conditioning technology can easily technically determined by using documents and doing a systematic inspection. From the results, possible optimizations can be safe derived. The next step is the calculation of the air balance (Additional and extracted air as benchmark of pressure ratios) for every area / room of the process chain. These important information data shows the hygiene and the climatic status quo. The analysis of the process gives very fast hints if and how inner charges emerge but also how risks for contamination can be avoided.

After the systemic collection and transparent description of hygiene – climatic status quo, easily target conditions can be defined and the process settings adapted using quality key figures of the company (e.g. hygienic or climatic limit values, shelf life). Optimization of the air management in the rooms can easily reached in some steps. Options are the insertion of enough filtered air and a homogenous flushing with air. By doing so the entry of unwanted microbiology from outside can be greatest possible avoided.

The leavings for additional air in the room and, if necessary, additionally transport ventilators must be placed in positions to help the flow; meaning clean and conditioned air is lead over the product in the right way to support the hygienic protection in the direction of the production flow. To guarantee a permanent flushing of the respective process areas, additional air should be brought into the whole room to prevent the emerge of air shadow areas and dead zones. Furthermore, the parts of additional and extracted air of the air velocity flows have to be adapted to the operating mode (production/cleaning) via controls.

Inner charges (heat, steam or dust) which have been detected during the process settings analysis, should, if possible, lead away where it emerged, meaning unwanted confounding factors (e. g. formation of condensate or lubrication contaminations)

Hygienic control of work surfaces.

Measuring of germ load in and from no-frost-refrigerators.

are prevented to the greatest possible amount and the process air is useable once again (Air circulation part).

New approaches of sustainable hygiene optimization to enhance food safety

Areas for the processing of cooled, open dairy products, like for example fermented milk products & desserts, but also matured cheese from the ripening to the packaging, have the highest hygiene level and the temperature of the additional air brought in should be in the range of the demanded room temperature.
To use energy efficient naturally existing outer conditions can be calculated and economically assimilated. For example, can the exact amount of added energy be calculated via an assumption from the Mollier – h-x diagram for the region of the plant. In this way, natural resources are integrated into the plant demands without costs.
These now optimized process settings can enhance hygienic food safety (shelf life) further trough added targeted hygiene arrangements on the various processing techniques linear to the process flow and save process costs.
A safe hygienesation during the production process should take place in the immediate surroundings of the various process steps to keep the air as well as the work surface permanent germ-poor. To reach this aim, the definition of task has to be construed to physical – microbiologic aspects strictly.
The overwhelming amount of bacterial has the design of rod cells and is build no wider than 1 µm and longer than 5 µm. Many pseudomonads have a diameter of 0,4 to 0,7 µm and lengths of 2-3 µm. The diameter of micro cocci is only 0,5 µm. Among the microorganism fungi are much bigger than bacteria. Airborne fungi are either sprouted fungi (yeasts, 4-15µm) or mildew (Spurs, 3-6 µm).
A procedure aligned to these facts has to fulfill the masses equality laws as result of the necessary adhesion (Agent on germ), and the complete reachability. To make sure to interfere the metabolism of microorganism the agents have to be dissolved in water-based phases, allowing, additionally, a technical controlled allocation.
A hygienesation procedure designed based on these criteria with a water-based agent and instructed SPS fine nebulization technique for spreading, was tested in various practical applications for fresh meat production. One significant demand was the retention of the existing process steps, without changes on the process engineering. It was reached by using the following scientific basics. Firstly, the liquid agent was transferred into a high effective fog via ultrasonic, deploying the adiabatic principle rule.

$$U = \frac{N}{\kappa - 1} k_B T = \frac{\frac{N}{N_A}}{\kappa - 1} N_A k_B T = \frac{nR}{\kappa - 1} T$$

Legend

N Number of gas particles
N_A Avogadro constant
n Amount of Substance (in Mol)
f Number of variability
k_B Boltzmann constant,
R General gas constant
T Temperature
κ Isentropic exponents

As is shown the change of the aggregate state from liquid to gaseous has an effect increasing characteristic, whereby in very short application time, small concentrations and temperature ranges starting from 2°C very good application efficiencies were reached, making the procedure crucially independent in the hygienic application of application temperature and time. To get a notion of the general application efficiency the agent was spread via the conventional spray method using hand spray bottles as well as technical standardised using ultrasonic nebulization.
Test were done referring to the German DIN 13697 about the application as fog and about spray applications. The result shows initial rates before seeding equal to the reduction rate at 12 food relevant test strains.

Test germ	Effectiveness in the treatment with the new hygienisation method	
	Nebulization	Spray method
Yeasts and Mildew		
Yarrowia lipolytica	+	+
Penicillium chrysogenum	+	+
Bakterien		
Escherichia coli	+	+
Enterobacter cloacae	+	+
Enterococcus faecium	+	+
Lactobacillus sakei	+	+
Listeria monocytogenes	+	+
Salmonella typhimurium	+	+
Pseudomonas aeruginosa	+	+
Staphylococcus aureus	+	+
Acinetobacter baumannii	+	+
Viruses		
Murines Norovirus	+	+

\+ Totally Inactivation

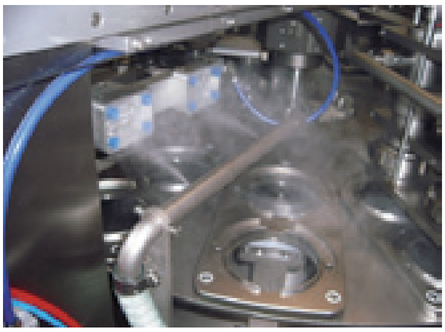
An extract of the test series using the new hygienisation method in the area of the filling of fermented milk products, as well as cheese ripening and packaging is shown shortly in the following.

Technical design of experimental setups on the process techniques

The liquid agent was transferred into microfine fog due to high-frequent ultrasonic vibes and without thermal impact delivered to the surroundings of the test applications, reaching all parts of the room, including the process surfaces immediately. The sizes array of the agent particles Größenspektrum der Wirkstoffpartikel displaces time-depending from initially 100-10 µm to a range of 10-0,1 µm particle size, measured with particle measuring instruments.
Due to their small particle size an agent fraction stays permanently in abeyance, behaving like airborne particles. In correlation with the due to the spread method reached nearly infinite surface and the resulting reactivity the air germ load is distinctly reduced already by the first application. On the other side bigger agent particles behave like bigger microorganisms – they sediment as a function of time and air flow. The results show that the tested method worked well on surfaces, floors on & within of machines, within of no-frost refrigerators, and on walls.
Another method, used as comparison in the test series, had the first impact only when reaching a temperature range distinctly above of 15° C (due to the thermokinetic metabolic of microorganism) and even then, only temporally /locally restricted.
Operating range ripening and packaging of hard cheese. Summary of technical experimental setups and results on end product.

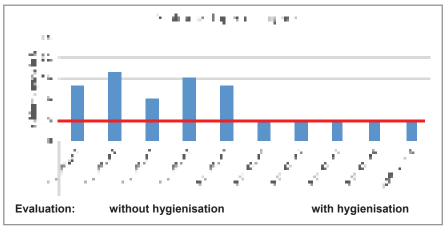
Experimental setup and result outlook

Fermented milk products & desserts through hygienic coverage of filling and seal systems



Hygienisation of air and surfaces in the filling & closing area.

Hygienisation of cold cut- and packaging lines.



The evaluation was based on the lower limit of 0,3%, whereby samples without visuable growth were declared as 0,3%.

Natural ripened soft and hard cheese through hygienisation from ripening room Reiferaum to the process step packaging

Hygienisation of air and surfaces in ripening area.

Hygienisation of air and surfaces during production of grating cheese.

The results by using grating cheese and the new hygienisation method show the germ status of untreated samples growing over two log-phases until the end of shelf life. Treated samples show a distinctly lower growth or stagnation until shelf life end. Furthermore, by using the method with semi-hard cheese packaging distinct differences in germ load of fresh packages as well as such after end of shelf life were detected.

Conclusion

Basically, due to a previously analysed process setting and a following optimized hygiene application – climatic optimization, every company can sustainable realize its tasks for secured product quality under economical aspects. Areas of process engineering can made safer by using hygiene, whereby negative influences through staff and the product flow itself can be further reduced.
Just in Air has developed into the market leader in this special area of hygiene – climatic process surroundings analysis and since years look successfully after the international meat industry. Therefore know – how of analysis and optimization must not necessary available in the plant ifself but can be brought in by specialized companies like Just in Air.