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Maximum food safety and security

Ralf Ohlmann, CEO of Just in Air® GmbH, reports on the hygiene and climatic product safety of sliced/packaged baked products.

Packaged baked goods with a long shelf life even without pasteurization? Yes, it's possible with the correct process environment. The new definition in this respect is a HYGIENE ROOM, which is a good, economical alternative to a CLEANROOM!

++ Ralf Ohlmann, Scientific Research Manager and CEO, Just in Air® GmbH

Growing demands for baked products with extended shelf lives, and for economical manufacturing processes, confront businesses with the need to rethink. And both of these aims are to be achieved without sacrificing product quality! This is exactly where these two tasks can be completed reliably through simple, solution-oriented steps.

A current expert study by the Just in Air® specialist hygiene institution to increase the food safety of sliced baked products (extension of minimum shelf life) demonstrates new routes to hygienization from an economic point of view.

In this study in several industrial bakeries, the causes of losses in hygiene quality in the ongoing process operation were located and identified by measurement technology and analysis, and a new hygienizing technology was tested under the following criteria.

+ Efficacy (treatment time and concentration)
+ Applicability (consideration of foodstuffs law and hygiene-toxicology aspects)
+ Process compatibility (technical adaption to process technology)
+ Economic efficiency (shelf life extension & and process costs saving)

A brief extract of the hygiene results of the test series, and photos of the technology, are presented below. Implementation of the first element of the task – PROCESS ENVIRONMENT – is divided into three essential steps that need to be worked through one after another;

+ Analyzing the process environment and process environment technology/technical building equipment as the CURRENT ACTUAL situation
+ Preparing functional specifications for engineering and technology (concept planning), oriented to the TARGET state
+ Stepwise, cross-interface implementation of individual measures from the specification to achieve the TARGET state

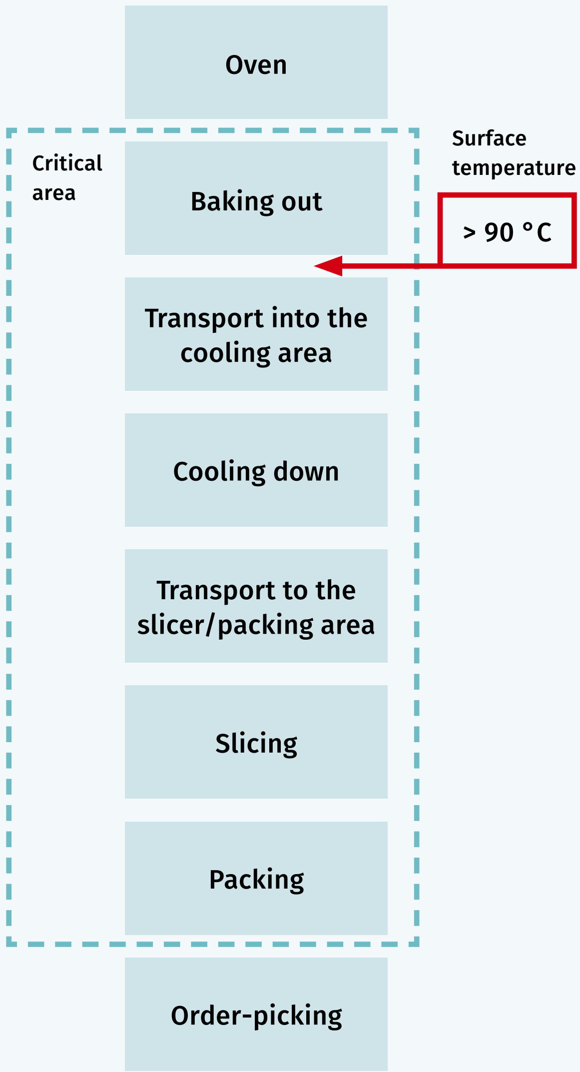
The Just in Air® specialist planning institute in Achim, Germany, has made a name for itself for more than 15 years in this special segment of hygiene – from climatic process environment analysis and the preparation of functional specification documents to planning air-conditioning and ventilation plants and comprehensive implementation, and as a partner for the baked goods sector of industry. The production and packaging of toast-bread/sandwich bread and of sliced baguettes (fine-milled flour and wholegrain) are examined in detail, based on Just in Air®'s countless projects together with its store of experience. In this situation, to prepare a detailed action plan for optimization that is both guaranteed (target-oriented and precisely accurate) and economical (as much as necessary, as little as possible), the factors causing losses of hygiene quality in the ongoing operating process must be located. This is achieved through a hygiene-climatic analysis that integrates the existing process engineering and surrounding technology/technical building equipment. In most cases, hygiene checks are brought in as proof of cleaning and disinfection, although not to display hygienic production monitoring in the process while it is running.

The simple starting point to illustrate the existing status of the baked products is to follow the process workflow systematically, starting at the end of the baking operation. This involves recording and assessing the process steps and spatial circumstances, coordinated to one another and linearly to the production unit's output point. This is done by visualizing airborne germ contamination levels, surface germ contamination levels, air flow patterns and the internal air balance, and by illustrating the long-term air temperature and humidity. The use of process workflows analyzed in this way as a basis very quickly yields indications as to whether and how internal burdens arise (dust, condensation as a cause of microbial growth, uncontrolled air flows etc.). The technology of the process environment/technical building equipment, e.g. circulating air coolers, ventilation plants etc., is another parameter used as a basis.

The entirety of these important basic data constitutes the CURRENT ACTUAL state. After the individual CURRENT ACTUAL states in the process workflow have been recorded and transparently illustrated, the TARGET states for the product and process environment can easily be defined based on the company's quality performance indicators (e.g. hygienic and climatic boundary values, minimum shelf life etc.). These should then be recorded in functional requirement specifications for engineering and technology in accordance with product requirements. In addition to a precise description of the optimization strategies, this also creates standardized foundations for invitation to tender documents (e.g. for ventilation technology, dust removal by suction etc.) to ensure one-to-one comparability between the tenders that are obtained, which also greatly simplifies price comparability. Needs-based air management is an essential component of safe, secure optimization. In this case there is truth in the scientific maxim: "If I check the climate, I can control the hygiene." The use of conditioned air technology achieves constant room climate conditions (air flows, temperatures, relative humidity, air filtering) in the individual areas, and does this from the end of baking to the packaged product. As well as climatic fundamentals, the hygiene bases must also be integrated into the overall design concept. In a number of cases, this can be achieved using any technology that increases both flexibility and food safety but simultaneously allows a reduction in process costs. The totality of these concepts will also be called HYGIENE ROOMS.

At the same time, a sensible distribution of ventilation/air-conditioning technology to provide climatic security, together with supporting sterilization methods (e.g.

Diagrammatic illustration of the hygiene–critical zone



source: Ohlmann

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++ **Airborne germ measurements in the HYGIENE ROOM**

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++ **Visualizing the air flow between clean and not clean**

radiation sources, active sterilization etc.) is used when open product and personnel are in the same room. In this respect, hygiene safeguarding is used precisely where the analyses demonstrate a potential risk due to introduced germs (airborne and smear contamination). This ensures the global presence of sustained safeguarding. In this situation, the design must be matched to the product (e.g. toast-bread/sandwich bread, flour slices/baguettes, wholegrain products etc.) and can include all aspects, as shown in detail by the following example.

The most urgent question is where does the (re)contamination risk with baked products start? Basically, freshly baked-out bread has an inherent thermal protection down to a surface temperature of > 90°C, but when the temperature falls below this value, the thermally-induced flow of air out of the bread (depending on the pore structure) can reverse its direction. At this point in time, however, the bread should already be in a hygienically and climatically controlled environment (HYGIENE ROOM). The hygienic-climatic zone can be present in the form of part of the building (room) or as plant technology (a hygiene tunnel). Moreover, the surfaces in contact with the product (conveyor belts, cutting tools, packaging materials etc.) in the process workflow from baking to the packed product must also be taken into account. To allow active process air reusability (proportion of recirculated air) in the HYGIENE ROOM, the contamination burdens arising internally (dust etc.) should be located and removed as far as possible at their source. In the slicing zone in particular, this contamination source is the cutting dust inside the slicing machines, which leads to severe contamination (air particle contamination, cleaning contamination), especially with toast-bread. High-vacuum suction exhaust systems, for example, which use the smallest possible amounts of air to safely and continuously remove the resulting dusts as safely as possible, can be used for targeted removal in the immediate vicinity of cutting tools without adversely interfering with the air balance. These systems have the advantage that they can also be used for discontinuous dry cleaning at the same time (floor and machine components by using appropriate suction tools). Ceiling supply stations with hose re-winder reels or runner rails, for example, can be used for this purpose, to ensure the tools need not be parked near the floor. This combination cleaning technique allows dust occurrence to be reduced by more than 90%, which also has a positive effect on cleaning costs (cycles) and times. This also permits room air that is significantly less polluted to be obtained, which can in turn be used to achieve an energy saving. Further approaches to technical removal are worked out and matched to the circumstances in the ongoing process environment. Air management by the use of ventilation/air-conditioning technology has a considerable influence on hygiene. By introducing adequately filtered air and by homogeneous air circulation in the room, for example, it is possible to reliably prevent the introduction of unwanted microbiology via ventilation installations.

In this respect, separation by using an M5 pre-filter and F9 main filter is already adequate from the physical point of view. Clean, conditioned air is guided over the product, e.g. by installing flow-supporting incoming air outlets in the room and by transport ventilators, in such a way that clean air in the same direction as the flow of product assists in safeguarding hygiene. Moreover, unwanted interfering climatic factors (condensation at cold-bridges etc.) are also largely avoided by specifically targeted air flows. The volumetric airflows should be adjustable between the proportions of fresh and outgoing air adapted to the respective type of operation (production/cleaning). To achieve constant flushing of the respective problem areas, air must be introduced in such a way as to give all-round coverage of the space, and as far as possible to avoid air shadow regions and dead zones.

Certain areas, e.g. for processing (conditioned) cut/sliced products (cooling area, making-up/packing), e.g. toast-bread/sandwich bread, sliced loaves etc., have the highest hygiene level, and the temperature of the inflowing air (taking the dew-point into account) should be in the region of the required room temperature. Additional circulating air coolers in the room can then ensure a constant room temperature. The cooling and heating demand for climatic air conditioning should be covered as far as possible by existing operating energies (brine networks, cold water circulations, heat recovery etc.) and is designed for the minimum volume of fresh air in


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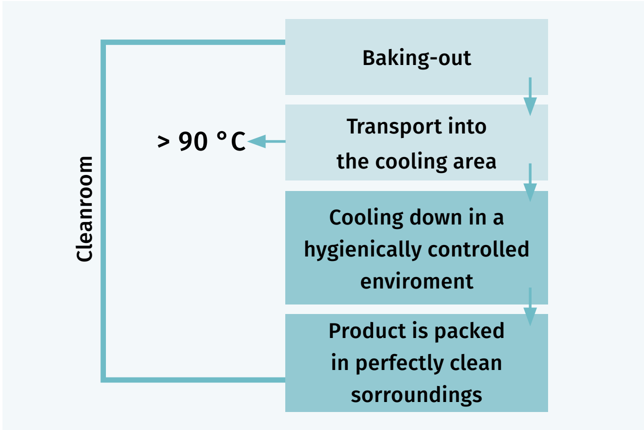
++ **Hygienizing the air and surfaces in the cooling area**



source: Ohlmann

++ **Optimum process enviroment**

production operation, with an adequate reserve. Existing natural external conditions can be calculated and integrated economically to save energy to the greatest possible extent. For example, the exact additional energy for this can be calculated by making an assumption from the Mollier h-x diagram for the factory's region. Thus natural resources are integrated into the factory's demands free of charge.

One example is the energy calculation from the factory's air. From an initial temperature T1 = 20°C to a set-point value T2 = 25°C gives 0.002 kW for 1 m³/h. This characteristic value must be taken as a basis for the energy input via heat recovery. Furthermore, heat input via oven flues or the exhaust air from the baking area must also be taken into account, and these can also be integrated into the thermal utilization. Hygiene air-locks are used to safeguard against uncontrolled ingress to hygienically sensitive areas, and these air-locks should be operated with a higher air change rate and should have adapted suction extraction with a lower air pressure than the adjoining HYGIENE ROOM. The required pressure cascades from clean to non-clean can be implemented easily by using this simple technique. The process environment optimized in this way can further increase food safety (minimum shelf life) and save process costs through additional targeted hygienizing measures applied to the individual process techniques linearly relative to the process workflow. Thus safe, secure hygienizing during the production process should take place in the immediate surroundings of the individual process steps in order to keep microbial contamination of both the air and the processing surfaces permanently low. However, the task remit must be designed strictly in accordance with physical-microbiological aspects.

The majority of bacteria are in the shape of rods (bacilli) not more than 1 µm wide and 5 µm long. Many Pseudomonads are 0.4 to 0.7 µm in diameter and 2 - 3 µm long. The diameter of micrococci is only 0.5 µm. Among microorganisms, fungi are considerably larger than bacteria. Airborne fungi are either yeasts (4 – 15 µm) or molds (spores 3 - 6 µm). Thus a process matched to this requirement must satisfy the equality of mass laws as a result of the necessary adhesion (active ingredient to organism) as well as fulfilling complete accessibility. To enable reliable interference with the microorganisms' metabolism, the active substances must be dissolved in an aqueous phase, which also allows technically controlled dispersal. A hygienizing method developed according to these criteria, with an aqueous active substance (in an application quantity that does not alter the humidity of the air and surfaces) and using an SPC-controlled fine nebulizing technique for its application, was tested in various practical deployments in the cooling/packing area. In addition to the specified high product quality, another essential requirement was retention of the existing process operations without any changes to the process technology. This was attained in accordance with the following scientific fundamentals. An ultrasonic technique was used to convert the liquid active substance into a highly-effective mist, making use of the fundamental adiabatic rule.

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

source: Ohlmann

++ **Legends: N Number of gas particles, N_A Avogadro's constant, n Amount of substance (in moles), f Number of absolute degrees of freedom, k_B Boltzmann's constant, R Universal gas constant, T Temperature, K Isentropic exponents**

Thus changing the physical state of aggregation from liquid to gas also potentiates efficacy, resulting in the achievement of very good efficacies after a very short treatment time and extremely low concentrations. Aerosol particle size approx. 0.1 µm, application quantity 0.05 – 0.1 ml/m³/h. Tests concerning application as a mist (air & surface disinfection) and spray applications (surface disinfection/intermediate disinfection) were carried out by analogy with DIN 13697. As a result, the initial inoculation figures were equal to the reduction values for 12 test strains relevant to foodstuffs. An easily understandable extract from the test series using the new hygienizing method for the hygienically safe processing of baked goods is presented below.

Summary and conclusions

Basically, every manufacturing operation can sustainably achieve its task of securing product quality, including the economic aspects, through prior analysis of the process

++ **Accumulation of cutting dust from a slicing machine without suction exhaust**

Test organism	Treatment efficacy of the new hygienizing process	
	Nebulizing	Spraying
Yeasts and molds		
Yarrowia lipolytica	+	+
Penicillium chrysogenum	+	+
Bacteria		
Escherichia coli	+	+
Enterobacter cloacae	+	+
Enterococcus faecium	+	+
Lactobacillus sakei	+	+
Listeria monocytogenes	+	+
Salmonella typhimurium	+	+
Pseudomonas aeruginosa	+	+
Staphylococcus aureus	+	+
Acinetobacter baumannii	+	+
Viruses		
Murine Norovirus	+	+

+ Complete inactivation

source: Ohlmann

environment followed by balanced implementation of hygienic-climatic optimization. Moreover, process technology areas can be hygienically secured, thus allowing a further reduction in adverse effects due to personnel and the product flow itself.

Just in Air® has developed to the point where it is the market leader in this specific segment of hygienic-climatic process environment analysis with subsequent optimization, and has already successfully assisted the international baked products industry for many years. Thus there is no imperative need for know-how about analysis and optimization to exist in a company itself, instead of which it can be requested to its full extent from specialist firms like Just in Air®. +++