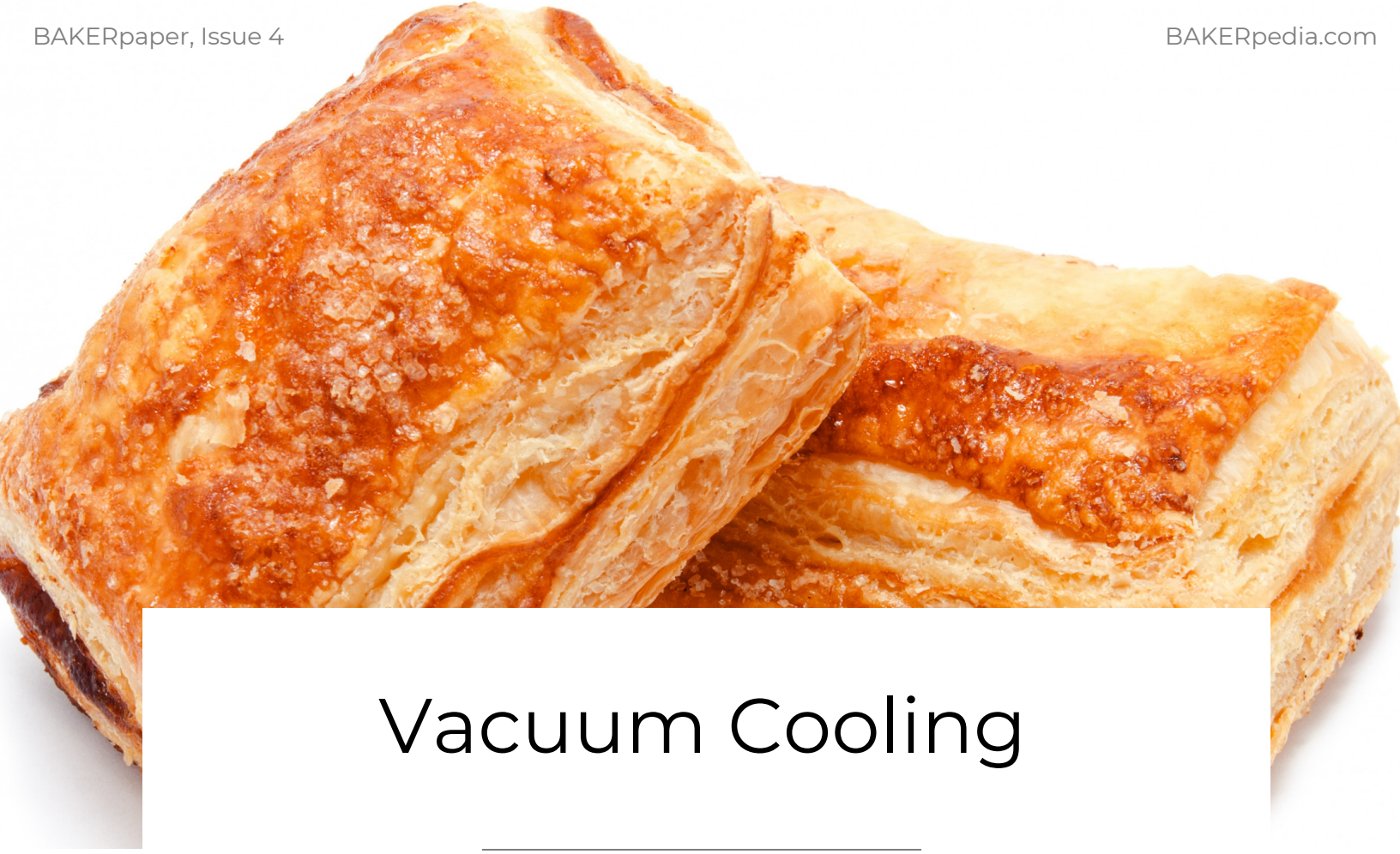

Vacuum Cooling

What is vacuum cooling?

Vacuum cooling is a rapid and efficient alternative to traditional cooling systems, such as spiral towers and ambient cooling. It uses evaporative cooling which relies on the power of vacuum to make vaporization of water take place quickly and at much lower temperatures. This technology not only cools bread but upgrades product quality and shelf life while shortening the baking time.[1,2]

For this process, product pieces coming from the oven at temperatures close to 96°C (205°F) at sea level are placed inside a vacuum chamber which is sealed to prevent gas exchange and partial evacuation of air. As a vacuum pump removes air from the cooling environment, the pressure inside the chamber decreases. The vacuum pressure inside the chamber causes a depression in the temperature at which the free water in the product boils.

How does the technology work?

As moisture evaporates and escapes from the crumb, the following happens:

- Heat is extracted from the baked good.
- Cooling proceeds is at a high rate of 22°C/min (40°F/min).
- This could cool the product to a final temperature of 30°C (86°F) as fast as 3 minutes.
- When the moisture balance is restored between the crust and crumb, the product is ready to be packaged. This usually takes anywhere within 5-30 minutes.
- Water vapor is collected through a condenser for further use or disposal.

Advantages

- Shorten total batch cycle times
- Speed up product cooling and achieve higher production rates
- Increase cooling capacity or reduce floor usage
- Maximize shape, stability and volume
- Improve the crust, making it thinner and crispier for a prolonged time
- Maximize the resilience of the crust, and prolonging freshness by delaying retrogradation
- Elevate process hygiene and food safety standards
- Extend mold-free shelf-life of baked goods by reducing post-baking contamination

What kinds of products can be vacuumed cooled?

- Croissants/Puff pastry
- Cakes
- Panettone
- Cookies
- Hamburger buns
- High volume pan bread

SPECIAL PRODUCTS

Especially for “difficult” bakery products like gluten-free and low-carb, vacuum cooling can dramatically increase the structure, quality and freshness/shelf life. Vacuum cooling also works for pre-bake and bake-off products. Productivity, quality and shelf life will also be improved for these product groups.

SPECIAL CONDITIONS

Cooling under vacuum eliminates the dependence on prevailing atmospheric/seasonal conditions, thus achieving consistent results at all times. Using the right equipment will also result in substantial lower energy consumption, caused by the shorter baking times and efficient cooling process. Heat recovery or free cooling technologies will further improve the energy balance.

Key variables involved

As any other unit operation, vacuum cooling requires properly sized equipment and an optimum interaction between process parameters and variables. It is key to monitor and control:

- Vacuum pressure of operation
- Cooling time
- Product load (lb/batch)
- Product temperature drop curve
- Condensate amount

A closer look at batch vacuum coolers

Vacuum coolers are inherently batch-mode systems that need to be properly connected and synchronized to the continuous up- and down-stream operations of high-speed lines. When a vacuum cooling system is installed on an existing production line, several adjustments must be made in order to prevent the cooling equipment from becoming a production bottleneck, such as:

- Proper line balancing such as timing of cooling, holding and transfer times
- Labor needs in case of manual product handling
- Product holding, loading/unloading equipment

Vacuum vs. traditional spiral cooling

Vacuum	Traditional
Cooling from 100°C (212°F) to 30°C (86°F) can be achieved in just 3 to 6 min	Cooling of a pound loaf requires 60 min and 30 minutes for buns and rolls
Compact design: the product is cooled in a 20 m2 piece of equipment	Large footprint: the product is cooled on a 3,200 ft2 (300 m2) spiral tower
Mold contamination risk is reduced given the relatively sterile conditions in the vacuum chamber	Mold contamination risk with airborne spores from drafts is high
Superior crust appearance and better symmetry as product shrinkage is greatly reduced	Crust shrinking is a phenomena often difficult to reduce
Slightly higher weight loss since cooling is carried out only through evaporation. This can be compensated fully by optimizing the baking/vacuum process, which can result in a higher water content in the final product.	Lower cooling loss due to combination of convection and evaporative cooling mechanisms
Shorter baking times or reduced energy consumption during baking to compensate for overall moisture loss in the product	Standard baking and cooling conditions
Scaling weight at divider and % absorption must be adjusted according to finished product moisture	Standard scaling weight and % absorption
Textural shelf-life (product staling) is a challenge if bake loss is not properly adjusted to vacuum cooling	Normal textural shelf-life with emulsifiers and specialty amylase preparations

Can vacuum cooling create a mold-free product?

Yes, it can. Sterilized baked products exit the oven at temperatures close to 96°C (205°F). This is above the kill step of all pathogens, including mold. The traditional ambient cooling methods using conveyor belt cooling exposes the bakery products to mold spores in the air. Once mold spores settle onto baked products, with the absence of mold inhibitors, it is only a matter of days before it starts growing.

That is why all mold growth happens at the surface of baked products. The less time the product is exposed to ambient air, which is less than a few minutes in vacuum cooling, the less likely it is exposed to mold spores, and the less dependent the manufacturer would be on mold inhibitors

Why does vacuum cooling cause a dryer product feel?

Two issues need to be explained. First, the amount of water. The amount of free water in the bread is reduced during the vacuum cooling process. To avoid this, shorten the baking time. This saves the water in the system and balances it out, retaining the same amount of free water in the final product.

Second, this happens in the crust. Directly after the vacuum cooling process, the crust can get very dry. This is because all the moisture is first taken out of the crust. Over time, the moisture balance will be equilibrated, but you will still have a very thin and perfect crust with prolonged crispness. Soft buns will stay soft, when baked and cooled in the proper way!

How can I prevent the filling from my pastries from oozing out during vacuum cooling?

Improper application of cooling parameters most often causes this problem. The right cooling parameters will let the fillings stay perfectly in place. In many instances, the cooling speed or other parameters will have to be adjusted to get the perfect results. It's like wearing gloves: not one size fits all, so it will take some troubleshooting.

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