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Proofing Control with Refrigeration Technology – An advanced process in the production of baked goods

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History

When bread was initially produced about 8,000 years ago, it was certainly not through the genius of only a few people but rather a logical result from a series of developments, encompassing the use of grain through, to the preparation of cereal meals. The preliminary product was just pulp, which over the course of time, was dried and later heated (baked).

However, one thing is for sure: bread was produced in the warmer regions of the world because it was only in these regions that people could live at that time and settle, due to the sowing and harvesting cycles and thus ultimately survive As a result of the changing temperatures from day to night and the seasons, bread production was immediately confronted with hot and cold conditions. Therefore, temperatures ranging from freezing to high heat have always had an impact on the outcome of the bread. Through observation and experience, people quickly learned how to control and master the individual technological phases. It started with the preparation of the dough and continued through the fermentation stage to the completion of the baking process. Sometimes the fermentation process needed to be delayed and at other times it had to be accelerated. The same applied to the baking process. Each individual factor had its optimum and maximum. Therefore the quality of the bread was first of all achieved empirically and then later governed by scientific findings to finally yield a food product, which was highly esteemed by the consumer and could make its way to the top of the list of all food products.

During its 8,000 years of history, the production of bread has been subjected to constant modifications and improvements, this was particularly so in the 20th century, with the emergence of automatically operating mixing, kneading, sheeting and forming machines. Mechanization – especially in combination with automation – displays a momentum of its own. Automated production processes geared towards uniformity are very susceptible to changing external processing parameters. This is, in particular, true of today's advanced freezing systems.

Both cold and hot temperatures play an equally important role in the entire process of bread making. Low temperatures – in particular at times of elevated ambient temperatures – are a pre-requisite for success. "Soft and cool makes the baker no fool" is a powerful proverb that has never lost its validity. It has always been necessary to keep certain types of dough cool, for example gingerbread and soft pretzel dough. The baking industry is also well aware of the fact that ice water is needed for the dough and a chilled room for storage and proofing are often necessary for successful baking.

In the 1980s, an unprecedented development in terms of refrigeration technology started in the baking business. The US, France and Switzerland were the pioneering countries in this field. "Fermentation dirigée" which means proofing control was introduced to the production of baked goods more quickly than any other comparable process. The legislation in individual countries, the invention of improved refrigeration systems and the increasing consumer requirements accelerated this trend and suddenly there was a completely new term on everyone's lips: Baked freshness.

Cold and warm

Prior to using refrigeration technology and related processes, one has to have a good understanding of the subject. Despite the common linguistic usage, from a physics point of view, cold and heat are not different types of energy. There is no "coldness energy" but rather only thermal energy, as one type of energy characterized by the temperature of items. Any item having a temperature above the absolute zero point of 0 degree Kelvin, which is –273.16 degrees Celsius, possesses a certain thermal energy. This thermal energy can be attributed to the internal movement of matter, the (self-) movement of the molecules. When one item needs to be heated, thermal energy must be introduced. When an item needs to be cooled down, thermal energy must be withdrawn. Therefore, in a freezing process, thermal energy is withdrawn and cold, as is sometimes said to be, is not added. In general, the following is valid: thermal energy flows from a place of higher temperature to a place of lower temperature.

Heat can be transferred mainly in one of the following three ways: by radiation, by conduction or by convection. In thermal engineering, all three types of heat transfer are effectively combined in most cases.

Heat radiation is a type of electromagnetic radiation and thus follows the same laws as a ray of light. Solar heat, for example, arrives on the earth as heat radiation. Heat is radiated from a warm item in the form of electromagnetic waves and is then absorbed to a more or lesser extent by a colder item. The second item warms up because of absorption. Items with matt black surfaces (e. g. black baking tray) have a better heat absorption than items with light and smooth surfaces (e. g. tinplate, aluminum). The reason for that is the higher reflection of radiation from smooth, light surfaces.

If there is a temperature difference in an item, heat conduction takes place irrespective of the state of aggregation. In this case, the energy is passed on via the collision of freely movable molecules, by oscillation or any other self-movements on a molecular level.

Convection takes place in liquids and gases. Here, the warm matter is transported in currents from spots with higher temperatures to spots with lower temperatures. It is distinguished between free convection and forced convection. Free convection is caused by the different density of warm and cold particles. Forced convection is produced by generating a current with a pump or fan.

In baking technology, the transfer of heat from a gaseous medium to a solid item plays a role in proofing and baking processes, as does the dissipation of heat from a solid item into a gaseous medium during cooling and freezing. This type of heat transfer, with the participation of convection and conduction, is called heat transmission. The level of heat transmission is related to the level of flow velocity of the gaseous medium; the higher the flow velocity, the higher the heat transmission. A very effective transition of thermal energy from a solid item into a surrounding medium can be achieved by evaporating a refrigerant agent (liquid nitrogen or solid CO_2) directly on the surface of the solid item. This process is also called cryogenic cooling.

The characteristics of thermal transfer and thermal transport, in particular of heat transmission and heat conduction, are key factors for the use and control of heat technology and refrigeration technology. They follow physical laws and reference numbers. Lack of respective background knowledge easily results in operational failures and non-conforming products. The freezing speed for example, is highly dependent on the temperature difference between the product to be frozen and the surrounding medium (often cold air), on the flow velocity of the surrounding medium and on the thermal conductivity of the item to be frozen.

Today, science and industry agree: that only a fast drop in temperature (flash freezing) delivers the required results; if the cooling-down process is too slow, it results in the formation of larger ice crystals (spears) which can destroy the gluten membranes and perforate the outer layer of the yeast cells which results in a loss of cell material. Furthermore, it must be taken into consideration that due to a slow formation of ice crystals during the freezing of the yeast cells, the water will separate from the soluble cell components which are then concentrated this way, thus leading to increased damage of the yeast cells.

A very rapid freezing process provokes the formation of blocks. This means that the water will freeze uniformly in the dough piece and in the yeast cells because there is no time for slow crystal growth. The limiting factor for the speed of the freezing process is mainly the heat conduction from the inside of the product to be frozen to the surface and the resulting transfer into the surrounding materials. Therefore, good knowledge of thermal conductivity is inevitable.

Metals, in general, are good heat conductors while wood, fabric and gases are poor heat conductors. Water also has a poor thermal conductivity. This means that flour, dough and bread are also poor heat conductors. In particular, proofed dough pieces and leavened baked goods have a spongy structure which is bad for the conduction of heat. The heat conductivity of a material is characterized by its heat transfer coefficient; the higher the heat coefficient, the better the heat conductivity.

Heat coefficients (thermal conductivity)	
Air	0.021 W/mK
Carbon dioxide	0.011 W/mK
Water	0.500 W/mK
Ice	1.900 W/mK
Flour	0.048 W/mK
Dough	0.510 W/mK
Bread	0.180 W/mK

Technical materials	
Glass	0.500 – 0.900 W/mK
Foam rubber	0.034 W/mK
Polystyrene	0.027 W/mK
Paper	0.130 W/mK
Press board	0.210 – 0.240 W/mK
Veneer	0.130 W/mK
Wood fiber board	0.028 – 0.048 W/mK
Cork	0.035 W/mK
Linen	0.057 W/mK
Fabric	0.300 – 0.320 W/mK
Marble	2.400 W/mK
Iron	63 W/mK
Wood	0.018 – 0.120 W/mK
Lightwood (rattan cane)	0.049 W/mK

Sheets, trays and pans		
Black plate		40.4 W/mK
Aluminum		195.2 W/mK
Tinplate		40.4 W/mK
Enameled metal sheet		40.4 W/mK
	■ Metal sheet	40.4 W/mK
	■ Enamel	0.6 W/mK

However, even in the case of very quick heat dissipation in the freezer during the flash freezing process, the freezing times could be long because of the relatively poor thermal conductivity of the products to be frozen. According to experience, dough pieces need the following flash freezing times until a core temperature of –9 °C has been reached:

Flash freezing times		
Rolls	50 g	30 minutes
Soft pretzels	50 g	18 minutes
Baguettes	300 g	30 minutes
Rolls	100 g	45 minutes
Rolls	250 g	60 minutes
Bread	500 g	150 minutes
Bread	1,000 g	200 minutes

The freezing times depend to a large extent on the

- size of the dough piece (weight)
- shape of the baked goods
- recipe / ingredients
- loading density in the cooling chamber (total amount of dough)
- air velocity
- packaging (packed or unpacked)
- type of tray or sheet (on which the dough pieces rest)
- initial temperature of the dough piece
- volume expansion in the cooling chamber
- control via air or core temperature

Generation of cold temperatures

The cooling processes applied differ as follows:

1. Conventional cooling:
   Re-circulating refrigerants evaporate and dissipate heat from the environment. The temperature drops.
2. Cryogenic cooling: The temperature drops because the refrigerants, which are not re-circulated, evaporate directly.

Nitrogen and carbon dioxide can be used for this process. Both methods (conventional and cryogenic cooling) have their own benefits. Cryogenic cooling is faster. The decision as to which type of process is chosen is predominantly governed by the type of application under consideration of the cost factor.

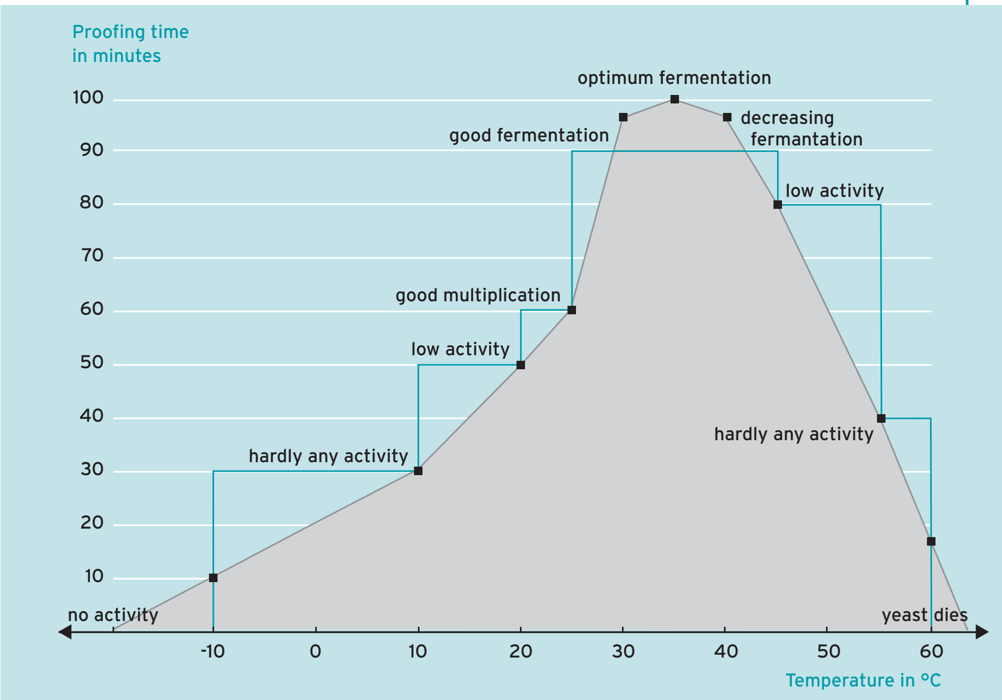
Conventional freezing systems require investment and energy; cryogenic equipment incurs rent and refrigerants.

Dough leavening by proofing

Proofing is the central process used for the leavening of bread, pastry and yeast dough. In the bakery, proofing is defined as alcoholic fermentation induced by yeast, whereby the enzymes from the yeast split simple sugar into carbon dioxide and alcohol. Sufficient leavening of dough and dough pieces is essential for optimum quality. The yeast has the task of producing a sufficient amount of carbon dioxide from the sugar. This process continues during the entire proofing period, i.e. from the time of dough preparation to the baking phase in the oven. The yeast is finally inactivated by the heat in the baking oven.

For an efficient production process, it is eminent that this central process is controlled as precisely as possible and that it is aligned to the respective upstream and downstream processes. The most important aspect is the availability of free space in the oven once the optimum proofing point has been reached. It is only when the dough pieces can be baked at their optimum ripeness that an acceptable quality of baked goods can be achieved.

The proofing time is steered by the amount of yeast, the temperature of the dough and the temperature of the proofing cabinet. At temperatures below –18 °C there is virtually no fermentation activity. With increasing temperatures, the activity of the yeast also increases up to a maximum temperature of about 35 °C. Beyond this temperature, the activity drops sharply.



Activity of yeast depends on the temperature (proofing curve)

Proofing control methods

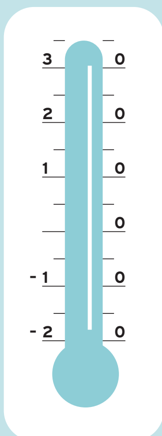
The proofing time can be controlled via the amount of yeast, the dough temperature and the temperature in the proofing chamber. The following methods are distinguished:

- Long floor-time (traditional / PATT process)
- Proofing retardation
- Proofing interruption
- Freezing of unproofed dough pieces
- Freezing of proofed dough pieces

Temperature ranges of cooling and freezing processes

Long floor-time (LFT)
(decelerated proofing)
+15 °C to +25 °C
(also called CP = controlled proofing)

Freezing of baked goods (FBG)
–18 °C to –20 °C
Flash freezing



Proofing temperature (PT)
+25 °C to +35 °C

Proofing retardation (PR)
+5 °C to +7 °C

Proofing interruption (PI)
–7 °C to –18 °C

Long floor time

"Traditional process" with long floor-time

The traditional process with long floor-time includes the storage of the formed dough pieces at ambient temperatures for up to 8 hours. It differs from the proofing retardation insofar as no elaborated technical equipment is required. The proofing time is controlled via room temperature, amount of yeast and also dough temperature. In general, the temperatures of the dough pieces during the final proofing vary from +7 °C to +20 °C. The ambient temperature is decisive for the entire final proofing time. Based on practical experience the following limit values were determined.

Total proofing time	Ambient temperature
a) 2 to 5 hours	20 – 25 °C (e.g. in summer)
b) 5 to 8 hours	15 – 20 °C (e.g. in winter)

The amount of yeast has to be reduced by 3 baker's percent for a) and by 2 % for b). (Commonly the amount of yeast added to dough with a short floor-time is 6–8 %).

"Traditional process" with long floor-time

Advantages

- no technical effort required
- most cost-efficient method
- baked goods with high quality taste
- available at any time of the day

Disadvantages

- susceptible to deviating temperatures
- determination of optimal proofing degree requires high professional skills from the personnel

PATT process

This is a patented process (PATT = Programmiertes Abkühlen Teilgegarter Teiglinge, programmed cooling of par-proofed dough pieces) which is predominantly employed in Switzerland and partly in Austria. It is a special form of long floor-time processing with precisely controlled climate parameters requiring special equipment. The first phase includes defined pre-proofing at low proofing temperatures and highly controlled humidity. During the second phase, the temperature of the pre-proofed dough pieces is lowered very slowly in order to stabilize this condition over a period of time as long as possible. Due to the long cool-down phase, the temperature difference between the surface and the core of the dough piece is very small, so that only minor amounts of moisture migrate from the core of the product to the surface. This keeps the moisture inside the dough piece.

PATT process

Advantages

- fast availability of baked goods because they can be baked immediately
- low energy costs compared e.g. to proofing interruption
- prolonged freshness of the baked goods

Disadvantages

- technical investment
- precise monitoring of the parameters required

Proofing retardation

Proofing retardation is the prolongation of the proofing time to maximal 24 hours at a storage temperature of between –5 °C and +5 °C. In order to retard the proofing of the dough pieces for maximal 24 hours, it is necessary to reduce the core temperature of the dough pieces to below 0 °C in the cooling equipment, after this they should also be stored at a temperature of about 0 °C. At the end of the storage time, the dough pieces should be given about 30 minutes time to acclimatize to the ambient temperature. After that, they should be placed in the proofing chamber for their final proof. The proofing retardation can be done independently of the outside temperature at a relatively low cost.

Proofing retardation

Advantages

- not susceptible to outside temperatures
- baked goods with high quality taste
- cost-efficient method because of low energy consumption
- simple method
- improved management of production peaks

Disadvantages

- susceptible to flour containing high amounts of enzymes
- technical investment

Proofing interruption

The proofing interruption process involves the stopping of the fermentation process by bringing the core temperature of the dough pieces down to between – 15 and – 18 °C. The items are also stored for up to 72 hours at this temperature. After expiration of the storage time, the dough pieces are thawed either for one or two hours at ambient temperatures before the final proof takes place in the proofing chamber or via an electronically controlled proofing-interruption program. A program controlled proofing interruption unit operates with temperature control and can be used for cooling and proofing. With a pre-programmed slow and controlled rise in temperature, the dough pieces are thawed and finally proofed over a total period of 8 to 10 hours. Due to the controlled thawing and fermentation phase, this process is foolproof.

Proofing interruption

Proofing interruption

Advantages

- not susceptible to outside temperatures
- controlled proofing process
- uniform baking result
- improved management of production peaks

Disadvantages

- technical investment
- higher energy consumption

Frozen dough pieces

Freezing of unproofed dough pieces

In general, the freezing of unproofed dough pieces follows the same procedure as the proofing interruption. However, after a core temperature of – 7 °C has been reached, the dough pieces are packed into plastic bags and then stored for a prolonged time at – 18 °C. The storage time may be several weeks.

Freezing of unproofed dough pieces

Advantages

- available at any time of the day
- storage in plastic bags possible for several weeks
- improved management of production peaks

Disadvantages

- technical investment
- higher energy consumption
- determination of optimum proofing degree requires a high level of professional skill from the personnel
- long thawing and proofing times

Freezing of proofed dough pieces

The freezing of partly proofed dough pieces allows for the production and storage of dough pieces for flexible use in the bake-off stations. These dough pieces can be baked directly in special, electronically controlled baking ovens with thawing and baking programs without a further final proof. The freshly baked products are available after about 30 minutes. The easy handling of the frozen dough pieces makes this process especially suitable for bake-off in bakery outlets.

Freezing of proofed dough pieces

Advantages

- lowest time requirement for the preparation of small baked goods in the outlets
- easy handling for the sales personnel

Disadvantages

- lower volume
- special baking oven with thawing and baking function required
- the principle only works manually in a deck oven
- the longer the time in the freezer, the lower the volume of the baked goods
- slightly reduced crispness phase

For this process, the following factors should be taken into consideration:

- the initial weight and the amount of yeast should be increased for pre-proofed dough pieces compared to traditionally produced dough pieces
- the dough pieces are flash frozen after 3/4 proofing time with the bloom pointing upwards
- a core temperature of –7 °C should be reached within 20 to 30 minutes
- the dough pieces are then packed in batches into plastic bags and stored in a freezer at a temperature of at least –18 °C until used
- the frozen dough pieces are baked off in a computer controlled baking oven with thawing and baking program without prior thawing
- compared to traditional processes, the total baking time is longer

Frozen dough pieces, unproofed, partly proofed, completely proofed

Freezing of leavened pastry

The following factors should be noted when processing frozen dough pieces for pastry products made from yeasted dough: For unproofed dough pieces, a low dough temperature and a short dough resting time after kneading are advantageous. When thawing the dough pieces, the initial climate should not be too moist to prevent excess condensation of water vapor on the surface of the dough pieces. The dough pieces can be baked off as usual. The most favorable condition for the production of pre-proofed frozen dough pieces are: common dough, common dough temperatures around 26 °C, 25 minutes dough rest, proofing time between half and two-thirds of the total proofing time, thawing/warm-up time in the oven of about 6 to 8 minutes, amount of steam 0.8 to 1 liter, oven temperature during thawing set to about 155 to 170 °C. These specifications are just general requirements, although other influencing factors might possibly have to be taken into consideration depending on the circumstances.

The advanced method of proofing time control allows the separation of the processing steps of dough preparation, proofing and baking. The advantages are not only clear for the bakery but also for the consumers: tasty baked goods fresh from the oven all day long.

Process of proofing time control

Long floor time

- storage for a maximum of 8 hours
- no technical effort required
- freshly baked rolls several times a day

PATT process

- storage for maximal 16 hours
- PATT equipment
- baked goods with high freshness several times a day

Proofing retardation

- storage for maximal 24 hours
- cooler or refrigerated chamber
- solves problems in the early mornings

Process of proofing time control

Proofing interruption

- storage overnight or on the weekends: maximum 72 hours
- proofing interrupter or freezer
- less production bottleneck at the beginning of the week

Freezing, unproofed

- storage for several weeks
- freezer (high performance freezer / CO_2)
- streamlining of the production

Freezing, proofed

- storage for several days
- freezer (high performance freezer / CO_2)
- freshly baked rolls within 30 minutes

Influencing parameters

First of all, it is important to note that basically no specific flour qualities are required for the new technology of proofing control. Many bakeries have been applying these new methods and processes for many years now without encountering any problems with the flour used. Furthermore, there is a large number of bakeries using the same kind of wheat flour for products made with proofing control, as well as for products made directly, without any specific problems.

However, it is known that the performance limits of wheat flour vary due to proofing control. Prolonged floor-times, pre-ferments and sponge dough, large amounts of dough and prolonged dough resting times and, in particular, long final proof as well as softer dough have always been more demanding on the baking properties of wheat flour. In Austria and Switzerland, where the dough, in general, is subjected to a longer floor-time, the flour has always been ground more coarsely resulting from a higher protein content with improved gluten quality than is the standard in Germany. However, one huge advantage in Germany has been the constant increase in protein values and gluten qualities over the past centuries achieved by the growing and selection of wheat varieties. It is an undisputed fact that longer floor-time – and this includes the final proofing time – at cool and in particular at freezing temperatures, is more demanding on the dough structure. This is predominantly due to the enzymatic activity in the flour which displays more gluten reducing effects during the prolonged exposition time, thus provoking reactions that impair the gas retention properties and the dough structure.

Flour

This results in the fact that there are certain demands on universal flour (in Germany wheat flour type 550) used in dough processes applying proofing control. A good and uniform baking result can be expected under consideration of inevitable bakery technological imponderabilities in terms of the baking properties of the flour for the analysis values and dough rheological properties depicted in the table below.

Yeast

It is commonly known in bakery technology that the temperature, to a large extent, influences the yeast and its metabolism. However, the behavior of the yeast at temperatures below zero has been subjected to intense research in recent years. Useful empirical values are now available from the yeast and baking industry, which have already been largely applied in the bakery trade.

Every expert knows the fermentation optimum of baker's yeast; it is at +35 °C. Higher temperatures delay and impair the enzymolysis of the yeast cells. The rising power fades and comes to a stop at temperatures of around +65 °C, due to the coagulation of the proteins in the cells. However, the fermentation intensity of the yeast also decreases more and more at falling temperatures from +30 °C to zero. These are the temperature ranges used for the long floor-time process, the PATT process, the process of proofing retardation and even partly in the process of proofing interruption. At a temperature of below zero the yeast's activity is low and its cell components (minerals, sugar, soluble proteins) cause a freezing point depression of the cell water so that the yeast cells, in general, only freeze at a temperature of –7 °C.

Optimal analysis value of universal flour for proofing control processes

High amount of protein

- protein content 12.5 – 13.5 %

Good gluten quality

- wet gluten 30 – 35 %
- sedimentation value 35 – 40

Elastic extensible gluten structure

- extensogram values, ratio number 2 – 4

Low enzymatic activity

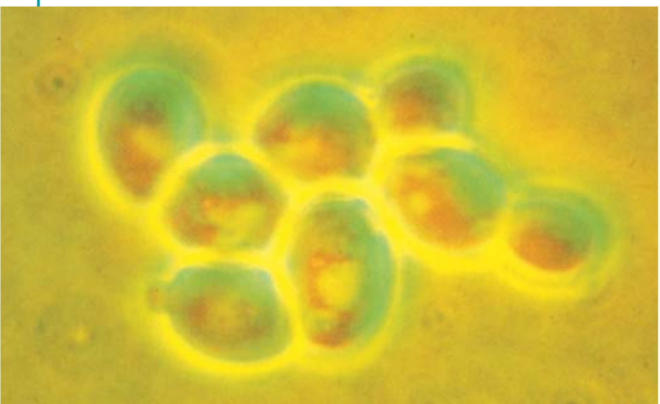
- falling number 300 – 350 N
- maltose number 1.5 – 2.0 %

Low mineral content (ash)

- minerals 0.5 – 0.6 %

Yeast contains about 70 % water; in its unprocessed state it is highly stable against cold and freezing temperatures. Yeast can withstand freezing temperatures as low as –20 °C for months, without noteworthy damage to its rising power. Several freezing and thawing cycles will not even impair the activity of the yeast. However, as soon as yeast cells are contained in dough, the freezing temperatures pose a problem. The resilience diminishes quickly and the fermentation performance together with the volume of the baked goods reduces remarkably. The kinds of yeasts with normal rising power are the varieties suited best for proofing control processes (including freezing). The production process of the yeast, its freshness at the time of use and the storage conditions have a large impact on the properties. Yeast with quick rising properties has not shown good results. Due to its fast rising potential, it provokes high susceptibility of the dough piece at all processing, storage and baking stages.

Yeast cells (magnified under the microscope)



Dough improvers

The new proofing control measures call for compound improvers tailor-made for these technologies. The research departments of the improver suppliers were challenged to present an optimal solution that could achieve a high and uniform quality standard for baked goods and be acceptable to producers and consumers alike.

Long floor-times and long resting times (or storage times) with changing temperatures (cold and warm temperatures) make high demands on the improver. This basically concerns the entire higher and longer internal and external stress of the dough pieces. It requires dough that is highly stable despite the constant activity of yeast and enzymes. The effect of the improver is specifically needed in all phases of the dough handling. The dough quality, i. e. structure, water-binding capacity, extensibility and elasticity must be supported. The consistency of the dough must be stable, except for the leavening. Dough softening or dough stiffening reactions must be kept within tight limits. For fulfilling these novel and comprehensive tasks, the research and development departments make use of components and active agents with well-known reaction mechanisms. However, an optimum baking result can only be achieved if all the ingredients (including yeast and improvers), technology and processes applied are aligned.

The principles of the three "key parameters" applicable for traditional dough also apply to frozen dough:

- gas formation capacity
- gas retention capacity
- rheological properties

Thus it is not surprising that the same baking-effective ingredients (active agents) are used for frozen dough as for traditional dough. However, the differences are the quantities and the ratio of the components. This means that, in general, problems arising with frozen dough cannot be mastered with conventional improvers. This is a well-known fact. Straightaway it can be noticed, that dough with controlled proofing, displays the following properties under the influence of lower temperatures:

- reduced gas formation
- reduced gas retention
- changing rheological properties of the dough

These differences can be partly put down to the yeast. If the proofing optimum of the yeast, which is +35 °C, fails to be reached, the rising power slows down. At a temperature of –9 °C, the yeast stops its metabolistic action completely. At a temperature of –16 °C, the enzymes stop their activity. At a temperature of –24 °C, a large portion of the yeast cells in the dough dies. In this way, low-molecular compounds containing sulfhydryl groups (e.g. glutathione, cysteine) are released from the yeast into the dough. These compounds soften the dough and require a special oxidative treatment.

The necessary ingredients in all frozen dough improvers are different kinds of sugar (sucrose, glucose). Sugar is necessary for the gas formation. The sugar contained in the flour (maltose) is not sufficient for that. The yeast always needs a sufficient amount of fermentable sugar to be available at the right time. This effect can be easily controlled by the formulation of the improver. Problems are posed by the different ways of processing. Thus it is highly important to ensure that the fermentation activity is constantly kept at the required optimal level, during the entire processing and controlled proofing of the dough pieces. Certain enzymes are very suitable for this. The high temperature-dependent activity of starch degrading enzymes must therefore be perfectly aligned to the mutual temperature-dependent fermentation activity of the yeast. This in turn requires differences in the composition of the enzyme complex, depending on the different methods used (e.g. frozen unproofed or pre-proofed dough pieces).

One main component in improvers for frozen baked goods are emulsifiers. Lecithin, diacetyl tartaric acid esters and – optionally – mono- and diglycerides of fatty acids are the emulsifiers most often used. They are sometimes even used in combination. The emulsifiers interact with the flour components, in particular with starch and gluten. In this way the amount of water absorbed by the dough is fixed by optimizing the amount of bound, immobilized and free water. The gluten membranes are thinner, easier to extend and have an improved elasticity without tearing. Of course, the emulsifiers also influence the freezing process of the water content in the dough. They support a fine distribution of free water in the dough and thus reduce the formation of large ice crystals, which may damage the gluten structure.

The control and improvement of the water distribution and water formation can also be achieved via stabilizers, which influence the swelling properties of the gluten, or bind larger amounts of water themselves. Phosphates and hydrocolloids (e.g. guar gum) are certain ecamples. In addition to other functions, soy flour and wheat gluten have the same effect (water binding).

One very important active agent in frozen dough is ascorbic acid. It is additionally needed in these applications to counteract the dough softening caused by glutathione and other compounds containing sulfhydryl groups. The dosing of ascorbic acid in frozen dough improvers is a difficult balancing act; too much is harmful during kneading, too little is detrimental during freezing, thawing, proofing and baking. Other ingredients in frozen dough improvers include cereal products, fats, milk products and maltodextrins, each playing its own part.

Taste

Yeast, predominately used to leaven dough and dough pieces, imparts a typical taste on bread and baked goods made from yeasted dough. The same applies to the aroma. This is most obvious with small baked goods such as different types of rolls. During the fermentation specific aroma and tasting compounds are developed. At the same time, a series of triggering and strengthening reactions are induced by components from the dough improvers such as sugar, malt, enzymes. The enzymatic and microbiological effects on products made by proofing control are extremely large due to the prolonged proofing times. This is confirmed by the relevantly better taste (more intense flavor) of rolls made with long floor-times and retarded or interrupted proofing processes. During the long resting-times – often overnight – of the dough pieces from the shaping to the baking process, enzymatic degradation takes place resulting in intermediate products with regards to flavor and formation of crumb and crust. Simultaneously aroma compounds are formed from the metabolism of the microorganisms, this allows the difference between traditionally produced rolls and ones made with proofing control to be easily determined organoleptically.

The improvements can also be seen in the structures of the crumb and the crust. Due to the more intense swelling of the dough pieces during the longer resting times, the baked goods aquire improved coherence, cutting and spreading properties. In addition the crust develops a softer-flaky appearance and stays crispier for a longer time. All these features are the result of an improved leavening and a fine-meshed interlacing of the crust. Regarding the question of taste, it must be mentioned, that it is much easier with the help of proofing control, to produce fresh products throughout the day.

Assortment of rolls

Par-baked / partly-baked products

In the 1960s, the "brown & serve" process was developed in the US. Another trial was the so-called baking interruption method (20 % reduced baking time and final baking with 40 % of the entire baking-time).

Today, there is a number of proven and scientifically established processes available that allow a baking process, that is time-independent of dough preparation and make-up.

Long floor times, proofing retardation and proofing interruption solve problems in the bakery, which would otherwise arise in the morning and in the afternoon. The freezing of dough pieces provides for a supply of ready-to-bake frozen dough pieces, being available throughout the day. However, some specific problems have not been solved yet.

There are incidents where a final proofing, after thawing, is neither possible nor reasonable. There are also problems with the transport of refrigerated or frozen dough pieces and sometimes the personnel that bake-off the products lack in minimal qualification. Finally, it could be that the customer (large consumer, hotel, canteen, catering service etc.) requests stick bread (or baguettes) or rolls fresh from the oven at any time of the day or night. No company can offer an uninterrupted service on site or regionally, this means that the customers can only proof and bake the dough pieces themselves. In general, neither experienced personnel nor the respective ovens are available. However, this problem can be easily solved today.

Partly baked (par-baked) products enable the commercial customers and the private customers to stock up on white bread and/or pastry products, that have already been subjected to a part of the baking process and which can then be baked off as needed. There is however a basic difference between par-baked goods that are frozen right after the partial baking process and par-baked goods that are stored at ambient temperatures. The later are often MAP products where the shelf-life is prolonged by the use of gas-tight packagings in which the air has been exchanged by nitrogen or carbon dioxide. Of course, the frozen par-baked product has the better freshness.

Par-baked bread needs a bake-off time of between 5 and 15 minutes at 200 to 220 °C depending on the pre-bake time and loaf size. Due to the removal of moisture from the crust, bread and small baked items display the desired crispness.

Advantages of proofing control

The advantages for the producer and the consumer are huge. This explains why the process of proofing control was introduced so quickly in the bakeries:

For the producer of baked goods

a) Equalizing of work peaks (five-day week)

b) Less bustle in the mornings

c) Better utilization of equipment capacities

d) Smoother course of operations

e) Production for stock-keeping

f) Reduction of personnel costs

g) Counteracting the lack of qualified personnel

h) Improving the quality standard

i) Optimizing the product range

j) Streamlining (improved operation), larger batches

k) Quality factor „freshness“

For the sale of baked goods

a) The products are available punctually in the mornings

b) Larger product range

c) Fresh rolls several times a day
(or continuously throughout the day)

d) Ideal for bake-off stations

e) Dough pieces can be delivered refrigerated or frozen

f) Peak demand can be equalized

g) Direct sale of frozen dough pieces and par-baked goods

h) Baking as the need arises – no returns

For the consumer

a) Fresh products throughout the day

b) Fragrant aroma and more intense taste

c) Crispness during consumption

d) Stock-keeping qualities for bake-off at home

e) Freshly baked goods in out-of-home consumption

f) Broad range of baked goods in public areas
(airports, train stations, shopping malls, sports events, etc.)