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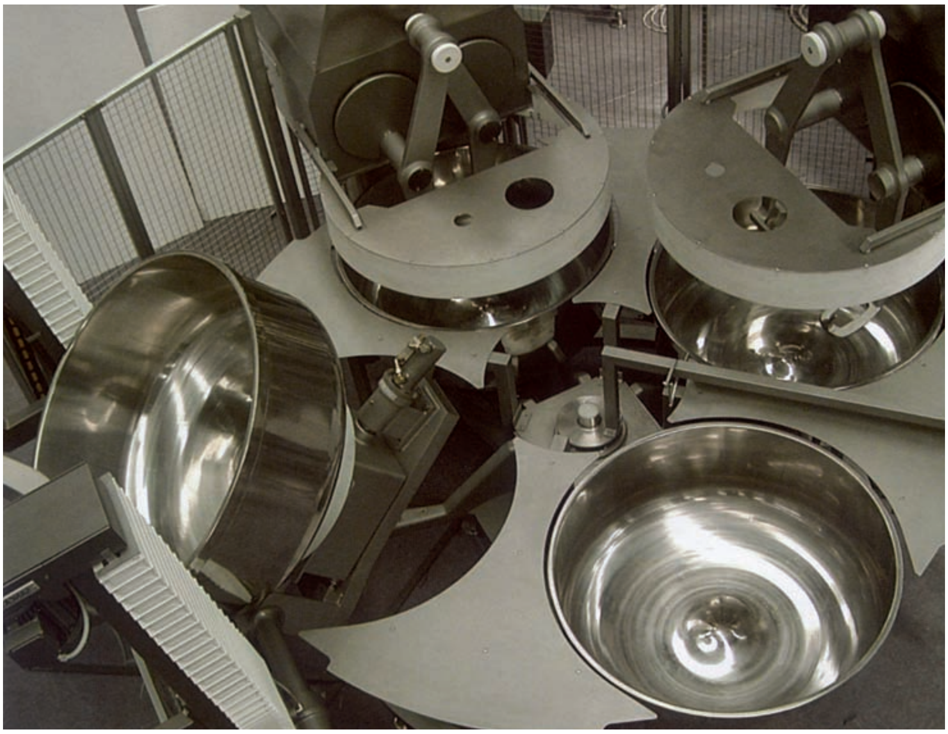
Latest advancements
Mixer technology for bread-making machines

Conventional mixers used in industrial bread-making are frequently flanked by plants offering latest useful functions for the production of well-hydrated dough with a homogeneous texture

Bread certainly is Italy's favourite food, thanks to its perfectly balanced mix of flavours, aromas and nutritional properties.
The data on Italian bread consumption confirm its popularity on Italian tables: 1.2 million tons of bread and similar products were consumed in 2005, worth Euro 2.86B altogether. The base ingredients used in bread-making are: flour, water, yeast, and salt, which may be added with other substances, such as malt, fats, eggs, milk, nuts, seeds, etc. Thanks to an adequate technological process, all these ingredients contribute to the creation of different types of bread, displayed in the appealing baskets of bakery shops and supermarkets, as: baguettes, toast bread, bread with olives or nuts. The sequence of operations composing this process, and contributing to the production of well-aired and porous structures, includes only a few – although basic – steps as: mixing, leavening, and baking.

The mixing phase

Mixing certainly is one of the most critical operations in the bread-making process. Here, in fact, all the ingredients are added and mixed to produce a perfectly homogeneous and hydrated dough, while insoluble proteins start forming the gluten assembly, from which depends the behaviour of the dough during fermentation and cooking. In this phase, the critical issues consists in: selecting top-quality raw materials; assessing with great care the mechanical properties of the flour, also in connection to the properties of the end-product; and in accurately monitoring specific parameters. Among these, temperature is probably the most important one, as it can strongly influence the dough's chemical, biological and rheological properties. In order to guarantee an environment suitable to the metabolism of yeasts, an optimal development of gluten is required, and, hence, in order to guarantee the top-quality of the final product, the temperature must be comprised between 23 and 27°C, according to the hydration rate. To this purpose, the heat developed during the process – resulting from the friction, the environment, the hydration heat and the speed of the mixing elements – must be kept under control.



Mixers and their features

In the case of industrial production, the mixing is performed by mixing machines, consisting mainly of: an *electric motor*, running at one or two speeds; a base, bearing the *mixing elements*; a *mixing bowl*, in rotary or stationary version, open or tightly sealed; *mixing arms*; and *transmission components* transmitting the movement to the bowl and to the various tools. Various different types of mixing machines are available on the market, offering a variety of properties and performances, and mainly characterised by the *number, shape* and *position of the mixing arms* (generally from one to three, equipped with beaters, hooks, spirals or rotary shafts, mounted in vertical, horizontal or skewed position), the *rotation speed* (conventional mixers achieve 25 to 35 r.p.m., with high-speed models reaching up to 70 to100 r.p.m., the *bowl unloading system* (which may be fixed or mobile, or equipped with lifting and tilting device for dough unloading), the *volume of dough* that can be mixed (ranging from capacities of less than 100 l to more than 1000 l), and, finally, by *the type of process* they can achieve (batch or continuous).
The most popular mixers in Italy for bread-making processes are of the "slow" type, i.e.:
– Fork mixer, mainly used for hard or medium-hard dough, with a water content of 32-35% or 45-50% respectively. Compared to other models, this kind of mixer is the slowest, and is characterised by a longer dough rising and kneading time for the same volume;
– Double-arm mixer, soft and medium-hard dough, characterised by a water content of 50-70% and 45-50%, respectively. The double arm action incorporates lots of air in the dough, and is excellent for capturing air and "opening" the dough, providing for shorter kneading time and faster rising processes; furthermore, the resulting volume of dough – and, hence, of end-product – is far higher;
– Spiral mixer; here the dough is the result of compressions from top to bottom; this unit produces soft and medium-hard dough. On one side, this mixer incorporates less air and causes a higher heating of the mix, but is characterised by a considerably shorter mixing time compared to other types of mixers.
The problem of excessive temperature increase in the dough varies according to the implemented type of mixer, and according to the friction developed by moving parts: fork mixers, for instance, cause the lowest temperature increase (0°-2°C), followed by double-arm mixers (4°-6°C), and spiral

mixers (with an increase of 9°-10°C). As for energy consumptions, on the other hand, spiral mixers rank first (for which, however, a system has been developed providing for up to 20-25% energy savings), followed by double-arm mixers and fork mixers. Next to conventional models, there are also **high-speed mixers**, in which the rest period can be avoided (3-5 minutes required for completing the hydration and formation of gluten in conventional mixing systems), since the high-speed movement brings about the same effects of the action of enzymes during the rest time required for fermentation. This technology, however, has not found fertile ground in Italy, whereas it developed itself mainly in the United Kingdom and US, because the resulting bread does not have the typical flavour and aroma required by Italian consumers, and also since this kind of process requires the addition of a considerable amount of oxidising agents, which doe not comply with Italian regulations on this matter. Another type of mixer, the carousel mixer, launched in the US by the end of the '50s, is suitable for continuous bread-making processes, in which the whole process is performed without stops.
These technologies are not widespread in Italy for the production of bread (also due to their high installation and maintenance costs), and are more popular in English-speaking countries or for the production of other kinds of baked goods.

Innovations on the market

The mixers conventionally used in bread-making processes may profit of innovative technologies and tools, capable of improving their effectiveness, reliability and efficiency, while providing for perfect dough in – often considerably – shorter times.
Dough cooling with liquid nitrogen: the problem of dough heat can be generally solved by implementing one of the following solutions: using pre-cooled flour and water, replacing part of the water with ground ice, blowing carbon dioxide into the dough, which chills the dough when the liquid turns into gas, or by means of a mechanical refrigerating system, consisting of a cooling jacket surrounding the mixing bowl, inside which the coolants (cold water, solutions of propylene-glycol, ammonia or halogenated hydrocarbons) are flowing.
An innovative system has been recently introduced on the market, consisting in the addition of liquid nitrogen directly into the pneumatic flour conveying pipe, by means of a series of specifically designed nozzles. Liquid nitrogen (injected at a temperature of–196°C) is used to decrease the flour temperature by approx. 25°C, which inside the silos can reach even 35-40°C. The integration of this injection system does not require considerable modifications to the plant, and can be performed quickly during a periodical machine standstill. This cooling system offers a variety of benefits, as: flexibility and high cooling effectiveness; homogeneous temperature; absence of thermal shock; high cooling speed; automation of the plant during mixing processes.
Continuous spiral-mixing system: a new technology has faced in the range of continuous mixers, combining the advantages of continuous process to the quality and flexibility of the spiral mixing system. Thanks to this technology, the limitations of conventional continuous systems can be avoided. Several advantages are offered, as: high production; delicate mixing; low heat; and high production flexibility. The ingredients fed by means of "loss in weight feeders" are blended in a premix chamber and mixed in a circular channel, in which a variable number of spiral mixing tools (depending on the required production per hour) are machining small portions of batch. Each spiral tool has a circular motion around its axis (responsible of the machining process) and a planetary motion around the bowl axis (for conveying the dough to the outlet area). The speed of each motion is independent and adjustable, for an efficient control

of the production both in terms of quality and quantity. Moreover, process parameters (including dough temperature, production data, etc.) are constantly monitored via a PLC.
Industrial mixing systems with lubrication-free gearboxes: of recent construction, these mixers are suitable for biscuits and industrial baked products and feature lubrication-free gearboxes. Planetary mixers derive their name from the movement of the mixing tool, which is similar to that of planets as it turns on itself and at the same time along the edge of the mixing bowl. These units are extremely versatile and are used for various applications, as sponge cakes and creams. In particular, the mixers featuring the new gearbox provide for higher process hygiene (thanks to their simple design that allows easy cleaning and to the total elimination of oil, which may contaminate food) and are characterised by sturdy mechanical construction; there are no seals and gaskets, and no special maintenance is required. Furthermore they provide for excellent use flexibility, as the gearbox is driven by two independent motors, providing for independent rotation of the tools and of their planetary movement.
New combined mix: a new mixing system has been combining in a sole machine the dough concepts and advantages of spiral and twin-arm mixers. The dough is the result of "compressions" between the mixing tools and the bowl wall, and of the "stretching" actions between the two arms, which cross in opposite directions. This sequence of compressions and stretching produces a complete dough "opening" followed by optimal gluten development. This mixer perfectly meets the needs of processing products with an "open structure", such as "ciabatta" or artisan bread, but they are suitable also for producing other kinds of products with a high fats content, as "panettone", croissants, donuts, puff pastry etc., as well as of classic products such as baguette, pizza or rye bread.
Compared to conventional mixing systems, the new mixer offers improved dough hydration and increase in water absorption, with minimum increase in temperature; excellent gluten development; shorter mixing time; and improved mixing of fat matter (butter, margarine, eggs, etc.).
Latest news on natural yeast fermentation: recently, a new system for the quick forming of sour dough from natural yeast fermentation has been developed suitable for feeding processing lines handling a variety of baked goods, including various types of rye and corn bread, leavened baked goods such as panettone, pandoro, colomba.
Here, the ingredients – flour, salt and yeast - are fed into the mixing bowl and then water is added at high pressure.
This system provides for an optimal distribution of water molecules between flour particles, which are perfectly hydrated. These particles glutinize creating a homogeneous product, ready for use.

FLOUR OXIDISING SUBSTANCES: WHAT'S THEIR USE?

Oxidisers are synthetic inorganic salts contributing to improve the rheologic properties of gluten, providing for improved water absorption and retention of carbon dioxide. When added to the dough ingredients, they guarantee the development of perfectly leavened products with a uniformly open structure. This effect derives from the peculiarity of these substances of inhibiting the proteolysis, i.e. the reaction that, by means of proteases, separates the proteins of the dough in shorter peptides, thus reducing the strength of the flour and weakening the structure of the dough. Oxidisers, in fact, transform the active part of proteins present in dough (showing a dominating presence of thiolic groups, -SH-), more sensitive to the aggression of protease, in the passive part (containing mainly disulphuric groups, -S-S-), less subject to chemical attack. In several countries, among which Italy, the use many oxidisers such as potassium bromate and azodicarbonamide, has been prohibited due to their toxicity. The sole additive accepted by Italian legislation is l-ascorbic acid (vitamin C), which may be added to the dough in one part per million.
The effect of L-ascorbic acid on dough was first noticed in 1935 by Jorgensen. Until that moment, the reducing action of Vitamin C was known, but practical tests on dough revealed an action similar to that of the oxidisers studied until that moment. In 1938, the researchers Melville and Shattock found an explanation to this phenomenon, and discovered that the enzymes present in the flour contribute to transform the L-ascorbic acid into de-hydroascorbic acid, a powerful oxidiser which, on its turn, oxidises the thiolic groups of gluten proteins, transforming them into bisulphuric groups.