LALLEMAND

BAKING UPDATE

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Continuous Mix

Practical technology from Lallemand Inc., parent of American Yeast Sales, producers and distributors of Eagle® yeast, fresh and instant.

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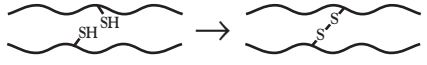
Oxidizing Agents

During mixing, the gluten in the flour is stretched and pulled apart so that it can be reformed during proofing and baking to provide the needed strength and structure. Oxidizing agents enhance gluten reformation and so are used to adjust dough strength, elasticity, and tolerance.

Gluten is composed of gliadins and glutenins, which interact to form a viscoelastic matrix in dough. Glutenins are large proteins composed of many subunits that contribute to the elasticity of dough. Gliadins are small single subunit proteins, which contribute to the viscous properties and extensibility of dough.

Gluten proteins contain amino acids with reactive sulfhydryl groups. In the native or reduced state, the proteins exist as separate entities. During the oxidation process, pairs of sulfhydryls become linked together in disulfide bonds. Through these sulfhydryl groups, one glutenin can become linked to several other glutenins, resulting in the formation of a network of chemically coupled proteins.



REDUCED OXIDIZED

When glutenins become linked (oxidized) during breadmaking, the dough strength increases but its extensibility decreases. During mixing, these linkages are broken mechanically to provide the extensibility needed for moulding. The process is reversible, and the addition of oxidizing agents increases the strength of the gluten matrix by increasing the number of sulfhydryl linkages.

Potassium bromate ($KBrO_3$) and ***calcium bromate*** ($Ca(BrO_3)_2$) have slow reaction rates when oxidizing the sulfhydryl groups in gluten to create disulfide bonds.

Potassium iodate (KIO_3) and ***calcium iodate*** ($Ca(IO_3)_2$) both have fast reaction rates. The reaction rate is controlled by the

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Bromate Replacement in Continuous Mix Systems

TRADITIONAL BREADMAKING systems like straight dough and sponge and dough require a lengthy fermentation process to develop the dough. No-time, Chorleywood, and continuous mix systems use chemical and mechanical processes to develop the dough more quickly using fewer steps. Continuous mix systems were developed around the use of potassium bromate as an oxidizing agent and can be especially challenging for bromate replacement.

The most common continuous mix systems in North America use Do-Maker or Amflow equipment. In these systems a liquid preferment is combined with the other ingredients in a premix step, then pumped into a developer. The developer kneads the premix at high speed under pressure into a fully developed dough in about one minute. The dough leaves the developer in a flowable, pressurized form, passes through an integrated divider/panner that replaces normal makeup, then is proofed and baked. The resulting finished product has a finer, more-uniform texture than with conventional systems.

Key parts of the continuous mix process are the preferment that activates the yeast, the high-speed mixing that develops the dough, and the oxidants that affect gas retention. The ideal oxidants for continuous mix are a combination of fast-acting and slow-acting. The fast-acting oxidant brings about a rapid oxidation of gluten proteins during and directly after mixing and gives the dough its initial gas retention. The slow-acting oxidant strengthens the gluten during final proof to give the dough its optimal gas retention when it enters the oven.

The fast-acting oxidants used in continuous mix are azodicarbonamide (ADA), potassium iodate, and calcium iodate. ADA and the iodates are often used in combination to avoid exceeding the legal limit for any of these oxidants, either alone or in combination. Calcium peroxide is another fast-acting oxidant but is not commonly used in continuous mix for oxidation.

The slow-acting oxidants formerly used are potassium bromate and calcium bromate. Ascorbic acid is an intermediate-acting oxidant used to replace bromate in other systems, but it cannot be used in continuous mix because it requires oxygen, which isn't present in the closed developer where mixing takes place.

Without bromate or ascorbic acid, the baker has to rely on fast-acting oxidants only. This reduces the tolerance of the continuous mix process to variations in oxidation requirements and mixing and makes it harder to maintain quality and uniformity.

Oxidation requirements in continuous

Continued

NO-TIME DOUGH PROCESSES

	NO-TIME	CONTINUOUS MIX	CHORLEYWOOD
Preferment	No	Yes	No
Mixing	Conventional Batch	High-speed Continuous (Amflow/Do-maker)	High-speed Batch (Tweedy)
Dough Development	Chemical (L-cysteine)	Mechanical	Mechanical
Oxidants	Ascorbic acid ADA (Bromate)	Iodate ADA (Bromate)	Ascorbic acid ADA (Bromate)
Make-up	Conventional	Divider/panner	Conventional

OXIDANT CHARACTERISTICS

OXIDANT/ REDUCTANT	MAXIMUM LEVEL	REACTION RATE	REMARKS
Potassium bromate Calcium bromate	75 ppm *	Slow	Subject to regulatory prohibitions
Potassium iodate Calcium iodate	75 ppm *	Very fast	Used in continuous mix
Calcium peroxide	75 ppm *	Fast	Dry dough effect
Azodicarbonamide (ADA)	45 ppm	Fast	All types of bread
Ascorbic acid	GMP (no limit)	Intermediate	Requires oxygen (dehydroascorbic acid)

** If more than one of these is used, total amount may not exceed 75 ppm.*

Oxidizing Agents *(Continued)*

rate of solubilization, which is slower for calcium iodate.

Calcium peroxide (CaO_2) also has a fast reaction rate but produces a softer, drier dough. Its action is initiated on contact with moisture, so it is usually used at the dough stage of a conventional breadmaking process.

Azodicarbonamide ($(NH_2.CO.N:)_2$) has a fast reaction rate but is slower than iodate; when it oxidizes gluten protein, it is converted into biurea.

L-Ascorbic acid ($C_6H_5O_6$) itself is a reducing agent, and in the absence of oxygen it breaks disulfide bonds in gluten protein and so reduces mix time and increases dough extensibility. In the presence of oxygen, L-ascorbic acid is converted into dehydro-L-ascorbic acid ($C_6H_6O_6$), which functions as an intermediate-speed oxidizing agent. Ascorbic acid does not function as an oxidizing agent in most continuous mix applications because there is insufficient oxygen in the Amflo and Do-maker dough developers for the reaction to dehydro-L-ascorbic acid to occur.

Eagle® CM-100

EAGLE® CM-100 is a bromate replacer for continuous mix applications that uses a combination of oxidizing agents and enzymes to optimize tolerance and consistency.

Continuous mix systems function best with the combined action of a fast oxidant to give the dough its initial gas retention and a slow oxidant to provide strength and tolerance for proofing and baking. Bromate has been the slow oxidant of choice, and ascorbic acid has become the most widely used replacement for bromate in other systems. Ascorbic acid is not effective in continuous mix, so most bromate replacers that contain only fast-acting oxidants reduce tolerance and consistency when they're used in continuous mix systems.

Eagle® CM-100 uses a combination of calcium iodate and ADA as the most desirable fast-acting oxidants. Calcium iodate dissolves and reacts more slowly than potassium iodate, and ADA reacts over a longer period of time. The combination allows for maximum dosing flexibility without exceeding the legal limit for any of those oxidants. Oxidant levels in continuous mix can be optimized by varying the dosage of Eagle® CM-100 up to 3 ounces/cwt without exceeding legal limits. Alternatively, oxidant levels can be optimized by adding extra ADA in combination with Eagle® CM-100 at a standard recommended dosage of 1 ounce/cwt.

Eagle® CM-100 contains a unique system of fungal enzymes from *Aspergillus oryzae* and *Aspergillus niger*. These natural ingredients enhance the effects of the oxidizing agents and compensate for their shortcomings. This allows an optimum level of fast-acting oxidants to be used to provide dough stability without making adjustments in mixing time or mixing speed. Overoxidation is avoided, so the process is more tolerant towards variations.

In addition to Eagle® CM-100, Lallemand/American Yeast also offers the Essential® and Fermaid® line of bromate replacers and dough conditioners for conventional systems. Formulations are available for sponge and dough, flour brew, straight dough, and frozen dough, and all are backed by technical support from experienced bakery technologists.

Bromate Replacement in Continuous Mix Systems

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mix are critical and depend on the wheat variety, milling conditions, and age of the flour. In general, high-extraction younger flours require more oxidation. Other ingredients, especially dairy products, also have an effect. Without slow-acting oxidants, the dough at the final proof is weaker and has a tendency to collapse, which results in a lower volume and a coarser crumb.

Increasing the level of fast-acting oxidants will improve dough stability, but at the same time may contribute to undesirable streaks and swirls in the crumb. These swirls will disappear by increasing energy input during mixing. Both higher mixing speeds and longer mix times will increase energy input. Mixing speed usually cannot be increased much, so mixing time has to be extended by slowing down the divider/panner, resulting in smaller throughput of the continuous mix line. Another way of reducing the mixing energy requirement is by switching from a water to a flour brew and increasing the brew time and temperature.

Overoxidation causes the dough to become bucky at the end of the final proof, which gives a coarser crumb structure and may cause capping problems at the depanner. Overoxidation can be corrected up to a point by increasing mixing energy input, but overmixing at high oxidant levels has to be avoided since it will damage the dough's gluten protein and will lower bread quality.

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Lallemand Baking Update is produced by Lallemand Inc. to provide bakers with a source of practical technology for solving problems. If you would like to be on our mailing list to receive future copies, or if you have questions or comments, please contact us at:

LALLEMAND Inc.
1620 Préfontaine
Montréal, QC H1W 2N8 CANADA
tel: (800) 840-4047 (514) 522-2133
fax: (514) 255-6861