



How to *rise up* to leavening challenges

An essential component of the baking process, leavening is responsible for the rise or lift in many baked goods and influences the taste and mouthfeel of products such as cakes, muffins, cookies and more. To ensure this activity functions properly, many bakers turn to chemical leavening systems.

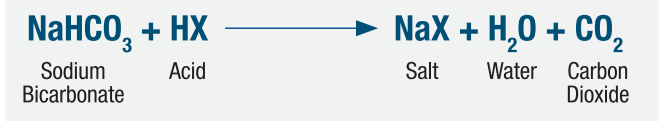
Chemical leavening systems based on a Bicarbonate and a leavening acid offer the advantage of predictable performance and precise delivery of leavening gas when it is needed during the baking process.

Similar systems are used in the formulation of effervescent powders and tablets that come to life when added to water.

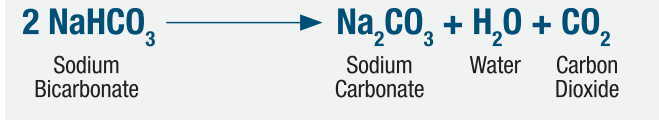
But some care must be taken to avoid triggering a pre-reaction that leads to an early release of carbon dioxide. If the leavening power or ability to generate carbon dioxide gas is lost during processing or storage, it won't be available when needed during the mixing and baking process, leaving products flat and vulnerable to possible taste and color issues.

Just to review the chemistry quickly, Bicarbonates release the leavening or effervescing gas carbon dioxide in two ways.

Reaction with Acid:



Reaction with heat:



Both reactions occur more readily when there is water present to start with.

So, based on how carbon dioxide is released from the Bicarbonates, the three biggest enemies of leavening system stability are elevated temperature, excessive moisture and acids in intimate contact with Bicarbonates. Luckily, there are strategies to minimize the risk of pre-reaction.

STRATEGIES FOR MITIGATING PRE-REACTION

There are many variables to monitor to ensure the leavening process functions correctly. While moisture control is imperative, acidic ingredients can also present challenges to formulators. By managing these risks, bakers create a safeguard for products and maintain quality.

WATER, WATER EVERYWHERE

To avoid a pre-reaction before the dough or batter is placed in the oven, bakers keep dry ingredients separate from liquids as long as possible. Water is an aggressive solvent. The water that is present in a formulation will begin to dissolve the Bicarbonate and

the acid that are present and bring them into close contact, resulting in the loss of carbon dioxide. This can happen in the package or on the mixing bench.

In a packaged mix, it is important to use ingredients that are as close to anhydrous as possible. Some moisture may be unavoidable, but for products with high acid content or long distribution chains in warm climates, additional safeguards may be required to assure stability.

ACIDIC INGREDIENTS

It would be nice if Bicarbonates only reacted with leavening acids when they were supposed to, but they don't discriminate. Any material with a low enough pH will do. Keep this in mind when working with these materials. Also consider the stability of fats that may be in the formula and levels of free fatty acids. Products with cornmeal can be challenging in this regard and limit shelf stability.

Product:	pH
Apples	2.9 - 3.3
Blueberries	3.2 - 3.4
Cocoa	5.3 - 6.0
Whole Eggs	6.4 - 8.2
Flour, White Bleached	5.7 - 5.9
Lemon Juice	2.2 - 2.4
Milk Powder	6.5 - 6.8
Malt Syrup	4.7 - 5.0
Orange Juice	3.4 - 4.0
Pumpkin	4.8 - 5.2
Sugar	6.5 - 7.0
Vinegar	2.4 - 3.4



ARM & HAMMER™: Partnering with Bakers Since 1846

For more than 174 years, we've teamed up with bakers to create tailor-made leavening ingredients that can be used in a wide range of applications. Get acquainted with ARM & HAMMER's™ lineup of Bicarbonates and learn why bakers consistently turn to our products to get the job done.

BIGGER IS BETTER

Sodium Bicarbonate comes in different particle size distributions. For example, an ARM & HAMMER™ Sodium Bicarbonate Grade 1 typically has a mean particle size of about 70 microns. Grade 2 has a mean particle size of 90 microns. This may seem like a small difference, but a Grade 2 crystal has much less surface area, and exposed surface area is where the leavening reaction takes place. Less surface area equals better stability. ARM & HAMMER™ also offers Sodium Bicarbonate grade 4 which has the same 90-micron

particle size, but a more narrowly defined size cut so there are fewer fine particles present.

SEPARATION AND ENCAPSULATION

Maintaining distance between the reactive leavening components helps to avoid pre-reaction. A classic example of this is the typical baking powder. These formulations have significant amounts of a diluent such as corn starch or calcium carbonate that make the baking powder easier to measure, but it also keeps the leavening acid and Bicarbonate relatively far away from each other.

Sodium Bicarbonate is generally available in a “treated” version that blends a flow aid with the Bicarbonate. The presence of the flow aid can provide some level of separation between the Sodium Bicarbonate particle and other formulation components.

For really challenging environments like frozen dough or certain refrigerated doughs, encapsulation of the acids and / or the Bicarbonates is the solution. The particles are covered with a layer of fat that protects them through processing and storage and

preserves their activity until the fat melts away in the oven.

WATER SCAVENGERS

There are many food grade additives available that act to absorb moisture. Often silicates are found in this role. In the development of effervescent products, it is not uncommon to use a heat-treated Sodium Bicarbonate. The treatment generates a layer of Sodium Carbonate around the Sodium Bicarbonate crystal and imparts stability, because it is resistant to moisture attack.

Troubleshooting Leavening Issues

Prior to going to market, conduct a solid, representative shelf life study that includes the finalized formula, packed in the package to be marketed. Make sure to perform the study under conditions the product is expected to encounter over the course of its life. It’s much better to find out that there is a problem during the study versus having a field incident.

If you find that you do have a problem,

- : go back to the ingredients and the processing. Look for lot-to-lot differences that may correlate with where the problem is being observed and where it is not. This may include differences between manufacturing facilities, transportation patterns, geographical distribution, etc. What you are looking for is opportunities where moisture, acids or elevated temperature have had a chance to attack the leavening system.





Ready to Rise Up?

ARM & HAMMER™ offers a broad range of Bicarbonates that enable formulators to achieve their goals. Technical experts are available to help bakers select leavening solutions and discuss specific formulating issues they may be encountering. Visit www.ahperformance.com to learn how ARM & HAMMER™ can take your products to the next level.

ARM & HAMMER™ PERFORMANCE PRODUCTS

- **SODIUM BICARBONATE GRADE 1 POWDERED** is the industry standard for scratch baking. It dissolves rapidly to assure quick, complete availability for reaction with the acid ingredients.
- **SODIUM BICARBONATE GRADE 1 TFF** is treated with tricalcium phosphate to improve flow quality. Like regular grade, it dissolves rapidly to assure quick, complete availability for reaction with the acid ingredients. The flow aid may provide some protection against pre-reaction of the leavening package in mixes.
- **SODIUM BICARBONATE GRADE 2 FINE GRANULAR** is for stability-challenged applications. This includes baking powders and dry mixes with higher levels of acidic components, such as corn bread and muffins.
- **SODIUM BICARBONATE GRADE 4 GRANULAR** is like Grade 2 but with a narrower particle size range that makes it especially useful in refrigerated doughs. This limits pre-reaction with acid ingredients.
- **FLOW K™ POTASSIUM BICARBONATE** is a replacement for Sodium Bicarbonate in most chemically leavened products. Never bitter, it may enhance perception of sweetness in finished goods.
- **AMMONIUM BICARBONATE** reacts rapidly in the presence of moisture and/or heat. It does produce a telltale Ammonia smell, so use is limited to baked goods with less than 5% finished product moisture content. Any higher and the Ammonia will not have time to evaporate. Because it leaves behind no residue, as all components are released as gases, it may be considered a processing aid. Labelling requirements should be discussed with your regulatory group.
- **TORTILLA BLEND™** is a unique Sodium Bicarbonate product formulated to produce leavening reactions at specific stages in the production of wheat flour tortillas. Used in combination with conventional leavening acids, Tortilla Blend helps optimize leavening performance.





The Bicarbonate Experts

ARM & HAMMER™ Performance Products is the leader in providing high-quality Bicarbonate products optimized to meet customer expectations.

For more than 174 years, the ARM & HAMMER™ logo has communicated our dedication to customer satisfaction — and it remains the symbol by which our quality makes itself known.



The Performance Products Group is guided by the principles of Responsible Care®, an Industry Initiative on environmental sustainability and health, safety and security issues. The Guiding Principles detail the group's commitment to protecting the environment, ensuring the safety and safe use of products, and continually improving products and processes to minimize their impact on our communities.

For more information about ARM & HAMMER™ Performance Products, visit www.ahperformance.com.

